ALL-HAZARD EMERGENCY PREPAREDNESS: AN ASSESSMENT OF THE HAZARD VULNERABILITY AND RESPONSE CAPACITY OF SECONDARY AND TERTIARY HOSPITALS IN RIYADH REGION, SAUDI ARABIA

Roaa Mohammed Hajjam, BSN, MPH

Epidemiology and Public Health, School of Medicine

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Supervised by:

Associate Professor Tessa Langley
Professor Sarah Lewis
Honorary Associate Professor Revati Phalkey

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DEDICATION

I dedicate this doctorate to ALLAH then to my family. It would not be possible to make my dream a reality without them standing beside me.

ABSTRACT

Introduction: Disasters pose a high risk of fatalities in many countries, and Saudi Arabia is not an exception. Extreme weather, mass gatherings, terrorism and fire can increase the intensity of disasters. When natural or man-made disasters happen, hospitals often bear the burden due to the need to admit many patients (victims of disaster events). The aim of the thesis is to assess the level of preparedness of secondary and tertiary hospitals in the Riyadh region for all types of hazards (all-hazard preparedness). Specifically, this study conducted an analysis of the vulnerability of hospitals to all types of hazards (all-hazard vulnerability). Functional emergency preparedness (preparedness for hazards that could prevent the hospital from performing its primary function), non-structural emergency preparedness (elements of hazard preparedness which require no physical infrastructure) emergency preparedness and capacity to respond to hazards for secondary and tertiary hospitals in Riyadh, Saudi Arabia were also assessed. Information on views of emergency managers were collected to understand challenges associated with the adoption and implementation of all-hazard approach to emergency preparedness in the region.

Methods: A systematic review of available literature which assessed the core elements of the all-hazards approach to emergency preparedness was first conducted. Furthermore, both quantitative and qualitative methods were used assess the vulnerability of selected health care facilities. Firstly, a modified Kaiser Permanente Hazard Vulnerability Assessment (KP-HVA) tool was used to assess hazard vulnerability (measuring probable and

actual hazards and the level of preparedness for these hazards) of selected hospitals. Secondly, the All-hazard Preparedness Assessment Questionnaire (APAQ) was designed and administered to Emergency Services Directors to assess preparedness for functional and non-structural components of the all-hazard approach to emergency preparedness in hospitals selected for the study. Finally, semi-structured interviews were conducted with Emergency Services Directors (with at least 5 years working experience) in hospitals to gain insights into their views on the implementation of the all-hazard emergency preparedness approach and associated challenges. All 58 hospitals in the region which met the eligibility criteria were invited to participate in this study. Data were collected from 42 hospitals which accepted the invitation. APAQ was validated and pilot tested prior to its usage for data collection in this thesis. The level of prepared of selected hospitals based on location (inner city or outer city), level of care provided (secondary or tertiary) and type of funding (private or public) were also compared.

Results: The systematic review identified 22 articles which reported the adoption of the all-hazard approach to emergency preparedness. The review revealed all-hazard approach has been adopted to some extent in assessing hazard vulnerabilities of healthcare facilities across many countries. However, this has been associated with several limitations and challenges. The majority of identified studies were conducted in Asia. Following the assessment of hazard vulnerability of selected hospitals using the KP-HVA tool, this study revealed that all the hospitals selected in the Riyadh region have a high probability of hazard occurrence while the level of preparedness of these hospitals, at best, can be described as moderate.

The assessment also revealed that the Riyadh region is prone to a wide range of hazards, with internal fire being the most common probable hazard among the secondary and tertiary hospitals. The analysis further revealed that some of the identified probable hazards have high likelihood of translating to actual hazards in many of the hospitals included in the study. Mass casualty was ranked as the first observed hazard in most of the hospitals selected, while IT outage was the most common hazard within hospital settings across the region. Following the evaluation of the functional and non-structural vulnerability components of the all-hazard approach, this study revealed that the level of capacity of hospitals across the Riyadh region to respond to hazards affecting functional components (functional emergency response capacity) can be said to be moderate while the level of the capacity of these hospitals to respond to hazards affecting non-structural components (non-structural response capacity) was assessed as being satisfactory. The overall emergency response capacity of hospitals in the region was assessed as moderate. The analysis further revealed that hospitals across the Riyadh region have a satisfactory level of preparedness for functional elements, such as emergency planning group/ committee, evacuation, fatality management, warning systems, and safety accessibility, and site accessibility. A moderate level of preparedness was observed for the functional elements, such as response protocol, human resources, disease surveillance, training and drills, and area in the health facility for all the selected hospitals in the region. An unsatisfactory level of preparedness was observed for subcommittees, health facility networking, patients' decontamination, hazard and vulnerability assessment, community involvement, public information, and transportation and communication in the selected hospital settings. This study found no significant difference between the general levels of preparedness for functional and non-structural hazards between private and public, inner city and outer city, and secondary and tertiary hospitals. However, hospital location, level of care provided, and type of funding significantly affected the level of preparedness for some individual elements of functional and non-structural components of all-hazard approach.

The qualitative study conducted revealed that methods commonly used in evaluating emergency plans across the region include regular drills, regular review of emergency plans, and the use of audit resources .Key challenges associated with effective emergency response capacity of hospitals in Riyadh region identified by Emergency Services Directors include inadequate human resources (such as doctors, nurses, and technicians) and lack of experience and knowledge among emergency response stakeholders. Concerning the strategies that can facilitate effective disaster response, most managers proposed the creation of platforms that can recruit and train volunteers who would be useful during disaster response.

Conclusion: The majority of hospitals in the Riyadh region, KSA have a moderate to high risk of hazards. Most of the hospitals have not implemented the all-hazards approach to emergency preparedness and response. This indicates that most of the hospitals in this region are not well prepared for disasters. Based on several gaps identified in this thesis, it is recommended that hospitals in the Riyadh region conduct HVA regularly to ensure they gain experience of its implementation and familiarize themselves with HVA tools.

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Conference presentations and posters

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Manuscript under preparation

1. All-hazards vulnerability analysis for emergency preparedness: a study of healthcare facilities in Riyadh Region, Saudi Arabia.

DECLARATION

I, Roaa Hajjam, hereby declare that this thesis is my own work, and neither the whole nor any part of this thesis has been submitted for a degree in any other university or institutions. Where information has been obtained from other sources, it has been indicated in this thesis.

Roaa Hajjam

Signature

TABLE OF CONTENTS

acknowledgements ..... **ii**
Abstract ..... **v**
Conference Presentation And Posters ..... **ix**
Declaration ..... **x**
Table of Contents ..... **xi**
List of Tables ..... **xvi**
List of Figures ..... **xviii**
List Abbreviations ..... **xx**
Operational Definitions ..... **xxii**
CHAPTER ONE **1**
BACKGROUND OF THE STUDY **1**
1.1 Introduction 1
1.2 From hazards to disasters 5
1.3 Climate change as a predictor of disasters and its impacts 8
1.4 The concept of hazard vulnerability assessment 10
1.4.1 All-hazard approach to disaster preparedness 11
1.4.2 Domains of all hazard vulnerability assessment 13
1.4.3 Conducting all hazard vulnerability assessment. 14
1.4.4 Disaster management in the context of multiple hazards 15
1.4.5 Different frameworks for disaster management 16
1.5 Disaster management cycle 22
1.5.1 Pre-disaster stage 23
1.5.2 Disaster stage 25
1.5.3 post-disaster stage 26
1.6 Disaster management and sustainable development goals 27
1.7 WHO Safe Hospital Strategy 32
1.8 Empirical Studies on hospital hazard preparedness and disaster management 37
1.9 Disasters in Saudi Arabia 41
1.9.1 Saudi Arabia – country profile 41
1.9.2 Review of Past Disaster Events in Saudi Arabia 41
1.9.3 Historical perspective of disaster management in KSA 45
1.9.4 Health care system structure in KSA 47
1.9.5 Regulation of healthcare providers in KSA 49
1.10 Rationale 50
1.11 Aim and Objectives 56
1.12 Conclusion 57
CHAPTER TWO **59**
RESEARCH METHODOLOGY **59**
2.1 The philosophical approach underpinning the research methodology. **59**
2.2 Quantitative study 61

2.2.1 Positivist paradigm 61
2.3 Qualitative studies 62
2.3.1 Constructive paradigm 62
2.4 Reflexivity 64
2.4.1 Reflexivity Implementation 65
2.4.2 Trustworthiness of findings 69
2.5 General Methods 70
2.5.1 Research design 71
2.5.2 Methods for systematic review 74
2.5.3 Methods for primary studies 74
2.5.3.1 Study setting 74
2.5.3.2 Sampling techniques and sample size 75
2.5.3.3 Recruitment of healthcare facilities 77
2.5.3.4 Participants' selection for the study 78
2.5.3.5 Instrument for data collection 80
(a) Hazard vulnerability assessment tool 80
(b) Instrument for the assessment of all-hazard preparedness of selected hospitals 81
2.5.3 Ethical considerations 83
2.6 Conclusion 84
CHAPTER THREE 85
THE EVIDENCE FOR THE USE OF ALL-HAZARDS APPROACH IN PUBLIC HEALTH DISASTER PREPAREDNESS: A SYSTEMATIC REVIEW 85
3.1 Introduction 85
3.2 Background of the review 85
3.3 Review aim 89
3.4 Review Question 90
3.5 Systematic Review Methods 90
3.5.1 Article search strategy 90
3.5.2 Inclusion and exclusion criteria 93
3.5.3 Article selection strategy 95
3.5.4 Strategies for data extraction 95
3.5.5 Data synthesis and integration 96
3.6 Results 96
3.6.1 Search results 96
3.6.2 Attributes of articles selected for review. 97
3.6.3 Analysis of Functional Components of All-hazard Approach in Selected Articles 107
3.6.4 Analysis of Structural Components of All-hazard Approach in Selected Articles 109
3.6.5 Analysis of Non-structural Components of All-hazard Approach in Selected Articles 111
3.7. Discussion 121
3.8 Strengths and limitations of the review 130

3.9 Conclusion and recommendations 131
3.10 Recommendation for research 132
CHAPTER FOUR 133
HAZARD VULNERABILITY ANALYSIS FOR THE SECONDARY AND TERTIARY HEALTHCARE SETTING AT RIYADH REGION 133
4.1 Overview 133
4.2 Summary of Methods 134
4.2.1 Selection of hospitals for assessment 134
4.2.2 Instrument for data collection 135
4.2.3 Respondents and administration of KP-HVA 136
4.2.4 Data collection 138
4.2.5 HVA data analysis 139
4.3 Results 141
4.3.1 Analysis of probable hazards in hospitals selected across Riyadh region, KSA. 141
4.3.2 Analysis of first-ranked probable hazards 143
4.3.3 Analysis of first-ranked probable hazard by hospital type 146
4.3.4 Analysis of organisational risks for probable hazards 147
4.3.5 Analysis of observed hazards in hospitals selected across Riyadh region, KSA. 152
4.3.6 Comparative analysis of probable and observed hazards. 153
4.3.7 Analysis of top ten actual disasters 154
4.4 Discussion 156
4.4.1 Summary of the main findings 156
4.4.2 Discussion of findings 157
4.5 Strengths and limitations 161
4.6 Recommendations 162
4.7 Conclusion 163
CHAPTER FIVE 164
ASSESSMENT OF ALL-HAZARD EMERGENCY PREPAREDNESS AND RESPONSE CAPACITY IN THE HEALTH CARE IN RIYADH REGION 164
5.1 Overview 164
5.2 Summary of Methods 168
5.2.1 Selection of hospitals and participants 168
5.2.2 Instrument for data collection 169
5.2.3 Pilot testing of APAQ 170
5.2.4 Administration of APAQ 171
5.2.5 Analysis of APAQ data 172
5.3 Results 174
5.3.1: Analysis of functional capacity of all selected hospitals 174
5.3.2 Analysis of non-structural capacity of all selected hospitals 178
5.3.3 Analysis of overall vulnerability across the region 180
5.3.4 Comparison of the preparedness levels of private and public hospitals 183

5.3.5 Comparison of the preparedness levels between secondary and tertiary hospitals ... 188
5.3.6 Analysis of preparedness levels of inner city and outer city hospitals ... 193
5.3.7: Analysis of the correlation between functional and non-structural capacities of selected hospitals ... 198
5.4 Discussion ... 203
5.4.1 Summary of findings ... 203
5.4.2 Discussion of findings ... 205
5.5 Strengths and limitations ... 211
5.6 Recommendations ... 213
5.7 Conclusion ... 214
CHAPTER SIX ... 216
THE LEVEL OF UNDERSTANDING OF ALL-HAZARD APPROACH BY EMERGENCY SERVICES DIRECTORS AND CHALLENGES ASSOCIATED WITH THE ADOPTION AND IMPLEMENTATION OF THE APPROACH IN SELECTED SECONDARY AND TERTIARY HEALTH FACILITIES: A QUALITATIVE STUDY ... 216
6.1 Overview ... 216
6.2 Summary of methods ... 217
6.2.1 Participants' selection and recruitment ... 217
6.2.2 Instrument for data collection ... 219
6.2.3 Interview data collection ... 219
6.2.4 Analysis of interview data ... 221
6.3 Results ... 225
6.3.1 Participant demographics ... 225
6.3.2 Emerging themes ... 226
6.3.2.1 Theme one: Methods for assessing the effectiveness of emergency response process. ... 227
6.3.2.2: Theme two: Factors and challenges associated with effective emergency response capability of hospitals. ... 237
6.3.2.3 Theme three: Strategies for effective disaster response activities ... 242
6.4 Discussion ... 246
6.4.1 Summary of findings ... 246
6.4.3 Discussion of findings ... 249
6.4.4 Strengths and limitations ... 252
6.6 Conclusions and recommendations ... 254
CHAPTER SEVEN ... 257
DISCUSSION AND CONCLUSION ... 257
7.1 Overview ... 257
7.2 Summary of findings ... 258
7.2.1 Findings from systematic review ... 258
7.2.2 Summary of findings from hazard vulnerability assessment of selected hospitals ... 260
7.2.3 Assessment of all hazard preparedness and response capacity of selected hospitals ... 261

7.2.4 Assessment of the level of understanding, best practices and challenges associated with disaster preparedness and response. 263
7.3 General Discussions 264
7.4 Research Strengths and Limitations 277
7.5 Changes since the Covid-19 Pandemic 282
7.6 Recommendations 284
7.7 Conclusions and remarks 288
REFERENCES.. 289
CHAPTER EIGHT: APPENDICES 303
Appendix A: Ethical approvals.. 303
Appendix 2.1 Ethical approvals from UoN 304
Appendix 2.2 Ethical approvals from Saudi Arabia for field visit and data collection.. 305
Appendix 2.3 Participants Consent Form.. 312
Participants Information Sheets 313
Appendix B Data collection tools 323
Appendix 4.1 Hazard Vulnerability Analysis Tool 2017 Ver 323
Appendix 4.2 Kaiser-HVA-Tool-and-Instruction.. 325
Questionnaire 331
Appendix 5.1 All-hazard Preparedness Assessment Questionnaire (APAQ) 331
Qualitative Interview Questions 403
Appendix 6.1 Interview guide 406
Appendix 6.2 The Qualitative Interview Charting the data into framework Matrix... 408
Appendix C Data Summary 421
Appendix 3.1 Systematic review search strategy 421
Appendix 4.3 Data tables for the observed hazards at the Healthcare facilities in Riyadh region.. 440
Appendix 5.2 Distribution of scores for individual elements of the functional domain across all selected hospitals in Riyadh Region of KSA hospitals in Riyadh Region of KSA.. 461
Appendix 5.4 Distribution of scores for individual elements of the functional and the non-structural domains across all selected hospitals in Riyadh Region of KSA hospitals in Riyadh Regio 468

LIST OF TABLES

Chapter Two

Table 2. 1 Distribution of respondents and non-respondents by type of healthcare facility (public or private) 79

Chapter Three

Table 3. 1 Details of search keywords and syntaxes for article identification 92

Table 3. 2 Number of articles retrieved from each database 97

Table 3. 3 List of included studies with summary characteristics 99

Table 3. 4 Summary of the functional capacity assessment of selected articles 108

Table 3. 5 Summary of the structural capacity assessment of selected articles 110

Table 3. 6 Summary of the non-structural capacity assessment of selected articles 113

Table 3. 7 Summary of aims findings and implications of results of articles reviewed ... 117

Chapter Four

Table 4. 1 Attributes of the KP-HVA tool 137

Table 4. 2 Summary of the frequently reported probable hazards across the Riyadh Region 142

Table 4. 3 Summary of the first ranked probable hazard in all the selected hospitals 146

Table 4. 4 Probability, Severity and Risk Scores for all hospitals selected from Riyadh Region 148

Table 4.5 Summary of the first-ranked observed hazard across included hospitals 152

Table 4. 6 Summary of the top actual disasters across the Riyadh Region 154

Chapter Five

Table 5.1 Core elements measured by APAQ 171

Table 5.2 The distribution of preparedness scores of individual elements of the functional capacity domain 176

Table 5.3 Rating of preparedness levels for elements of functional components across hospitals in Riyadh region. 178

Table 5.4 The distribution of preparedness scores of individual elements of the non-structural capacity 179
Table 5.5 Distribution of vulnerabilities of individual elements of non-structural capacity across selected hospitals in Riyadh region 180
Table 5.6 Analysis of total functional and total non-structural capacities of selected hospitals 181
Table 5.7 Distribution of overall vulnerabilities of selected hospitals in Riyadh region ... 183
Table 5.8 Distribution of preparedness scores of individual elements of the functional capacity domain in selected private and public hospitals 184
Table 5.9 Distribution of preparedness scores for individual elements of the non-structural domain obtained by private and public hospitals 187
Table 5.10 Distribution of preparedness scores of individual elements of the functional capacity domain in selected secondary and tertiary hospitals 189
Table 5.11 Distribution of preparedness scores for individual elements of the non-structural domain obtained by secondary and tertiary hospitals. 191
Table 5.12 Distribution of preparedness scores of individual elements of the functional capacity domain in selected inner city and outer city hospitals 193
Table 5.13 Distribution of preparedness scores for individual elements of the non-structural domain obtained by inner city and outer city hospitals. 197

Chapter Six

Table 6.1 Inclusion and exclusion criteria for the qualitative interview study 218
Table 6.2 Participant demographics 226
Table 6.3 Themes emerging from semi-structured interviews. 227

LIST OF FIGURES

Chapter One

Figure 1.1 Pressure and Release Model showing the progression of Vulnerability adopted from (13) 6

Figure 1.2 CRED Natural disaster classification within EM-DAT database (2013) 7

Figure 1.3 Schematic representation of the disaster management cycle 23

Figure 1.4 Health system impacts of floods/windstorms (111) 33

Figure 1.5 The structure of health system in KSA (136) 48

Chapter Two

Figure 2.1: Summary of research design 73

Figure 2.2: Map of the Kingdom of Saudi Arabia showing the proposed place of the study the provinces of Riyadh Region (174) 75

Figure 2.3: Provinces in Riyadh Region with hospitals meeting the eligibility criteria. Hospitals in the shaded regions were excluded due to the fact that they have capacity below 100 beds. 77

Figure 2.4 Distribution of hospitals selected for the study 78

Chapter Three

Figure 3.1: PRISMA flow chart for article screening 98

Chapter Four

Figure 4.1 Frequency of first-ranked probable hazards in all hospitals selected across Riyadh Region 145

Figure 4.2 Distribution of preparedness level for all first-ranked disasters in all selected hospitals 147

Figure 4.3 Distribution of probability, severity, and risk scores for all selected hospitals 149

Figure 4.4 Analysis of the relationship between probability and severity scores 150

Figure 4.5 Analysis of the relationship between probability and risk scores (A), severity and risk scores (B) 151

Figure 4.6 Distribution of the occurrence of top observed hazards in Riyadh region 155

Chapter Five

Figure 5.1 Mean score for individual elements of the functional domain for private and public hospitals 186

Figure 5.2 Comparison of the mean values for individual elements of the non-structural domains for private and public hospitals. Values are mean ± SEM 188

Figure 5. 3 Mean score for individual elements of the functional domain for secondary and tertiary hospitals 190

Figure 5. 4 Comparison of the mean values for individual elements of the non-structural domains for secondary and tertiary hospitals. Values are mean ± SEM 192

Figure 5.5 Mean score for individual elements of the functional domain for inner city and outer city hospitals. 195

Figure 5.6 The comparison of mean values obtained for individual elements of the non-structural domain for inner city and outer city hospitals. Values are mean ± SEM .. 198

Figure 5.7 Correlation between preparedness scores for functional and non-structural components of all-hazard preparedness for all selected hospitals across Riyadh region 199

Figure 5.8 Correlation between preparedness scores for functional and non-structural components of all-hazard preparedness for selected private (A) and public (B) hospitals 200

Figure 5.9 Correlation between preparedness scores for functional and non-structural components of all-hazard preparedness for selected secondary (A) and tertiary (B) hospitals 201

Figure 5.10 Correlation between preparedness scores for functional and non-structural components of all-hazard preparedness for selected inner city (A) and outer city (B) hospitals 202

LIST ABBREVIATIONS

ASHE	American Society for Healthcare Engineering
ACEP	American College of Emergency Physician
APAQ	All-hazard Preparedness Assessment Questionnaire
BA	Below average
CBAHI	Central Board for Accreditation of Healthcare Institutions
CETS	Community Emergency Transport System
COVID-19	Coronavirus disease
CRED	Centre for Research on the Epidemiology of Disasters
EMS	Emergency Medical services
EOC	Emergency Operation Centre
ESCAP	Economic and Social Commission for Asia and the Pacific
GDCD	General Directorate of Civil Defense
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
HAH	Hospital All-hazards Self-assessment
HFA	Hyogo Framework for Action
HVA	Hazard Vulnerability Analysis
HVAC	Heating, Ventilation, and Air Conditioning
IT	Information Technology
JBI	The Joanna Briggs Institute

JCAHO	Joint Commission on Accreditation of Healthcare Organizations.
KP-HVA	Kaiser Permanente Hazard and Vulnerability Assessment
KSA	Kingdom of Saudi Arabia
LRRD	Linking Relief, Rehabilitation and Development
MAA	Mutual Aid Agreements (MAA)
MCEs	Mass Casualty Events
MOH	Ministry of Health
MOI	Ministry of Interior
PAR	Pressure and Release model
RTA	Road Traffic Accidents
SA	Saudi Arabia
SOPs	Standard Operating Procedures
SRCA	Saudi Red Crescent Authority
TRM	Total Risk Management
UN	United Nation
UNDRR	United Nations Office for Disaster Risk Reduction
UoN	University of Nottingham
US	United state
WHO	World Health Organisation
MCIs	Mass Casualty Incidents

OPERATIONAL DEFINITIONS

Terms	Definition
Disaster/emergency preparedness	This was interpreted in this thesis as actions that an organisation can take to prepare for the impact of disasters and to reduce the impact of disasters. This includes actions relating to the prediction, prevention, mitigation and effectively coping with effects of disasters
Hazard vulnerability	This is interpreted as the degree to which an organisation is exposed to a hazard or the likelihood of an organisation experiencing the hazard
Hazard vulnerability assessment	This was interpreted in this study as the process of investigation leading to the identification of hazards and risks that an organisation is exposed to, and for which such an organisation must be prepared for
Response capacity	This was defined in this study as the ability of an organisation to deal with the impact of a disaster on the organisation
All-hazard preparedness	This was interpreted as the preparedness of an organisation for all types of hazards that the organisation is exposed to

All-hazard emergency response	This was defined as response to all types of emergency situations that faces an organisation
Hazard probability	This refers to the quantitative measurement of the possibility of the occurrence of a hazard within a particular organisation
Hazard severity	This refers to the totality of all types of damage (impact) that is possible if a disaster occurs as a result of a particular hazard
Risk score	This refers to the product of mean hazard probability and mean hazard severity

CHAPTER ONE

BACKGROUND OF THE STUDY

1.1 Introduction

According to the World Health Organization (1), disasters refer to occurrences resulting in significant disruption of the normal functioning of a society, leading to human, environmental and material destruction beyond what such a society can cope with. Broadly, disasters refer to natural or man-made occurrences with the potential to cause death, harm, and displacement, disruption of health and economic systems as well as substantial destruction of infrastructure within a population (2). According to Dar et al (3), any event resulting in a significant impact on human society via the impact of an external force beyond what can be managed locally can also be regarded as a disaster(3).

Globally, a significant number of disasters are recorded annually. According to data in the Emergency Event Database (EM-DAT) collated by the Centre for Research on the Epidemiology of Disaster (4), a total of 387 disasters were recorded globally in 2022. This represents a slight increase over the annual average of 370 disasters per year recorded between 2002 and 2021 (4). The analysis of these disasters by their types indicated that there were 22 drought incidents, 31 earthquakes, 12 extreme temperatures, 176 floods, 17 landslides, 108 storms, 5 volcanic activities, and 15 wildfires in 2022 alone (4). Compared to annual averages recorded globally between 2002 and 2021, these figures represent 25% increase in the number droughts, 14.8% increase in the number of earthquakes, 36.8% decrease in the number extreme temperature events, 4.8% increase in the number of floods, 5.5% decrease in the number of landslide events, 3.8% increase in the number of storms, 16.7% decrease in the number of volcanic events, and 36.4% increase in the number of wildfires (4).

Significant mortality as well as economic loss have been reportedly associated with these disaster events(5-7). In fact, EM-DAT (4) reported that about 30,704 deaths were associated with disaster events in 2022 alone. This number was observed to be three times higher than the mortality reported in 2021 but about half of the annual average (60,995 deaths) recorded between 2002 and 2021 (4). Average annual economic costs associated with disasters between 2002 and 2021 were estimated as $187.7 billion per annum and the associated cost for 2022 alone was estimated as $223.8 billion. Available data also indicated that Asia experienced the highest number of disaster events (137) in 2022, resulting in the death of about 7,500 people and economic costs of $48.7 billion.

This increasing incidence of disaster, together with the associated human and economic costs, has motivated interests in addressing causes of disasters and the establishment of measures to prevent future occurrence of disasters. The most commonly adopted means of preventing disasters is by building the capacity of cities and organisations to recognise hazards while also increasing the level of disaster preparedness and effective response (8-10). According to the United Nations International Strategy for Disaster Reduction (UNISDR), the concept of hazard and vulnerability is central to the understanding of what disasters are. It has also been reported that disasters result from the impact of hazards on vulnerable people (11). While hazard can simply be described as a potential source of danger, a population is described as “vulnerable” when it lacks the capability to predict, prevent, cope with or recover from the impact of disasters (12). Therefore, the general perception is that disaster results from combined effects of hazards, vulnerability and the inability of a population to reduce adverse effects of disaster risks (13, 14). Usually, factors such as poverty, isolation and insecurity have been implicated as contributors to the vulnerability of a population or group (15, 16). Moreover, studies indicate that population growth, technological advancement as well as attendant effects of economic growth are drivers of disasters (17, 18).

In the event of a disaster, inputs from many organisations to provide immediate help to victims and to restore the community to its pre-disaster state are often required. Hospitals particularly play key roles during disaster response as medical care and treatments for injured people are critical components of an effective disaster response. However, healthcare organisations themselves are not immune to disaster events. It is against this background that increasing attention have been placed on ensuring that healthcare organisations are better prepared and are capable of effective response to disasters. However, an increasing body of evidence point to a myriad of challenges facing the building of structures to facilitate effective disaster preparedness and response within healthcare organisations globally(19-21). One of such challenges relates to the lack of efficiency in hazard vulnerability assessment of healthcare facilities. Julia and Ferreira (22) particularly identified that hazard vulnerability assessment of healthcare facilities is often conducted using a mono-hazard approach which makes these facilities ill prepared to respond effectively to multiple hazards (22). Moreover, a comprehensive conceptualisation and aggregation of data on the exact nature of challenges facing approached for the assessment of hazard vulnerabilities of hospitals is generally lacking. This thesis partly hopes to address these problems by adopting an all-hazard approach to hazard vulnerability assessment. Specifically, all-hazard approach refers to an emergency preparedness approach which enables an organisation to prepare for all types of hazards, irrespective of their causes. In the first instance, it is important to understand how this approach has been used within the context of healthcare institutions. It is also important to identify tools that have been previously used while investigating how this approach could be adopted to assess the level of hazard vulnerability of selected healthcare institutions in Riyadh region of Saudi Arabia (the target location for this study).

This focus of this opening chapter is the delineation of the meaning and scope hazard vulnerability assessment, the discussion of the role of climate change in disaster occurrence, the explanation of the concept of all-hazard approach to hazard vulnerability assessment as well as the discussion of various theories, statutory and concepts relating to disaster management. Moreover, stages involved in disaster response as well as the relationship between effective disaster response and sustainable development will be discussed. As would be expected in this chapter, a review of the history of disasters, previous and current disaster management efforts, and the structure of the healthcare system in the Kingdom of Saudi Arabia (KSA) were discussed. This chapter also highlights the justification for this study and provides clear statements of the aim and objectives of this study.

1.2 From hazards to disasters

According to the United Nations International Strategy for Disaster Reduction (UNISDR), hazard and vulnerability are concepts that are central to the understanding of what disasters are. It has been reported that disasters result from the impact of the hazard on vulnerable people (11). While hazards can simply be described as potential sources of danger, a population is described as “vulnerable” when it lacks the capability to predict, prevent, cope with or recover from the impact of disasters (12). Therefore, the general perception is that disaster results from combined effects of hazards, vulnerability and the inability of a population to reduce adverse effects of disaster risks (13, 14). Usually, factors such as poverty, isolation and insecurity have been implicated as contributors to the vulnerability of a population or group (15, 16). Moreover, studies indicate that population growth, technological advancement as well as attendant effects of economic growth are drivers of disaster (17, 18).

The Pressure and Release (PAR) model is a theoretical model which explains the relationship between natural hazards and processes leading to population vulnerability (Figure 1.1) (13). The PAR model recognizes that disaster occurs when forces of natural hazards and vulnerabilities intersect each other (13, 23). The focus of the model is that processes which generate vulnerabilities can lead to pressure on one hand while the actual exposure to hazard can also mount pressure on the system from another angle. Therefore, to reduce this pressure, factors leading to vulnerabilities need to be addressed (23). Figure 1.1 indicates that processes leading to vulnerabilities can be appreciated by first understanding root causes of vulnerabilities, the intrinsic dynamic pressure and the unsafe conditions that could arise from the full progression of those vulnerabilities(13, 23). The conclusion of the PAR is that if unsafe conditions arising from vulnerabilities are not addressed, disasters due to natural hazards will be unpreventable(13).

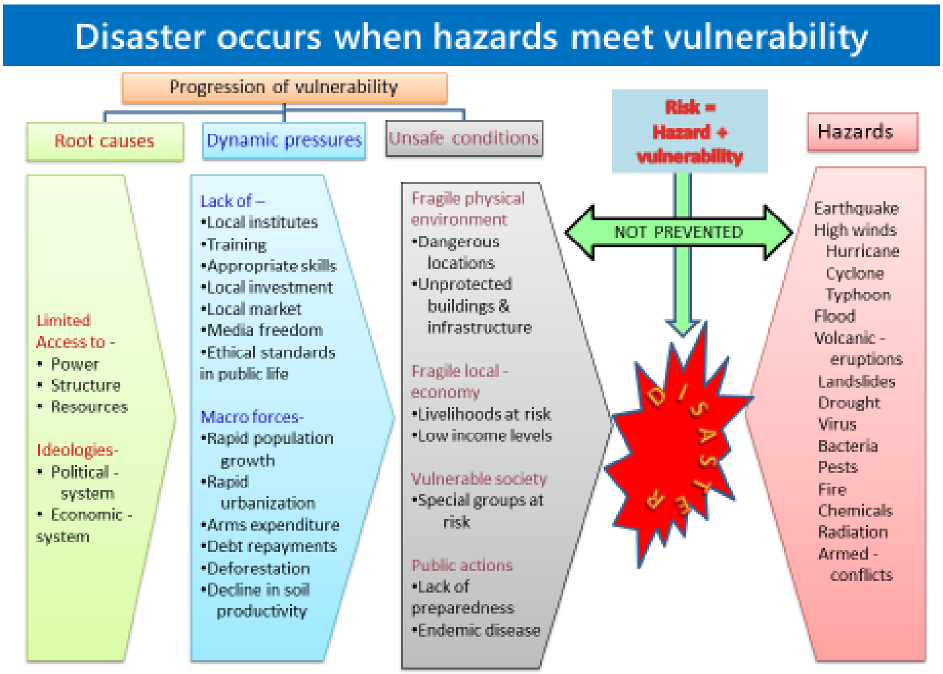

Figure 1. 1 Pressure and Release Model showing the progression of Vulnerability adopted from (13)

The Centre for Research on the Epidemiology of Disasters (CRED) generally classifies disasters as either natural or technological disasters (24). Natural disasters are described as rapid or slow geophysical, hydrological, climatological, or biological events resulting in significant damage. As shown in Figure 1.2, examples of natural disasters include hydrological events such as floods, avalanches, earthquakes, tsunamis, volcanic eruptions, and landslides. These are generally categorised as geophysical events(25). Other common examples of natural disasters according to CRED (24, 26) include climatological occurrences such as drought, wildfires and extreme temperatures, meteorological events such as storms and cyclones, and biological events including disease epidemics and plagues.

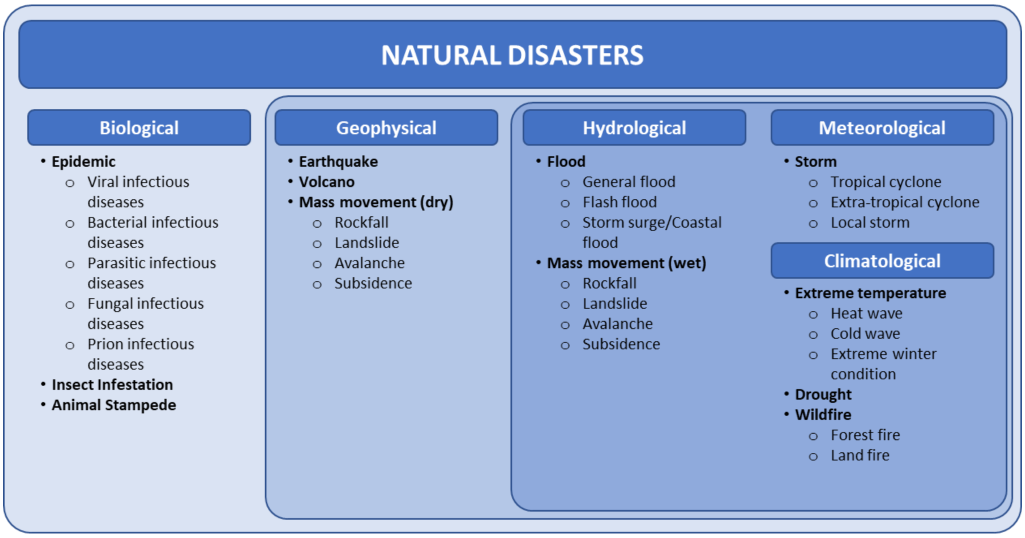

Figure 1. 2 CRED Natural disaster classification within EM-DAT database (2013)

On the other hand, technological disasters refer to man-made events resulting from human activities (and often occurring close to where human beings live) leading to environmental degradation, air and water pollution and accidents(27, 28). Typical examples of technological disasters include communal clashes, conflicts or wars, industrial and road accidents and other events leading to human displacement(29). Diverse factors contribute to the development of both natural and technological disasters. These include poverty, pandemic threats, poorly planned urbanisation, excessive utilisation or exploitation of natural resources and climate change (16, 30). According to Weichselgartner (30), these factors (often referred to as aggravating factors) can significantly increase the rate of occurrence, complexity and impact of disasters. .

1.3 Climate change as a predictor of disasters and its impacts

The change in climatic conditions, arising from increased emission of greenhouses gases due to human activities, has been recognised as a contributor to the occurrence of disasters globally (31). The impact of this natural phenomenon is multifaceted. It contributes significantly to the occurrence of natural disasters such as floods and drought (32). Attendant local and global consequences of climate change include hazards affecting human beings and infrastructures. According to Masika (33), change in climatic conditions can significantly weaken the resilience of a community to disasters and facilitate the exposure to new forms of hazards. People displaced by climate change may become prone to emergencies resulting from moving from one community to another. In addition, climate change may also aggravate the impact of unrelated disasters. For example, it was reported that an urban earthquake claimed the lives of about 35,000 elderly people who were already suffering from heatwaves across Europe in 2003 (31). Moreover, Scawthorn (34) opined that the impact of an earthquake during drought might be escalated due to low water pressure or lack of enough water to combat fires resulting from the earthquake.

Prior to the outbreak of Covid-19, the World Health Organization, indicated that about 2.6 billion people have been affected by disasters in the last ten years (35). Most of these disasters occurred at a mass casualty scale and affected a high number of victims that local medical supplies and response capacities cannot cater for. According to the United Nations' Economic and

Social Commission for Asia and the Pacific (ESCAP), about 47% of total global disasters in 2015 were reported in the Asia-Pacific region (36). This translated to 160 out of the 344 disasters reported globally for that year (36). Available data also indicate that many of these disasters were large scale disasters which caused about 16,000 fatalities (CRED, 2015). In addition, 64% of global disaster fatalities occurred in Asia in 2015 (36). More recent data on the rate of disasters globally have been presented earlier in this chapter.

The direct costs associated with disasters within the Asia-Pacific region in 2015 were estimated at US$ 45.1 billion, excluding the indirect costs of disasters which may be significantly higher (36). It has also been suggested that the actual cost of disasters in this region may be significantly higher than what is reported due to lack of proper systematic assessment of disasters, especially slow-onset disasters such as drought and forest fires (37). Recent data from CRED indicate that there were 281 disasters resulting from extreme weather. These affected about 61.7 million people and resulted in 10,373 deaths in 2018 (38) . In particular, the report indicated that about 32 million people across Asia were affected by weather-related disaster in 2018 (39).

The impact of disasters can be direct and indirect. According to Alraga (40), disasters can directly cause death, injury and disability in people. Direct negative health impact of disasters on people and their communities could also have a physical and/or mental health dimension (40 - 42). Indirect effects of disasters largely refer to impacts on infrastructure, health system, social system and service delivery within the society (43-45). An example of such indirect effects includes how the collapse or destruction of hospital buildings due to fire incident or other related events could lead to disruption in healthcare services delivery from such buildings. Several studies have also indicated that the economic impact of disasters as well as the potential impact in eroding social development cannot be overemphasized (41). While efforts could be made to minimize factors that lead to natural and man-made disasters, it is known that the absolute prevention of disasters (particularly natural disasters) is often difficult. This, therefore, means that the preparedness for consequences of disasters (particularly health impacts) represents a key strategy in disaster management (2, 46, 47). Unfortunately, studies have reported challenges in this regard in many parts of the world (48, 49).

1.4 The concept of hazard vulnerability assessment

The impact of disasters varies from one population to another (50). Therefore, assessing the hazard vulnerability of a group has been recognised as a strategy for preventing and preparing such a group impact of disasters. Hazard Vulnerability Assessment (HVA) has become a subject of many studies which seek to develop effective assessment methods (51, 52). Generally, hazard vulnerability assessment refers to a systematic identification and analysis of all possible hazards that a group or population is exposed to (52). It also involves the assessment of risks associated with identified hazards with emphasis on the assessment of the probability that the hazard will occur and the attendant effect of the hazard on the population (53). Findings of HVA are therefore studied with a view to comparing vulnerabilities to the different hazards and the service demand that the occurrence of the hazard will create (54).

Usually, hazard vulnerability assessment is carried out at the community or hospital level (52). This is usually conducted using special tools such as the Kaiser Permanente Hazard Vulnerability (KP-HVA) tool. The choice of the hospital setting for HVA is predicated on the fact that the hospital occupies a critical position with respect to disaster preparedness or response (55). This is because victims or casualties arising from a disaster are usually treated within the hospital setting.

In addition, ongoing care for disaster victims or any disease outbreak following a disaster is managed by the hospital. The hospital itself could experience internal and external disasters which it must be adequately prepared for as an organisation. It is therefore important to assess, not just the vulnerability of the hospital setting but also, its capacity to respond to disasters as well as the disaster mitigation plan operational at the hospital level (52).

1.4.1 All-hazard approach to disaster preparedness

In response to challenges around emergency preparedness in many countries, the WHO commissioned a study to assess emergency preparedness and response in selected countries across the globe (56). The observational study was conducted in countries with previous experience of natural disasters (56). Among other findings, the study revealed that even though the majority of selected countries have experienced disasters such as floods and earthquakes, there is a significant lack of recognition of other forms of hazards, such as technological hazards, which pose as much danger as natural disasters. This led to the recommendation by WHO for countries to adopt an “all-hazard” approach to emergency preparedness and response. According to the World Health Organization (57), the “all-hazard” approach is based on the recognition that the impact of various disasters types (particularly on health) may be similar even when these disasters arise from different sources. . Therefore, there is a need for risk reduction and emergency preparedness/response plans to be prepared in a way that they are effective for all types of hazards, irrespective of the cause (58).

Usually, emergency preparedness involves a range of activities including planning, the development of appropriate infrastructure, acquisition of requisite knowledge and capabilities as well as training/capacity building required for a sustained high level of preparedness (59). According to Adini et al. (59), when developing emergency preparedness plans, the focus must be on getting the entire community prepared for an emergency. Therefore, such plans must be backed by an appropriate level of funding. Moreover, there is a need for health institutions to have plans for an appropriate response for conventional and non-conventional disasters (60-62). For instance, in the case of a disaster involving chemicals, health institutions must be prepared and have the capacity to decontaminate casualties, treat acute stress reactions and be able to deal with the sudden surge in the number of patients (60). However, the thrust of the “all-hazard” concept is that emergency preparedness efforts in such hospitals must be developed in a way that made such efforts applicable to all forms of hazards(58).

Based on this, Adini et al (59) opined that while assessing the emergency preparedness of a hospital, key consideration should include the appraisal of the disaster response plan available in the institution, its emergency coordination and communication strategy, the type of training provided for staff members, hospital expansion strategy for handling patient upsurge which is typical during emergency as well as the availability of equipment and medical supplies. Moreover, in alliance with the all-hazard approach of the WHO, such assessment should consider how such a hospital's emergency preparedness and response is applicable to all types of hazard or disasters.

1.4.2 Domains of all hazard vulnerability assessment

Generally, there are three major domains of the all-hazard approach to emergency preparedness, namely functional, structural, and non-structural domains (63, 64). The functional domain largely relates to elements that if affected in a disaster will prevent the organisation from performing its functions (65). In other words, functional emergency preparedness ensures that the organisation can perform its functions during a disaster. Elements within this domain include communication plan, hazard and vulnerability assessment, emergency management plan, command and control, human resources, safety and early warning systems, blood bank and fatality management. The second domain is the non-structural domain, and this largely refers to other components of the all-hazard preparedness which requires no physical infrastructure. It largely covers elements such as the availability of equipment and supplies, architectural safety, infrastructural protection, critical systems such as those for telecommunication, electricity and water supply, fire protection, waste management, medical gas system, heating ventilation and air conditioning, office furniture, utilities, and security systems amongst others (65). Structural domain is the last domain of the all-hazard approach, and this largely refers to factors relating to the building within which the organisation operates. Factors often covered under the structural domains include those contributing to or affecting building integrity (such as cracks, columns, walls, foundation, beams, and other building defects). Moreover, the occurrence of previous disaster which could have impact on building infrastructure is also considered under this category.

1.4.3 Conducting all hazard vulnerability assessment.

Several key factors are considered when conducting a hazard risk assessment. In the first instance, the HVA team must have a clear understanding of the all-hazards approach. All-hazard approach refers to an integrated approach to emergency preparedness and planning that focuses on the development of capacity/capabilities of an organisation to respond to all types of disasters man-made and natural disasters that may occur. To achieve this, people in charge of emergency preparedness at the organisational level must also have a good knowledge of available resources, resources needed for an emergency response which are not available, and how soon unavailable resources can be acquired. Finally, the HVA must also take into account all actions which can reduce vulnerability to all types of hazards (52). When developing HVA at the community level, it is important that all key stakeholders within the community are represented in the HVA team. HVA team members should include participants drawn from the emergency response or management organisations within the community as well as those responsible for safety such as the policy and firefighters. Moreover, health personnel from the hospital, community leaders, the military and public health experts are also important members of community HVA teams (66).

For HVA at the hospital level, it is important to also have a multidisciplinary team. According to Du et al (52) , in addition to core medical staff members such as clinicians, nurses and laboratory scientists, the HVA team should include professionals drawn from the hospital's emergency department and other departments such as the IT, security and ancillary staffs such as those in charge of finance, administration, cleaning and food. It is also important to include stakeholders such as public service professionals (e.g. police) in the HVA team (52).

1.4.4 Disaster management in the context of multiple hazards

In the past, disaster management often focused on one type of hazard, such as floods or earthquakes. However, it is now understood that disasters can be caused by different hazards, including natural, man-made, and technological disasters (31, 67). That means that it is important to take all hazards into consideration in disaster management. A disaster may involve multiple hazards. For instance, a hurricane can result in flooding, power outages, and wind damage among other issues.

Focusing on multiple hazards can help efforts towards climate change and sustainable development goals in numerous ways. First, it can help to identify and address the root causes of disasters. By taking a holistic approach to disaster management, it is possible to identify and address the root causes of disasters (68, 69). This can help reduce the risk and enhance the ability of communities to recover from disasters. Second, the approach can help develop more effective and efficient disaster management strategies. Third, it can help to establish more resilient communities that are better able to withstand the impacts of disasters(68, 69). Focusing on multiple hazards makes a real difference in the fight against climate change and the pursuit of sustainable development.

The link between the consideration for multiple hazards in disaster management and climate change should be emphasized. Climate change has been identified as a significant driver of increased disaster risk and severity, as it leads to more frequent and intense hazards (IPCC, 2014). By adopting a comprehensive approach that accounts for multiple hazards, disaster management efforts can contribute to mitigating the impacts of climate change by addressing both its immediate cause and underlying factors. This integrated approach aligns with the objectives of sustainable development, as it promotes the resilience and well-being of communities in the face of environmental challenges.

1.4.5 Different frameworks for disaster management

There are two key frameworks used in disaster management. The first is the multi-hazard approach, which is a specialized approach to disaster management that focuses on preparing for and responding to certain types of disasters. This approach is often used by organizations that are responsible for response to particular disaster, such as fire departments, hospitals, and emergency management agencies. The Pan American Health Organization (PAHO) describes the multi-hazard response framework as a set of management issues that should be coordinated at different administrative levels within the national health sector, as well as between sectors (70). This framework described various stages of emergency response and prescribe roles for different agencies and organisations involved in the response process. For instance, in the event of a flood, this approach would involve the coordination of emergency response activities among government agencies responsible for managing water, the public health department, teams involved in disaster response, and organisations within the community. The multi-hazard response approach would also encourage collaboration with non-health sectors, such as transportation, infrastructure, and environmental agencies. The collaboration would make it possible to properly address specific challenges that may be associated with the flood. While the WHO strongly recommends the multi-hazard approach, it is used in different contexts by institutions such as the United Nations International Strategy for Disaster Reduction (UNISDR) and national disaster management agencies. The approach provides a framework that is flexible, adaptable and can be used in a range of hazards, including floods, wildfires, earthquakes, and pandemics. By focusing on specific types of hazards and their unique characteristics. the multi-hazard approach guarantees that response efforts are inclusive, resilient, and responsive to various disasters.

The other disaster management approach is the all-hazard approach that seeks to reduce the risk of all types of disasters. The approach is based on the principle of preparedness, which implies that it is better to be prepared for a disaster than to react after it has occurred. The United States Centre for Medicare and Medicaid Services defines all-hazards disaster preparedness as, “an integrated approach to emergency preparedness planning that focuses on capacities and capabilities that are critical to preparedness for a full spectrum of emergencies or disasters.” (71). According to the World Health Organization (72), the All-Hazards Approach (AHA) has been widely recognized as the primary framework for disaster planning on a global scale.

In response to challenges around emergency preparedness in many countries, the WHO commissioned a study to assess emergency preparedness and response in selected countries across the globe(73).The observational study was conducted in countries with previous experience of natural disasters (74). Among other findings, the study revealed that even though the majority of the countries have experienced disasters such as floods and earthquakes, there is a significant lack of recognition of other forms of hazards, such as technological hazards, which pose as much danger as those natural disasters previously experienced. This led to the recommendation by WHO for countries to adopt an “all-hazard” approach to emergency preparedness and response.

According to the World Health Organisation (57), the "all-hazard" approach is widely recognized for its effectiveness in disaster management. This approach acknowledges that hazards can arise from various sources but emphasises that their impact, particularly on health, shares commonalities. (58), Adopting an all-hazard approach allows for comprehensive planning and then implementation of risk reduction, emergency preparedness, and response measures. This is regardless of the specific cause of the hazard. Although an all-hazards approach does require planning for a broader spectrum of emergencies, it is important to indicate that it does not necessarily involve planning for every possible emergency. For instance, there is no need for an emergency management department in areas not prone to hurricanes to allocate resources for hurricane preparedness. Using functional and prioritised contingency planning, makes the best possible use of limited resources(75). This approach allows organisations to focus their efforts on the most probable and impactful hazards while still maintaining a comprehensive and adaptable approach to disaster management.

By adopting the all-hazards approach, hospitals can develop standardized and comprehensive strategies that are applicable to a wide range of hazards. This approach ensures that hospitals are well-prepared not only for known hazards but also for unforeseen or emerging threats. By building resilience across all hazards, hospitals can adapt and respond effectively, minimizing the potential impact on patients, staff, and the community. Therefore, while recognising the significance of preparing for specific hazards (such as biological hazards), adopting an all-hazards approach provides a comprehensive framework for hospitals to enhance their overall disaster preparedness and response capabilities.

While the all-hazards approach has several strengths, it is not without limitations. One key consideration is the allocation of resources. Planning for a broad spectrum of emergencies can potentially strain limited resources, especially when addressing hazards that are less likely to occur in a specific geographic area. For instance, allocating resources for hurricane preparedness in regions not prone to hurricanes may not be the most efficient use of resources. In such cases, a risk-based approach that prioritises the most probable and impactful hazards can optimise resource allocation (75). Another aspect to consider is the adaptability of the all-hazard approach to emerging threats. As new hazards arise or existing hazards evolve, it is important for the all-hazard framework to remain responsive and adaptable. Continuous assessment and monitoring of emerging threats, as well as the flexibility to adjust preparedness measures, accordingly, are crucial to ensure that the approach remains effective in addressing evolving challenges. Furthermore, the implementation of the all-hazard approach requires effective coordination and collaboration among various stakeholders, including government agencies, healthcare organizations, and community members. Achieving this level of coordination can be challenging, particularly in complex disaster scenarios that involve multiple hazards and diverse stakeholders. It requires strong governance, communication, and cooperation mechanisms to ensure the seamless integration of efforts across different sectors and levels of governance.

It is important to note that while the terms "all-hazard" and “multi-hazard” are sometimes used interchangeably, they actually have distinct meanings within the context of emergency preparedness (76, 77). The all-hazard approach to emergency preparedness offers distinct advantages, particularly within the healthcare setting. While it acknowledges the importance of risk management and preparedness measures at the healthcare system level (78), the all-hazard approach extends beyond healthcare-specific hazards and encompasses a comprehensive range of potential emergencies. As outlined in the World Health Organization's

Health Emergency and Disaster Risk Management Framework, the all-hazard approach focuses on building the capacities and resources necessary to respond effectively to a wide range of hazards, including natural disasters, pandemics, and man-made emergencies (72, 79).Bodas et al.(72) provides a critique to the traditional all-hazards approach. The study stated that it is not sufficient to address the complex and interconnected challenges posed by modern hazards. Firstly, the study argued that the approach is based on a narrow definition of hazard, which does not consider the full range of threats that communities encounter. Secondly, the study argued that the traditional approach is often reactive instead of proactive and focuses on responding to disasters instead of preventing them. The study also reported that the traditional approach is usually top-down, instead of bottom-up, and that it does not adequately involve local communities in planning and decision-making. The all-hazards approach recognises the interconnectedness of these hazards and acknowledges the need for a unified and integrated response strategy that can be applied across various scenarios (72, 80) . Unlike the traditional approach, which may have limitations such as its narrow definition of hazards and reactive nature, the all-hazards approach takes a proactive stance by prioritizing prevention and mitigation efforts. Additionally, the all-hazards approach embraces a bottom-up perspective and actively involves local communities in the planning and decision-making processes, ensuring a more inclusive and contextually relevant approach to disaster management (72, 80). Therefore, the all-hazards approach provides a more holistic and robust foundation for effectively addressing the complex challenges posed by a variety of hazards while promoting resilience in communities. Based on the report by Bodas et al., (72), the top ten hazards were prioritised when using the all-hazard approach in this study. This helped to make data collected manageable. This approach appreciates that hazards are often very different, and that preparing for all hazards when some hazards are very unlikely in some areas is not a good use of resource.

Overall, while the multi-hazard and all-hazard frameworks share some similarities, they have different emphases. and are focused on different stages of emergency preparedness. By adopting an all-hazard approach to emergency preparedness, healthcare organisations can help ensure that they are adequately prepared to respond to a wide range of emergencies and can play a key role in protecting public health and safety in times of crisis.

1.5 Disaster management cycle

According to the International Federation of Red Cross and Red Crescent National Societies (IFRC), disaster management refers to the organisation and utilisation of available resources and personnel to address the impact of disasters with special focus on preparedness, response, and recovery. The general aim of disaster management is the planning, organisation, coordination, and implementation of actions necessary for preventing the occurrence of a disaster (or its threat) and for reducing disaster impacts or severity (81). Disaster management also entails preparedness for disaster, building capacities for timely response, the assessment of disaster impacts, strategies for recovery from disasters and rehabilitation of disaster victims (81).

Like HVA, disaster management requires many participants, including government agencies and non-governmental organisations (82). Key components of an effective disaster management strategy include pre-disaster planning and preparedness, disaster response training, information management, crisis management plans and public relation (83). The Disaster Management Cycle presents these components as a sequence of events containing six major activities that are divided into three phases, namely pre-disaster, during disaster and post-disaster sage see Pre-disaster stage (Figure 1.3). In many disaster cases, such as the recent outbreak of COVID-19 infection, these stages are often a continuum of many cycles of pre-disaster, disaster, and post disaster stages.

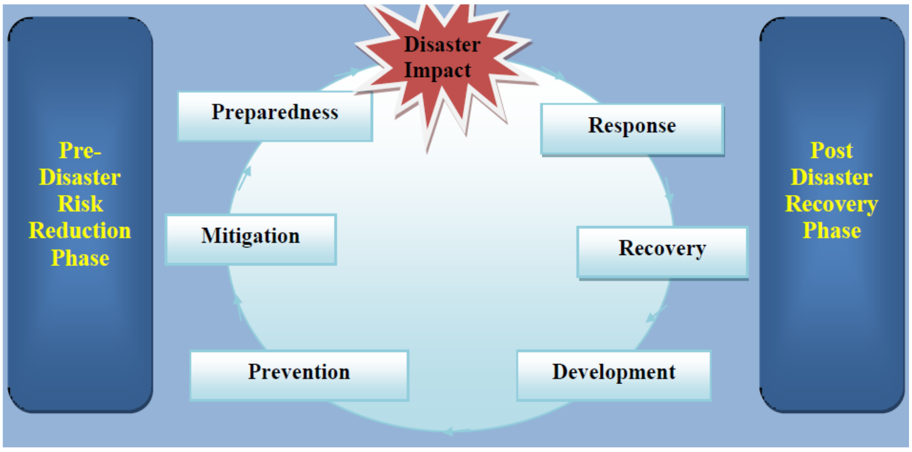

Figure 1. 3 Schematic representation of the disaster management cycle

(*Source:* Ministry of Home Affairs, Govt. of India, Disaster Management in India, 2011)

1.5.1 Pre-disaster stage

Activities during the pre-disaster stage are aimed at the reduction of the impact of disasters in term of preventing human, material or environmental losses or ensuring that impacts are minimal if the disaster eventually occurs (82). According to the Disaster Management Cycle (Figure 1.3), the first category of activities under this phase is prevention. This focuses on reducing the possibility of disasters occurring by reducing the chance of a hazard turning into disaster (vulnerability) or modifying the hazard in such a way that the intensity of resulting disaster is reduced if it happens (83).

In addition, prevention efforts could also include attempts to remove the hazard by improving conditions which constitute elements of the risk. It has been suggested that the use of the word “prevention” to describe these activities can easily be misconstrued. Therefore, its use has been discouraged as it could easily lead to the assumption that disasters are preventable. Terms such as protective or preventive activities have been suggested instead (84). The second category of activities is referred to as mitigation. Efforts within this category aim at preventing future occurrences of disasters by embracing all efforts to reduce impacts of the hazard and its associated vulnerabilities (83). In other words, mitigation attempts to reduce the translation of hazards to disasters in the future. This long-term outlook of mitigation activities distinguishes them from other activities within the Disaster Management Cycle (30). Often, these activities include both physical (structural) and non-physical (non-structural) measures which directly or indirectly address the hazard. For instance, measures to address the threat of flooding may include physical features such as building flood reeves as well as non-physical measures such as implementing land-use planning and insurance (85, 86). Other non-structural measures could address issues relating to land tenure and the implementation of resistant building codes for earth-related natural disasters such as earthquakes (85). These efforts have been reportedly judged as cost-effective in reducing the impact of hazardous events, even though they may not be suitable at times.

When required, mitigation activities are backed with regulations to enforce adherence to laid down policies as well as sanctions for the refusal to adhere to these regulations (87).

The last category of activities within the pre-disaster stage is preparedness. This refers to measures which give disaster-prone populations and organisations the ability to respond rapidly and cope effectively during a disaster occurrence (2). Processes in this category, therefore, include activities such as the development of tested and validated emergency plans, installation of early warning systems, keeping stock of essential materials and resources, public awareness and disaster education as well as training of relevant personnel in emergency response(88).Other key activities also include developing good evacuation plans for disaster-prone areas as well as capacities for effective search and rescue (89). It is also important that these activities are backed by relevant legislation and are properly funded (87). It has been suggested that disaster preparedness should be a continuous cycle of all activities characterising the process to ensure its effectiveness(88).

1.5.2 Disaster stage

Response to the disaster is the sole activity that is carried out during the disaster phase. This is usually in the form of making contingency arrangements for victims of the disaster, producing warning signals to prevent other people from becoming victims and setting up a centre for the control of the disaster response (90). Efforts at this stage could also include evacuating people from the disaster zone to a safe place and the provision of medical aid/assistance to those who are in need. Usually, disasters render people homeless (either due to damage to home by the disaster itself or due to the fact that people have to move away from their home to a safe place). Therefore, the provision of essential needs such as shelter, food and clothing are common features in disaster response. Relief activities during or immediately after a disaster may also include clearing of debris, search and rescue of people, and assessment of the physical and economic damage done by the disaster (91).

1.5.3 post-disaster stage

Activities during the post-disaster phase usually centre around the provision of emergency relief, rehabilitating affected individuals as well as the reconstruction of damaged physical structures (92). These are together known as recovery (93). The central aim of the recovery process is the restoration of the affected area back to what it used to be. It also focuses on deciding on changes that must be made or issues that need to be addressed after the immediate needs of people or areas affected by the disaster have been met. About the rebuilding of damaged structures, recovery efforts are usually focused on rebuilding in such a way that reduces the impact of future disasters (94).

Rehabilitation usually entails the provision of ad hoc public facilities and interim housing facilities for those that are displaced. For reconstruction, the focus is to return affected areas to a better functioning status compared to what it was before the disaster. Efforts usually involve replacing damaged buildings, re-installing more efficient essential facilities and addressing vulnerabilities leading to the disaster (95). Since hazard vulnerability is usually higher in underdeveloped or developing countries, post-disaster reconstruction often leads to development as structures which were not in place prior to the disaster are constructed at this stage (96). Flood prevention measures such as the building of embankments, building of irrigation facilities against drought or prevention of landslides by increased plant cover where they never existed represent development.

1.6 Disaster management and sustainable development goals

According to the United Nations Office for Disaster Risk Reduction (UNDRR), disaster reduction and sustainable development are closely related (97). Moreover, the United Nations' 2030 Agenda for sustainable development clearly highlights the important role of disaster reduction in facilitating sustainable development at different levels (98). In the first instance, the document recognised that reducing hazard vulnerability of people in poor communities or the building of disaster averting infrastructures will be critical to the achievement of the sustainable development goals (98). Secondly, the 2030 Agenda for sustainable development made clear reference to the reports of the Third UN World Conference on Disaster Risk Reduction as well as the Sendai Framework for Disaster Risk Reduction 2015-2030. Lastly, goals and targets set by the sustainable development agenda are often the central focus of common measures for disaster reduction (98) .Therefore, since hazard vulnerability assessments help in the design and implementation of disaster reduction measures (as they expose hazards that a particular organisation or community is most prone to), it is essential hazard vulnerability assessments of organisations or communities (which is the focus of this thesis) be routinely conducted as they also highlight the relevance of these global agendas.

The Sendai Framework for Disaster Risk Reduction 2015–2030 is a resolution of the Third United Nations World Conference on Disaster Risk Reduction held in Sendai, Miyagi, Japan in 2015 (99). Preceding the Sendai Framework was the Hyogo Framework for Action 2005 -2015 (HFA), which was a 10-year plan with the aim of building the resilience of communities to disaster (98). The need to build on the successes of the HFA in promoting public and institutional awareness of disaster and in obtaining the commitment of political leaders led to the development of the Sendai Framework. Critical focal points of the Sendai agreement include encouraging UN member nations to implement a review of the implementations of the Hyogo Framework and to adopt futuristic, focused, and well-planned strategies for disaster management beyond 2015. The Framework also focuses on the consideration of lessons learnt from and benefits of the implementation of the Hyogo Framework while identifying modalities for cooperative efforts towards disaster reduction post-2015.

The Sendai Framework outlines four action points towards the prevention of new and reduction of already known disaster risks. These include promoting a clear understanding of disaster risks, developing strategies for strengthening the management of disaster risks, investment in building resilience which ensures disaster reduction and improving capacities for disaster preparedness which ensures an effective response and the ability to adequately recover, rehabilitate and reconstruct following an emergency or disaster (100). Moreover, to achieve its central aim of reducing disaster risks and associated losses over a 15-year period, the Sendai Framework sets seven global targets (and lower indices compared to value for 2005 - 2015) to be achieved by 2030. These include to significantly reduce global disaster-related mortality, the number of people affected by disasters globally, disaster-related economic losses in relation to global GDP, and damage to essential infrastructure and disruption of basic and essential service (e.g., health and education) due to disasters. The Framework was also aimed at increasing the number of countries with effective national and local disaster management strategies, enhancing cooperation and support for developing countries towards the implementation of the Framework, and increasing the availability and access to early warning systems and risk information for multiple hazards.

However, though the Sendai Framework was adopted by about 187 countries the globe, many of the challenges that the Framework was established to address still exist (101-104). The (United Nation, 2023) recently published mid-term review of the framework further confirmed these challenges while also highlighting some significant achievements that have been recorded (105). Some of the achievements highlighted in the mid-review report includes the reduction in the global disaster mortality from 1.77 per 100,000 in 2005 – 2014 to 0.84 per 100,000 in 2012 – 2021 (105). However, the number of people affected by disaster increased from 1,147 per 100,000 people in 2005 – 2014 to 2,066 per 100,000 people in 2012 – 2021 (105). The economic impact of disaster remains largely unchanged while more countries have been reported to publish national disaster risk reduction strategies. The Kingdom of Saudi Arabia is one of the Arab

Countries who are signatories to Sendai Framework. However, details of how this framework has been implemented in KSA as well as data on achievements recorded locally are largely lacking.

The achievement of the Sendai Framework notwithstanding, its effectiveness in translating its objectives into action remains to be seen. Some scholars argue that the Framework's focus on risk reduction and preparedness may detract from its ability to address the root causes of vulnerability and disaster risk (106, 107). Others note that the Framework's goals and targets lack specificity and may be difficult to measure or achieve. Additionally, the Framework's success is highly dependent on the willingness and ability of countries to commit to its implementation, which is often constrained by resource limitations and competing priorities(108, 109). Therefore, while the Sendai Framework presents a valuable framework for disaster risk reduction and emergency management, its limitations and challenges must be critically appraised to ensure its effectiveness in achieving its intended goals.

Linking Relief, Rehabilitation and Development (LRRD) is another concept that links the occurrence of disasters with development goals, and which further highlights the importance of the study reported in this thesis relating to hazard vulnerability assessment of hospitals in Saudi Arabia. The central focus of the LRRD is to provide a connection between short-term relief measures implemented immediately after a disaster with long-term development goals (110). According to the Principles of Good Humanitarian Donorship, the provision of humanitarian assistance should facilitate recovery and long-term development after a disaster (111). Moreover, such assistance should strive to maintain sustainable living conditions which move the affected people (or community) from recovery to development. This principle presumes that a carefully planned development strategy (in line with the concept of LRRD) will not only reduce the need for emergency relief but also incorporate elements of disaster prevention, preparedness, risk reduction and early warning signalling systems (112)

Initially, the LRRD concept was conceptualised to exist as a linear process between rehabilitation, relief and development (112). However, real-life experiences following disaster incidents indicate that rehabilitation, relief and development cannot be treated as different individual entities while responding to emergencies (110). For instance, it has been indicated that during protracted disasters or following a period of conflicts, the dynamics of the resulting environment will render the implementation of these response options separately ineffective.

The concept of LRRD was supported by the European Union via policy commitments and the incorporation of legal frameworks and financial systems as operating mechanisms(110). Despite this, available evidence indicates that LRRD implementation is still challenging due to the difficulty in addressing critical problems which characterise the gap between immediate disaster response and sustainable development strategies(113). The EU response to the earthquake disaster in Haiti (in 2010), involving the provision of 100 million Euro for the provision of emergency assistance (such as food, water, sanitation, basic shelter, and healthcare) represents a good example in this case. Available reports indicate gaps in funding which affected reconstruction efforts following the disaster (110). Therefore, it has been suggested that implementing LRRD will benefit from a case-by-case analysis as opposed to a systematic adoption strategy.

While the approach recognizes that disasters can have long-lasting impacts on individuals, families, and communities and that recovery efforts need to be sustainable and address underlying vulnerabilities, the application of LRRD has been criticized for being too idealistic and difficult to implement in practice (114, 115). Critics argue that LRRD requires long-term planning, coordination, and sustained financial and political commitment, which can be challenging to achieve in the aftermath of a disaster(116). Additionally, the prioritisation of development objectives may detract from the immediate relief needs of affected populations. Despite these criticisms, LRRD remains a useful concept for guiding emergency disaster management efforts towards more sustainable and resilient outcomes.

1.7 WHO Safe Hospital Strategy

The hospital represents a critical asset when it comes to response to disasters and emergencies (117). However, the hospital setting itself is not immune to disasters which could be external or arise from hospital-based hazard vulnerabilities. When this happens, health workers become major casualties of the disaster and may be unable to provide healthcare and other related services when such services are needed (65). In addition to natural disasters, investments in hospital infrastructure can be lost when poorly constructed hospital facilities are damaged either by direct or indirect acts of violence. This can lead to primary failure of the hospital as a result of damaged structure which renders the hospital unfit for use (Figure 1.4) (118, 119). It has been indicated that such acts are increasingly becoming common in many parts of the world, leading to increased threat to the security, workers and patients at the hospital (120). This scenario makes it imperative to develop a measure which guarantees safety of health facilities at all levels within the society. Ensuring this demands that the protection of hospitals against identified hazards and vulnerabilities should be made a priority (120). These factors partly inform the focus of this study on hospital settings across the Kingdom of Saudi Arabia. On the other hand, hospital staff members and resources may become exhausted during disaster, leading to what is generally known as secondary failure of the hospital (Figure 1.4) (118).

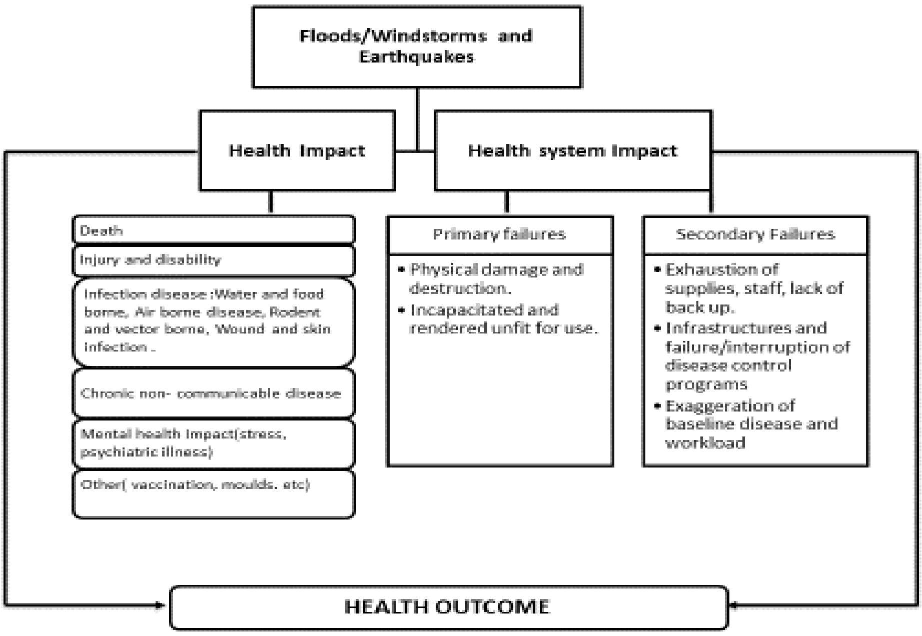

Figure 1. 4 Health system impacts of floods/windstorms (111)

Therefore, it is essential that there are measures in place to protect the physical building, core facilities and all hospital systems while providing security for health workers and patients. These will ensure that critical hospital functions are provided in the event of disasters and emergencies.

The aforementioned represent core features of the Safe Hospital programme, which has become a widely used strategy for reducing disaster risks particularly at the hospital level across many nations (121). The safe hospital concept encompasses diverse types of healthcare organisations and considers the critical role played by these organisations in maintaining a safe health system. In relation to these, functional and non-structural elements of all-hazard preparedness, which relate to issues raised in this section, were assessed in the present study. The assessment of structural components of the all-hazard requires some technical skills which the researcher do not possess. Therefore, structural capacities were not assessed in this study.

Several recent developments highlight the importance of the Safe Hospital programme in disaster management. For instance, the Hyogo Framework for Action 2005-2015 specifically advocated for the promotion of maintaining hospitals that are safe from disasters (122). The Framework recommended that new hospitals facilities are constructed with sufficient resilience and strengthened capacity to remain functional during disasters (121). It also recommended the implementation of disaster control measures which reinforces existing health care facilities. In addition, the concept of safe hospitals was also highlighted in the 2013 Announcement of the High-Level Dialogue of the Global Platform for Disaster Risk Reduction(121) .

Based on this principle, countries with high level of disaster vulnerabilities currently adopt strategies including the assessment of hospitals for disaster risks and preparedness (48). Common strategies in this regard include reconstructing selected hospitals to increase their disaster resilience, installation of safety systems as well as human and infrastructural capacity building (117). However, available research evidence indicates that these strategies are sporadic, ill-planned and not backed with an appropriate plan for effective emergency response in many countries (121). Moreover, challenges such as lack of resources for constructing new facilities and inadequate or ineffective security for patients and health workers have also been reported for poor disaster-prone countries (62). Even where policies and strategies are in place, there are challenges of adequate funding and human resources who could effectively implement these policies in some countries (48). These challenges represent focal points that the Safe Hospital Framework hopes to address.

The comprehensive Safe Hospital Framework (119) encourages the adoption of an all-hazard approach while evaluating the safety of hospital facilities as well as circumstances affecting staff and patients which may lead to emergencies/disaster and will require adequate health responses(119). Specific objectives of the Framework include to:

1. Ensure the capability of hospitals to function appropriately and provide sustained health services required during and after emergencies/ disasters.
2. Ensure the protection of all hospital users (including staff, patients, and their families)

3. Ensure the protection of the physical integrity of buildings, systems and facilities used by hospitals.
4. Ensure that hospitals are safe and are resilient against future disasters.

Based on these objectives, the Safe Hospital Framework's expectations include the need for hospitals to be safe and resilient to disasters, and that hospitals are able to deliver required healthcare services during and after an emergency or disaster. The Framework also hopes to ensure the recognition of the hospital setting as a critical community asset and key contributors to effective disaster response. Finally, the Framework seeks to ensure that hospitals are designed and constructed with adequate consideration given to future disaster risks and in a reliable, efficient, and environmentally sustainable way which enhances the hospital's safety and ensures its functionality during emergencies/disasters. However, the investigation of how principles involved in the Safe Hospital Framework has been implemented in hospitals across the Kingdom of Saudi Arabia is generally lacking.

Despite these, available information indicate that the principles of the Safe Hospital Framework have been adopted at varying degrees across many countries (123-125). However, in a report which examined the implementation of the framework across Europe, Shaw (126) highlighted many challenges facing the adoption of the framework. These challenges include the lack of mechanisms for the collation of existing guidelines on hospital safety across Europe, the fact that many previous policies were presented as mere advice to government rather than as a framework that needs to be backed by relevant policies and legislations, the lack of willingness or inability of some countries to interpret European guidance on hospital safety at the local level, and the overt emphasis on patient safety which largely divert attentions away from hospital safety (126). Though available evidence is lacking, it is possible that many of these challenges may have contributed to the poor adoption of Safe Hospital Framework in KSA. Factors such as the lack of political will and challenges associated with the interpretation of the framework at the local hospital level is particularly relevant in the context of KSA.

1.8 Empirical Studies on hospital hazard preparedness and disaster management

A significant body of research evidence has examined the preparedness of hospitals in disaster management and their vulnerabilities to specific hazards. Notably, Bazyar et al. (127) reported the inadequate level of preparedness of hospitals, attributed this to factors such as insufficient funding, inadequate staff training, and limited coordination among stakeholders. The study reported that Iranian hospitals demonstrated moderate overall preparedness, with areas like education and human resources at a moderate level. However, preparedness in reception, emergency services, communications, management and commanding, and logistics was found to be weak. Hospital preparedness for security and non-structural safety was assessed as moderate, while preparedness for structural safety was deemed weak. These findings underscore the importance of hospital disaster preparedness and highlight the need for healthcare institutions to take proactive measures to enhance their preparedness for disasters.

A different study by Munasinghe et al. (128) provides useful insights into hospital disaster preparedness and the specific vulnerabilities they may face. The study highlights a major gap in publications assessing hospital-level disaster preparedness worldwide, with developing countries featuring less prominently. Surprisingly, despite the increase in disaster events globally, the number of publications on hospital disaster preparedness reduced in the latter half of the decade. Iran, a highly vulnerable country to disasters, emerged as a leading contributor to studies on hospital preparedness. The study also revealed that chemical hazards, CBRN (chemical, biological, radiological, and nuclear) events, as well as bioterrorism were given significant attention in the Americas and European regions. The South-east region focused mainly on natural disasters and infectious disease outbreaks. Developing countries with a low Human Development Index (HDI) showed lower research investment and fewer publications, despite their high vulnerability. Concerning the specific aspects of hospital preparedness, the study stresses on several neglected areas.

While highlighting the inadequate level of preparedness of hospitals, Munasinghe et al (128) indicated that access routes and transportation facilities (which are critical for ensuring hospitals remain safe and accessible during emergencies), were given insufficient attention. Adequate transport equipment, including ambulances, is crucial for the timely movement of casualties and patients during disasters. The study also highlights the lack of emphasis on back-up power, which is essential for sustaining hospital operations when there are power failures. Morgue facilities and dead body handling, critical for proper identification and respectful management of deceased individuals during crises, were often overlooked. Vaccination, rewards/incentives for staff, and volunteer programs, crucial for staff motivation and well-being during disasters, were given inadequate attention.

Munasinghe et al (128) stressed the importance of addressing these neglected aspects in comprehensive disaster plans, as they can significantly impact response effectiveness across different disaster scenarios. Considering these often-overlooked areas can help hospitals enhance their general preparedness and response capabilities.

Disaster preparedness for hospitals encompasses a range of critical measures, including comprehensive planning, early warning systems, education, and exercises. Dowlati et al.(129) drew attention to the specific importance of preparedness for biological hazards within the broader hospital disaster management plan. The review highlights the general lack of preparedness among hospitals to effectively manage biological hazards, which poses significant risks to patients and personnel. According to Dowlati et al. (129), the development of a detailed hospital preparedness plan aligned with wider health system policies is crucial. This plan should address administrative, specialized, and logistical aspects comprehensively.

Administrative activities involve various essential components such as planning, collaboration with external agencies, risk communication, education, and practical exercises. Specialized measures encompass early detection and surveillance systems, diagnostic laboratories, psychological support, infection control, decontamination protocols, and the establishment of specialized biological teams. Logistical considerations include increasing capacity, supplies, equipment, personnel organization, volunteer forces, and security arrangements. Neglecting preparedness for biological hazards presents significant challenges during disasters and puts the health and well-being of personnel and victims at risk. While Dowlati et al. (129) emphasised the importance of hospitals prioritising and implementing preparedness plans for specific hazards, it is crucial to recognise the need for an all-hazards approach to building resilience and enhancing effectiveness in disaster management.

By adopting an all-hazards approach, hospitals can develop standardized and comprehensive strategies that are applicable to a wide range of hazards. This approach ensures hospitals are well-prepared not only for known hazards but also for unforeseen or emerging threats. By building resilience across all hazards, hospitals can adapt and respond effectively, minimizing the potential impact on patients, staff, and the community. Therefore, while recognizing the significance of preparing for specific hazards such as biological risks, adopting an all-hazards approach provides a comprehensive framework for hospitals to enhance their overall disaster preparedness and response capabilities.

1.9 Disasters in Saudi Arabia

1.9.1 Saudi Arabia – country profile

Saudi Arabia is a Kingdom in Southwestern Asia which occupies the largest area of the Arabian Peninsula (surface area of 2,149,690 km^2). The Kingdom has an estimated population of 27.137 million, consisting of 30% children (age 0 – 14 years), 4.75% elderly people (60 years or older) and 27.8% migrant workers (130) The majority of the country's population live in urban areas with only 18.6% in rural areas. The Kingdom of Saudi Arabia (KSA) has a varied geographical landscape, ranging from coastal regions in the eastern and western regions to the mountainous topographies in the south-western region and deserts around the southern borders (131). KSA is divided into 13 provinces and each province is further divided into governorates which are headed by governors.

1.9.2 Review of Past Disaster Events in Saudi Arabia

Like many other countries, KSA is faced with hazard vulnerabilities of man-made and natural sources (131). Human-related hazards in KSA are in the form of terrorist attacks, motor vehicle accidents and large-scale religious gatherings. According to Alamri (131), the incidence of terrorist attacks is increasing in the country. The Ministry of Interior in Saudi Arabia reported over 500,000 motor vehicle crashes, leading to about 6000 deaths in 2008 and indicated that this has an increasing trend(132). The majority of these incidences are as a result of what is generally classified as drive-related offences which include road-code violations, vehicle misuse and driving misjudgement(133). Due to the significance of the Islamic towns in KSA such as Mecca and Medina, some disasters have been reported to be associated with the influx of people into KSA (about 2 million people within 30 days of Ramadan) (131). For instance, Dhaffar et al (134) reported an increasing number of emergency admissions at the Al-Noor Specialist Hospital in Makkah during the Ramadan pilgrimage when most of the visitors are fasting. For Hajj, a 15-fold increase in the population of Makkah, which puts stress on basic amenities and health services has been reported (131). In addition, increased disaster risks such as food and water shortage, stampede, the spread of infectious diseases and fatalities have been reported in association with these religious visits. For example, about 1,426 people were victims of stampede due to the overcrowding of a pedestrian tunnel in Makkah in 1990 while 346 deaths were reported due to stampede in Mina in 2006 (135). Hundreds of deaths due to tent fires have also been linked to pilgrimage visits to KSA (135).

KSA is also prone to technology-related hazards due to significant high oil exploration activities going on in the country (136). This includes hazards risks such as oil leakages, spills, well-related accidents, fires, and explosions. For instance, 36 instances of oil spillage were reported in the Arabian Gulf alone in 2005. Recent figures probably exceed this figure (136). These risks are associated with significant effects on health arising from air and water pollution.

Moreover, the occurrence of natural disasters is becoming common in KSA, though this has not received sufficient media attention (131). Flood has been reported as the most common natural disaster and accounted for 70% of all the major disasters suffered by the country between 1900 and 2010. Factors such as improper drainage systems and geographical topography of some of the densely populated towns have been implicated as contributing to flooding in KSA (137). For instance, some towns (such as Jeddah and Makkah) are situated in areas which are surrounded by mountains. KSA is also affected by disasters related to climate change. Available data indicate increasing incidence of violent storms, with its attendant health and economic effect on the people, in KSA (137).

Generally, other identified contributory factors to the hazard vulnerability at the community level in KSA include the high level of illiteracy among the populace as well as improper communication of disaster risk to people groups and communities (138). These factors also significantly affect disaster preparedness and response activities or organisations, such as healthcare facilities within the country. Another factor is the frequency of religious gatherings within the country which can affect the effectiveness of risk and disaster preparedness. This is because as a group of people leave the country after one event , another set of people are arriving for another event (139). Moreover, research evidence indicates that the reluctance of international experts to work in the country due to the fear of terrorist attacks may also contribute to poor vulnerability of organisations across KSA (140). This prevents the country (as well as organisations within the country) from learning from and leveraging on the experience of leading experts in emergency preparedness and response for the development of proper disaster management strategies.

The ability of a nation to respond effectively to a disaster will determine the extent of the impact of such a disaster. Like hazard vulnerabilities, certain social and demographic factors also affect disaster response in KSA (137).

Such factors include the language barrier and significantly high levels of illiteracy among the most vulnerable population groups (140). For instance, illiteracy will hinder people's reaction and may negatively impact on their attitudes towards disasters. Available data indicate that 8.6% male and 23.6% female residents of age 15 years and above in KSA are illiterate (141). This segment of the population will be unable to read safety codes and disaster warnings and information on most platforms for public announcement and therefore are at higher risks of becoming disaster victims (137). Moreover, the Saudi Ministry of Economy and Planning(141) indicates that about 53.1% of workers in the country are migrants, many of whom speak languages (such as Urdu and Filipino) different from native languages (e.g. Arabic) in KSA. Therefore, there exists a need for important disaster-related information to be translated to these languages so as to improve the efficiency of disaster response operations.

Moreover, due to religious inclinations, many people in KSA believe that whatever happens is an act of God (137). This belief system can prevent people from taking responsibility for the right attitude towards disaster risks. It has also been indicated that people in many communities with high disaster vulnerabilities often disregard official messages about a disaster (142).

1.9.3 Historical perspective of disaster management in KSA

Efforts towards emergency/disaster management in KSA started over 80 years ago, and this has witnessed slow but steady growth over the years (143). This began with the formation of the fire brigade in Makkah in 1972. Managed by the Makkah Provincial Council, the organisation was meant to provide safety-related functions to pilgrims who visit the town on an annual basis. In 1948, the Centre of General Security was established, and this merged with the Makkah fire brigade to become the General Security and Fire Services. Steady improvements and growth over a period of 32 years led to the establishment of more fire brigades across towns such as Makkah, Medina, Jeddah, Qassim, Dammam and Riyadh (131). The General Security and Fire Services was dissolved in 1965, leading to the establishment of the General Directorate of Civil Defense (GDCD), which currently regulates disaster management in KSA (131). The law guiding the operations of the GDCD interprets “civil defence” as activities required for the protection of civilians and properties from dangers resulting from fire, natural disasters, wars and other accidents (131). Prescribed roles for the organisation include rescuing disaster victims and transportation of people affected by emergencies to safe locations (131).

Moreover, Article 4, Section 2 of the law guiding the operations of the GDCD identifies the following roles for the GDCD during emergencies/disaster:

1. The organisation and operation of the national warning systems during emergencies
2. Management of electricity and organisation of evacuation plans during disasters.

3. Fire safety roles and the provision of basic life support services to victims of disasters.
4. Demarcation and cordoning of affected areas during disasters.
5. Collaboration with other relevant agencies to ensure the safety of civilians during emergencies.
6. Cleaning of post-disaster debris and rehabilitation of damaged areas

The GDCD is governed by a board which implements guiding policies and plans projects. The board also establishes safety and fitness standards, training guidelines, policies for the recruitment of volunteers, expansion plans as well as the budget provisions for the organisation (144). The governing board works together with an executive committee which is responsible for the day-to-day administration of the GDCD (144).

Other recent developments in terms of disaster management in KSA are also evident. For instance, there is increased vigilance towards the detection of suspected activities and new traffic control systems have recently been installed KSA intending to reducing disasters resulting from motor vehicle accidents (144). Also, reforms are currently being implemented to simplify the Hajj process and make it safer while the Ministry of Health is currently implementing reforms which address challenging around the provision healthcare services to pilgrims during Ramadan and Hajj (139). Despite these improvements, disaster management in KSA still faces challenges arising mostly from political instability and climate change (131).

1.9.4 Health care system structure in KSA

The Kingdom of Saudi Arabia operates a three-tier health care system - primary, secondary and tertiary (145). This corresponds to health centres, general hospitals, and specialist hospitals in that order. The Kingdom's Ministry of Health is headed by the Minister of Health, who oversees the day-to-day running of the country's health system. The Ministry has a carefully defined and decentralized administrative structure and is responsible for the strategic planning, formulation of health policies, supervision of health service delivery programmes and monitoring of all health-related activities (145). KSA has 19 health regions (each led by a Regional Director General of Health Services) and each regional health directorate has constituent health sections which supervises at least one general hospital, health centres, school health services, health offices and the private health sector in each section. The health directorate has the capacity to recruit, train, supervise, and evaluate its staff and cater for their welfare. The link between the health ministry and other health-related sectors (e.g., education, agriculture, municipal and rural affairs) is shown in Figure 1.5.

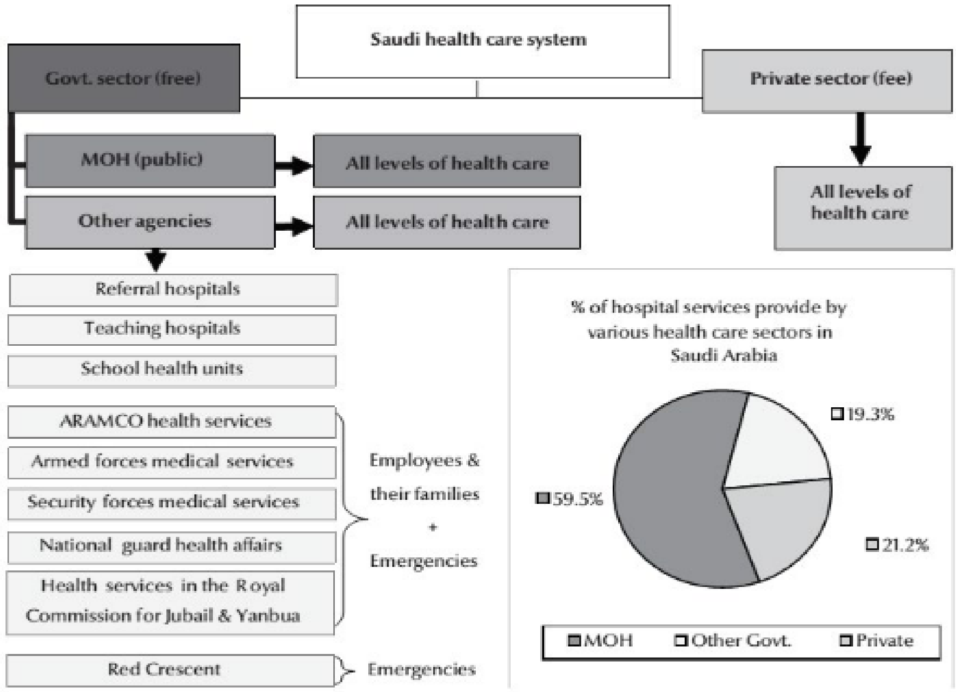

Figure 1. 5 The structure of health system in KSA (136)

The Ministry of Health in KSA provides services through 186 hospitals (59% of the country's 314 hospitals) and 1756 health centres (47% of the total 3756 health centres) in addition to several dispensaries, health units and clinics. Each region in KSA has a dental centre that acts as a referral centre for all health centres and hospitals. There are also five specialist hospitals for chest related ailments and eight medical rehabilitation centres for speech and hearing therapy, accident injury repair and physiotherapy. The country also has five central reference laboratories and twenty-four health quarantine centres located along the border with neighbouring countries (145).

Other relevant health-related agencies include the health facilities of the military, National Guard, universities (and affiliated teaching hospitals), large multinational corporations and specialist hospitals. Apart from the specialist hospitals, these health facilities primarily serve workers of the different establishments where they are established and members of their families. The private sector also contributes to health provision in KSA. These include private hospitals, clinics, dispensaries and pharmacies which are mostly located in urban centres. The private sector currently employs 28% of the country's physicians and 19% of its nurses; providing 19% of all hospital beds as at 2011(146).

1.9.5 Regulation of healthcare providers in KSA

Due to the increasing incidence of disasters in KSA and other related factors (including recent technological advancement), the need for the accreditation and quality assurance of health care facilities has become necessary. The Central Board for Accreditation of Healthcare Institutions (CBAHI), an organisation established in 2005, regulates the accreditation of healthcare providers in Saudi Arabia against quality standards set in line with best practices from around the world (147). The establishment of CBAHI was in accordance with the recommendation of the Saudi Health Council, and the organisation is responsible for formulating and implementing quality standards for the health sector in KSA (147). The role of the organisation also includes the evaluation of the healthcare provider to ensure compliance with standards which protect the safety of health workers and patients within the hospital setting. Accreditation by CBAHI became compulsory in KSA in 2013, and it is currently a prerequisite for the renewal of operating licences for healthcare facilities in the country.

Standards set by CBAHI generally address three areas of operations within the hospital setting. In the first instance, the structure standard evaluates inputs such as bed availability, adequacy of manpower as well as the availability of protective gear, key operational facilities, and consumables. On the other hand, the activity and procedure standard centres on the evaluation of the quality of intervention/treatment given to patients together with all associated administrative activities. Finally, CBAHI's outcome standard examines the outcome of interventions administered to patient's vis-à-vis expected purpose of the treatment approach. Performance indicators covered in this regard largely focused on estimating the occurrence of negative outcomes such as mortality rate, falls, infection rate following surgery etc (147).These standards are also relevant in terms of the assessment of hospitals emergency/disaster preparedness. However, it is not yet fully understood how compliance with CBAHI standards contribute to all-hazard preparedness and disaster response capacity of hospitals in Saudi Arabia and this represents one of the gaps that this study aims to address.

1.10 Rationale

Following from the discussion of various issues presented in this chapter, it is evident that there is a lack of information on the extent to which the all-hazard approach has been adopted globally and particularly in Saudi Arabia and there is, therefore, a need for a study of the state of the art in this regard. Secondly, information on the level of hazard vulnerability of hospitals across Saudi Arabia is generally lacking or at best not up-to-date, and a study which assesses hazard vulnerability as well as the capacity of hospitals in the region to respond effectively to disasters is needed. It has been highlighted that Emergency managers play keep roles in emergency preparedness and response. However, the lack of qualitative research evidence on their perceptions, feelings and knowledge represents a key gap that needs to be addressed. Altogether, these represent the rationale for this study.

As earlier iterated in this thesis, KSA is a disaster-prone country due to its geography, tense international relationship with its neighbours and its religious significance as an important country of pilgrimage for Muslims. Consequently, the country has experienced many types of disasters as reviewed in Section 1.8.2. However, obvious gaps in skills and competence of healthcare workers to effectively respond to disaster events in KSA has been reported(143, 148). For instance, in a study which focused on the assessment of the disaster readiness and response abilities of nurses, Al Harthi et al (148) reported that disaster preparedness and response as a specialty in KSA is at its infancy and there is a lack of quality education for nurses in this regards. The study also identified challenges such as the lack of expertise in research and clinical implementation of disaster response strategies.

Following a review of 104 articles on disaster preparedness and response in KSA, Alrehali (149) reported that challenges facing effective disaster preparedness and response in KSA are multifaceted and include issues around the lack of effective and specific policies, the vagueness and lack of clarity of available legislations and plans, poor stakeholder engagement and coordination, and poor archiving and storage of relevant information. Though the General Directorate of Civil Defence (GDCD) coordinates efforts around disaster preparedness and response in KSA, it is evident that there are obvious flaws in the policy and its implementation. Understanding the impact of these challenges and how they can be addressed, particularly in terms of adopting the right approach towards disaster preparedness and response, provides a veritable justification for this study.

In fact, evidence from the review conducted by Alyami et al (143) indicated that, to a large extent, a single-hazard approach to disaster preparedness and response which involves preparing for and responding to single disaster events (perhaps the most common in each area) is the approach adopted in KSA. This approach is somewhat similar to the top-hazard approach that was described by Bodas *et al.*(72) Top-hazard approach identifies the top hazard that a locality is vulnerable to (based on available indicators) and efforts are directed towards preparing and responding to this disaster. However, it is not even clear how effectively KSA has adopted this approach.

While the use of all-hazard approach to emergency preparedness has been widely recommended (79, 150), there are also indications that the approach has not been widely adopted. This is despite the fact that the World Health Organisation has conducted the evaluation of emergency preparedness of several regions and recommended the use of all-hazard approach in emergency preparedness (56). Moreover, a review of studies reporting the implementation of the approach is also generally lacking. Therefore, there is a need for a review of where this approach has been implemented or where its implementation has been mentioned in literature. Such a review will also indicate how successful the implementation of the all-hazard approach has been.

In addition, having highlighted the importance of all-hazard approach to emergency preparedness, it is imperative to assess if this approach is being implemented in selected hospitals in KSA to ascertain if the procedures in operation within KSA are up-to-date and in line with global best practices. Also, the importance of the safe hospital framework in disaster preparedness has been highlighted. However, the level of implementation of this strategy in KSA or information about the intention to implement this strategy is generally lacking. Moreover, since data on the implementation of the all-hazard approach to emergency preparedness in KSA is generally lacking, this project will also investigate the extent of the implementation of the approach in KSA for emergency preparedness.

This project also used the all-hazard approach to assess emergency preparedness of secondary and tertiary healthcare facilities to generate useful data on this approach for KSA. It is believed that data generated represent a significant contribution to knowledge which can inform future policy and development planning for better emergency response in KSA. Though there are three domains of the all-hazard approach, including the functional, structural, and non-structural domains, the structural domain was not assessed in the HVA conducted in this study. This is because the researcher lacked some technical knowledge of hospital building structures needed for effective structural assessment.

It is also known that the hospital is one of the key institutions with critical roles in disaster response. Despite these factors, the status of healthcare facilities in KSA with respect to emergency preparedness is generally not known. Moreover, since hazards can be multi-faceted and the hospital itself is not immune to internal and external disasters, it is important to assess the vulnerability of selected hospitals with a view to ascertaining if these hospitals are adequately prepared for hazards which they are vulnerable to. The rationale behind this is that if selected hospitals themselves are not adequately prepared to respond to their own hazards, their importance as key institutions with specific roles in local, regional, and national disasters become questionable. This project also provided information on strategies adopted by secondary and tertiary healthcare facilities across KSA to mitigate against the impact of disasters and to enable to respond effectively in the case of either an internal or external disaster.

A mixed method approach was adopted in this study. The choice is based on the fact that this research approach combines both qualitative and quantitative research approaches in a way that balances out the limitations of each of these individual research approaches (151). For instance, there are certain data that numerical values cannot describe, such as data on feeling and emotions. Therefore, research that is solely based of quantitative approach will not be able to collect these types of data. However, mixed method approach allows the collection of these type of data in conjunction with quantitative data, thereby providing more clarity and improving the validity of research conducted (152). This observation is validated by the observation that few qualitative studies which exist on this subject such as (153-156) provided insights that could not be captured by quantitative studies.

However, the majority of available evidence on the subject of hospital hazard preparedness largely adopted quantitative approaches. Therefore, there is a general lack of qualitative research evidence on the subject (153). Specifically, there is a need for studies focusing on the perceptions, attitudes, and knowledge of individuals involved in hazard vulnerability assessment in hospitals globally.

These and the fact that there are fundamental differences in the information provided by previous qualitative and quantitative reports partly provides the justification for the multi-method approach adopted in this study. Emergency services directors are best positioned to provide useful information about their understanding of all-hazard approach, how they implement this approach and challenges associated with the implementation of all-hazard approach and the safe hospital framework (if it is currently being implemented). This explains why data collection efforts focused on emergency departments in selected hospitals in this study.

The selection of this department is based on the rationale that it is the first department within the hospital setting with the responsibility to respond to victims of disasters as well as for the design and implementation of disaster response plans for the hospital. Therefore, this is the department of the hospital where emergency preparedness should be at its best. Moreover, the focus on Emergency Departments is consistent with previous studies, such as the study by Alzahrani and Kyratsis (157) .

In addition, previous research has consistently shown that the Emergency Department (ED) is a critical department within the hospital setting, particularly in terms of disaster preparedness and response. The ED has a critical role in triaging and treating patients, coordinating with other hospital departments, and communicating with external agencies and stakeholders (158-160). The ED is also responsible for designing and implementing disaster response plans for the hospital, making it a key department for assessing overall emergency preparedness in the hospital setting (158, 160). Recognising the significance of the ED in disaster response, it becomes imperative to focus data collection efforts on this department in the selected hospitals. While there may be limited literature available on this specific topic, it is important to acknowledge any existing gaps and highlight the importance of studying the ED's role in emergency preparedness within the hospital setting. Consequently, this study places primary emphasis on the ED as the focal point for data collection, aiming to gain a comprehensive understanding of emergency preparedness from the perspective of this critical department.

While some community-related hazards in KSA are generally known (as earlier highlighted in this Chapter), specific hazards facing healthcare organisations or the extent to which some of the known community-based hazards also affect the hospital settings are not fully understood. This indicates the need for the systematic identification of hazards and vulnerability assessment of hospitals in KSA. In addition, there is a need to identify actual hazards that hospitals in KSA regularly experience or what they are perceived to be.

1.11 Aim and Objectives

This study aims at the investigation of the level of disaster preparedness of selected healthcare facilities across Riyadh Region of the Kingdom of Saudi Arabia. The focus of this study is to investigate hazard vulnerabilities of these selected healthcare facilities and to assess the extent to which they have adopted an all-hazard approach in emergency preparedness.

Specifically, this study will:

1. Conduct a systematic review of the implementation of all-hazard approach to emergency preparedness globally.
2. Assess the hazard vulnerability of selected secondary and tertiary health care facilities in Riyadh region, KSA through a quantitative questionnaire (HVA).
3. Assess the level of emergency preparedness and capacity of selected secondary and tertiary health care facilities in Riyadh region, KSA to respond effectively to all types of hazards. This will be carried out through a quantitative questionnaire.
4. Understand the challenges associated with the adoption and implementation of the all-hazard approach in selected hospitals in Riyadh region of KSA. This will be accomplished through qualitative interviews with emergency services directors.

1.12 Conclusion

This chapter has provided background information about the definition and scope of disaster response as considered in this thesis. Moreover, various issues which help the understanding of background to the problem addressed in this thesis have been provided alongside a brief highlight of the historical perspectives to disaster occurrence and disaster response efforts in KSA have been provided. The structure of the healthcare system in KSA as well as highlights of the importance of the healthcare system to effective disaster response have been provided. Finally, key concepts of all-hazard approach to disaster response have been discussed in addition to the rationale, aim and objectives of this study. The next chapter discusses research methodology adopted for this study.

CHAPTER TWO

RESEARCH METHODOLOGY

2.1 The philosophical approach underpinning the research methodology.

In this chapter, the philosophical principles that underlie the research are presented. These principles are examined in line with the mixed-methods approach used, with each of the techniques used being considered independently. A research paradigm refers to a "*set of beliefs, values, and assumptions that a community of researchers has in common regarding the nature and conduct of research*," (161). These beliefs and worldviews are important in steering research interests, including the choice of research methods and data analysis methods.

This research studied aspects of all-hazard emergency preparedness by assessing the hazard vulnerability and response capacity of secondary and tertiary hospitals in Riyadh region, Saudi Arabia. The all-hazard emergency preparedness approach provides a detailed framework for emergency management that can be used for a number of hazards and disasters. Instead of focusing on certain types of emergencies, the all-hazard approach states that emergencies can occur from different causes and need a flexible and adaptive response. Therefore, this thesis aimed at investigating the level of disaster preparedness of selected healthcare facilities across the Riyadh Region of the Kingdom of Saudi Arabia. The study reviewed hazard vulnerabilities of the selected healthcare facilities and assessed the extent to which they had adopted an all-hazard approach in emergency preparedness.

Considering the study objectives mentioned in Chapter 1, the thesis opted to use a pragmatic approach to gain knowledge and answer the research questions instead of concentrating on a specific philosophical paradigm. In this case, a mixed methods approach featuring both qualitative and quantitative studies was used. Appropriate methods were used to answer each of the research questions. The mixed methods design offered many benefits, including the ability to triangulate findings across various sources of data, which enhanced the validity and reliability of the study findings. The mixed methods approach employed in this study enables a comprehensive and multi-faceted examination of emergency preparedness in healthcare facilities. It allowed the integration of quantitative data obtained through standardised tools, such as the KP-HVA, with qualitative insights derived from interviews, thereby providing a more holistic understanding of the research objectives. The philosophical underpinning of this approach recognises the value of both objective measurement and subjective experiences in generating comprehensive knowledge. Furthermore, the epistemological and ontological perspectives guiding this research acknowledge the interplay between observable phenomena and individual interpretations. This ensures a more nuanced exploration of emergency preparedness in healthcare settings. The epistemological basis that supports these designs and their suitability for the studies in which they were used are elaborated in greater detail in the following sections.

2.2 Quantitative study

2.2.1 Positivist paradigm

The positivist paradigm is characterized by its dependence on measurement and reason. The concept posits that knowledge can be gained from neutral and quantifiable observations of activity, action, or reaction. According to positivism, if an aspect cannot be measured in this manner, it cannot be known with certainty (162). As a concept that seeks to interpret observations through measurable entities, positivism is often used in research. This approach is reliant on deductive logic, where a hypothesis is devised and afterwards tested using mathematical calculations and equations to come up with reliable conclusions. Researchers who use the scientific method in this manner are interested in studying cause and effect relationships, and therefore, must be able to control the possible impacts of explanatory factors on the dependent factors (162, 163). Within this paradigm, context is often considered as insignificant, and researchers may assume that the outcome obtained in one context can be applied to other situations through deductive inference.

The positivist paradigm guided the quantitative components of this thesis, to test the theory that the selected secondary and tertiary healthcare institutions in Saudi Arabia have a high level of hazard vulnerability. The suggested theories looked into the cause-effect relationship between the independent factor (in this case hazard vulnerabilities) and the tested dependent outcomes in the level of preparedness in each health facility, which best fits under the positivist paradigm described above. By controlling for other known and hypothesised explanatory factors, the researcher managed to establish a causal relationship between the existence of multiple hazard vulnerabilities and the level of preparedness in each health facility.

Chapter 4 presents the results of the first quantitative study, which assessed the hazard vulnerability of secondary and tertiary healthcare facilities in the Riyadh region, KSA. This involved a multi-centre survey utilizing the Kaiser Permanente Hazard Vulnerability Assessment Tool (KP-HVA). This quantitative assessment provided standardized data on the vulnerability of selected healthcare institutions, enabling a systematic analysis of potential hazards.

Chapter 5 presents results of the second quantitative component of this research, which evaluated the preparedness and response capability of selected healthcare facilities in the Riyadh region using an all-hazards approach. This component involved the administration of a research questionnaire, which utilized all-hazard tools to assess the emergency preparedness of the hospitals. By employing this approach, the research aimed to capture a comprehensive view of the facilities' preparedness levels, considering a wide range of potential hazards.

2.3 Qualitative studies

2.3.1 Constructive paradigm

Studies that are grounded in the constructivist approach are often interested in understanding the world of human experience. Such studies identify that reality is constructed in a social manner and cannot be stable. This paradigm admits that different individuals are likely to have diverse accounts of the same phenomenon under investigation(164, 165). Researchers that follow this paradigm consider the views of the study participants with a lot of primacy, accounting for their unique backgrounds and experiences. The role of the researcher is to try to understand the meaning that participants attach to a certain phenomenon in its distinctive context (165). Consequently, constructivists have a high tendency to Favour qualitative data collection methods such as interviews. Unlike the positivist paradigm, research guided by the constructivist paradigm does not start with a preconceived theory, but instead produces theory inductively from the patterns and meanings discovered across the research process (164, 165)

The second aspect of the investigation conducted in this thesis relied on constructivism and qualitative methods since it focused on identifying the level of understanding of all-hazard approach by emergency services directors and challenges associated with the adoption and implementation of the approach in selected secondary and tertiary health facilities. Furthermore, this aspect of the study was designed to complement the quantitative information gained through the assessment of the preparedness and response capacity of selected hospitals. This approach was best to fulfil this objective provided that there is a knowledge gap in this domain.

Chapter 6 presents the results of the qualitative component of this research. This involved in-depth interviews with Directors of Emergency Departments from selected hospitals. These qualitative interviews were conducted to complement the quantitative data obtained through the assessments of preparedness and response. They provided valuable insights into the understanding of the all-hazard approach among emergency services directors and helped in the identification of challenges associated with its adoption and implementation at the facility level. Additionally, these interviews facilitated a deeper exploration of the strengths, weaknesses, threats, and opportunities related to emergency management. They provided a platform for interviewees to express their opinions and contribute to a more nuanced understanding of the research topic.

2.4 Reflexivity

Generally, reflexivity helps the researcher to be aware of his/her influence on the implementation of the research as well as findings of the research (166, 167). Haynes (168) particularly defined reflexivity as "*an awareness of the researcher's role in the practice of research and the way this is influenced by the object of the research, enabling the researcher to acknowledge the way in which he or she affects both the research processes and outcomes".* The importance of reflexivity in qualitative research has been described extensively. The need for reflexivity include the fact that the conduct of qualitative research significantly involves the participation of the researcher and the researcher's previous experience can introduce significant bias to the research process and the way results are interpreted (167). While highlighting how reflexivity helps the researcher to question his/her way of thinking and how this affects the research, Dodgson (166) iterated that being reflexive involves constant revision of the researcher's prior understanding in the light of new findings and how this affects the implementation of the research process. Haynes (168) particularly indicated that the reflection that characterises reflexivity helps the research to query how his/her values and perceptions about the study affect research design, collection of data and the interpretation of data collected. This section summarizes the implementation of reflexivity in this research. In addition, the researcher's cultural and career backgrounds and trustworthiness of data collected were also discussed in this section.

2.4.1 Reflexivity Implementation

Reflexivity was implemented in this study in a number of ways to eliminate (and where not possible, reduce) bias in data collection and interpretation. In the first instance, I used a reflexive diary throughout the process of this research. The use of a reflexive diary has been suggested as a good strategy for the implementation of reflexivity in qualitative research (169). This is a simple record of the researcher's experience during the research process. The researcher documented what was done and why they were done. In this case, the diary particularly helped me in documenting my experiences from my perspectives as well as my reactions and reflection about issues discussed during the interview of emergency services directors. This diary therefore became very useful during the interpretation and analysis of data. It helped me to isolate my prior knowledge and preconceptions as much as possible from the opinions of the managers interviewed, and to a great extent, this enhanced the trustworthiness of findings presented in this chapter.

Secondly, it has been suggested that a researcher can achieve reflexivity by asking pertinent him or herself pertinent questions about his/her background, prior knowledge of the subject under investigation, belief system that can influence how data collected is viewed, the meaning derived from participants' comments and experiences that has shaped or currently shaping the researcher’s perspectives. I also engaged in this process and the different areas that I reflected upon with a view to implement reflexivity in this study are documented in this section.

Firstly, I was born, and I grew up in Riyadh region of KSA. This has given a good understanding of the cultural background of the area as well as the cultural background of the emergency managers that were interviewed. Also, this gave me a good understanding of the geographical locations of each of the hospitals selected in this study as well as the nature of events and activities that takes place in these areas that could have implications for disaster manager. Therefore, there was an initial preconception that some areas are generally safe and will not be prone to disaster. As a resident of Riyadh, I have never experienced or heard of any disaster events in those regions. However, I had to query this preconception and decided to adopt a more neutral approach to responses provided by participants interviewed. Moreover, the fact that not many studies have been published about the subject under investigation in the region also helped in maintaining this neutral position in data collection and analysis. However, my knowledge of the area is also beneficial to the conduct of this research and the process of data collection. It helped me in understanding some of the challenges described by emergency services directors, particularly in relation to access to external emergency services as well as issues relating to the space available within the organisation vis-à-vis the size of the community that the hospital serves,

Secondly, I trained previously as a nurse and worked as a Registered Nurse within the hospital setting in Riyadh region for almost 4 years. This also provides me with the understanding of the structure of the health system generally in the region as well as an appreciation of how a typical hospital operate within the region. As a nurse, I also participated in drill exercises previously in the hospital where I worked. While this is associated with a risk of bias, I had to ask myself if what I experienced more than 12 years ago will still be the experience today. Questioning my perspective in this way allowed me to jettison my previous opinion about drill exercises and the organisation of emergency response within the hospital setting. From a positive angle, this prior experience helped me to relate better with challenges described by interviewed emergency services manager, particularly with respect to challenges associated with the implementation of drills and training exercises. Moreover, adopting a neutral approach became easier when I reflected on the fact that my experience in the one hospital where I worked previously may be significantly different from what operates in other hospital settings within the region. I reflected that I will be preventing myself from learning about what happens in other settings if I do not isolate my previous experience from information being provided by emergency services directors.

Thirdly, I completed a master's in public health (MPH) programme and worked as a Senior Public Health Specialist with Saudi Red Crescent Authority (and had a role in the Trauma Epidemiology Centre in Riyadh) prior to this study. These experiences partly motivated my decision to pursue a PhD programme that focuses on the assessment of the level of emergency preparedness of hospital settings in Riyadh region. This motivation came from many angles. In the first instance, my research project for the MPH programme focused on the investigation of how health facilities work in collaboration to enhance their level of emergency preparedness in the region. I also administered a questionnaire to emergency services directors to collect data for that study. These represents some experiences that were very useful for the implementation of this present study. While this also have a risk of introducing bias, the influence of this experience was managed by questioning myself if the situation in the hospitals 12 years ago when I conducted the MPH research will still remain the same. Also, all the emergency services directors interviewed in this present study were different from those recruited for the previous study, as many of them would have retired or move to other roles. It was therefore easy to listen to new opportunities and challenges facing the implementation of emergency response plans as well as hazard vulnerability assessment as iterated by these new sets of managers.

From another angle, my role within the Red Crescent Authority between 2014 and 2021 involves ensuring the quality of ambulatory services provided by the organisation during a disaster event. This gave me an opportunity to review reports from my organisation as well as other organisations, including hospitals. Largely, rather than making me bias, this experience significantly helped me to relate with comments made by participants during the interviews, I was constantly documenting my feelings and reactions with respect to this as interviewers gave their opinions about challenges associated with and strategies for improving emergency response and preparedness within healthcare facilities. As Red Crescent Authority is a key external organisation that many of the respondent referred to in their comments, I was able to recognise their challenges and frustrations because I have a good understanding of how the Red Crescent Authority functions. However, I refrained from making comments that will link me with the organisation so that respondents can express themselves freely.

2.4.2 Trustworthiness of findings

Trustworthiness indicates the authenticity of research findings, and this often achieved by minimising biases associated with data collection and interpretation, particularly those arising from the researcher's personal experiences (170, 171). Out of many available approaches for achieving this, the use of "bracketing" has been particularly popular among qualitative researchers Dorfler et al(172). Bracketing largely is an approach through which the researcher sets aside previous knowledge, ideas, opinions, and thoughts about the subject being investigated throughout the research process with a view to mitigate against the adverse effects that such preconceptions could have on the research outcome (173). This was adopted in this study in a reflexive manner to isolate prior experiences and knowledge document in the previous section. The practical way in which this was done to ensure the trustworthiness of data in this study involved the documentation of the researcher's experience feelings and experience during and immediately after interview sessions. This was then reviewed thoroughly before the analysis of data to ensure that the position of the researcher was well isolated when analysing data. However, where prior experiences helped in proper understanding of respondents' comments, knowledge of past experience was used. During data collection, bracketing was achieved by ensuring that questions were asked without references to the researcher's previous experience. Also, in occasions where issues that the researcher is already aware of came up, the researcher did not assume based on this prior knowledge but proceeded to ask participants for their opinions. It is the participants' opinions that were recorded and analysed in this study. Altogether, these approaches ensure that data presented are authentic, credible, and trustworthy.

2.5 General Methods

Background information presented in the previous chapter has indicated that there is a need for a wider adoption of all-hazard approach to emergency preparedness as this will ensure that the healthcare institution is adequately prepared for all types of emergency situations. Therefore, this study assessed the adoption of this approach to emergency preparedness in selected hospitals in Riyadh region of KSA, with focus on their emergency departments as these sections are often responsible for emergency planning for each hospital. This section provides details of the methods of investigation for all studies, including systematic review of the implementation of all-hazard approach and the hazard vulnerability assessment of selected hospitals. The description of tools used and justifications for the selection of tools, as well as methods used for tools administration are presented in this section. Moreover, details of how the semi-structured interviews were conducted were also provided in this section. In the first instance, a summary of the general research design and details of the method for hazard vulnerability assessment of selected hospitals in Riyadh region are presented. e provided. This includes a detailed description of the setting, the process, and criteria for the selection of hospitals, tool used, and processes involved in hazard vulnerability assessment and highlights of different variables measured in the study. Moreover, details of the method for the assessment of all-hazard preparedness of selected hospitals via the administration of a bespoke questionnaire together with details of the participants selection, data collection and analysis for this aspect of the study are discussed. Details of the design and implementation of semi-structured interview for emergency managers are discussed. Details of ethical considerations as well as strategies for data analysis are covered in this section.

2.5.1 Research design

This research adopted a mixed method research approach involving a systematic review of existing studies on where, when and how the all hazard approach has previously been used, hazard vulnerability assessment of selected hospitals using a previously validated questionnaire (quantitative), the assessment of level of preparedness and response capability of selected hospitals using a newly developed questionnaire (quantitative) and the exploration of the understanding of the all-hazard approach amongst emergency services directors in the region. Several factors informed the choice of this research approach. In the first instance, it is known that quantitative studies are often based on deductive reasoning in which case a hypothesis is formulated and findings from the analysis of data collected is used to deduce if the hypothesis is to be accepted or rejected (174). However, this deductive approach is known to be associated with several limitations; including the fact that response options (particularly if data collection involves the use of questionnaires) are often limited and may not truly represent opinions of respondents and the fact that some attributes which cannot be measured numerically are often missed (175, 176). Qualitative studies on the other hand are inductive in approach and could measure attributes often missed in quantitative studies (177). However, the fact that the influence of the research could significantly influence findings has been recognised as major limitation. The need to balance out these limitations by using the strength of one approach to address the limitation of the other approach partly motivated the choice of mixed-method approach in this study.

In addition, philosophical assumptions/epistemological underpinnings of quantitative and qualitative studies are different (176). According to Queirós et al (178), quantitative studies are often grounded in realist philosophical assumptions unlike qualitative studies which are often grounded in idealism or pragmatism. However, each of these epistemological views have their strengths and limitations. Therefore, a mixed method approach allows the conduct of the research in way that combines the realist assumptions of quantitative studies with the idealist assumptions of qualitative studies, making findings obtained to be more comprehensive (174, 179). Despite these advantages, mixed method research designs have also been criticised for being expensive, time consuming and requiring expertise in techniques for collection and analysis of both qualitative and quantitative data (151, 178).

In addition, many of the previous studies on disaster preparedness of communities and organisations are overtly quantitative in approach. These studies often involve the use of questionnaire or similar tools to assess the level of preparedness of these communities or organisations. Therefore, there is a general lack of studies which look at factors that may be affective the level of disaster preparedness or ability of communities/organisations to effectively respond to disasters from a qualitative point of view. It is therefore opined that the use of a mixed method approach in this study will help to partly address this gap. Based on these, a summary of proposed investigations in this research is presented in Figure 2.1.

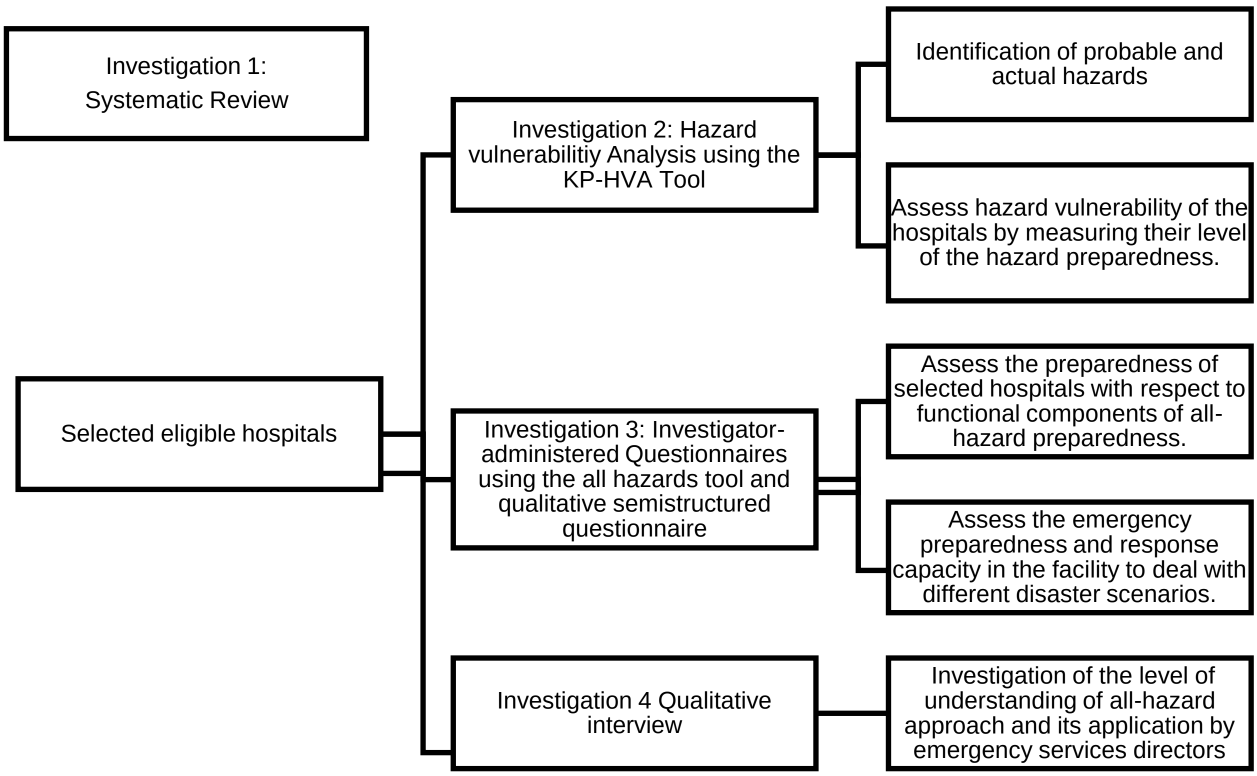

Figure 2. 1: Summary of research design

2.5.2 Methods for systematic review

A review of previous reports of how all hazard approach has been used to assess hazard vulnerability of healthcare facilities was the first investigation conducted in this thesis. Details of the strategy adopted for article identification (database searches), article selection, data synthesis and data analysis are presented in Section 3.5.5.

2.5.3 Methods for primary studies

2.5.3.1 Study setting

The target location for this study was Riyadh region of the Kingdom of Saudi Arabia. Riyadh regions is located in the centre of the Kingdom of Saudi Arabia as well as the centre of the Arabia Peninsula (180) . The region covered an area of 404,240 km^2 and is the second largest region in KSA. According to the 2018 Census data, the region has a population of 8,446,866 people which represents an increase of 2.76% compared the population figure of 2017 (180). The region is divided into 22 provinces as shown in Figure 2.2.

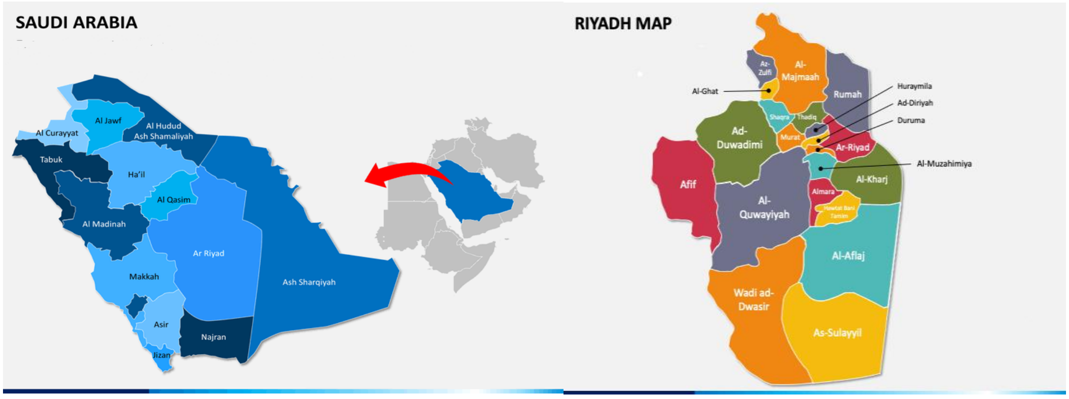

Figure 2. 2: Map of the Kingdom of Saudi Arabia showing the proposed place of the study the provinces of Riyadh Region (174)

Though accurate data on the exact number of disaster events in Riyadh region is generally lacking due to poor record keeping, available data indicated that the region has in the past experienced flooding in 2005, 2009, 2010 and in 2015 (181) . Moreover, one incident of dust storm was reported in 2018 while terrorist attacks has been identified as the most common disaster event in the region (occurred 7 times between 1995 and 2011)(181). This history of previous disaster events, together with the fact that the region has several secondary and tertiary healthcare facilities (including private health facilities and public health facilities) partly motivated the choice of the region as the focus for this study. Moreover, Riyadh region is the most prominent geographical area of KSA, and the region has experienced remarkable growth in recent years in terms of urban infrastructure development and population growth (180).

2.5.3.2 Sampling techniques and sample size

Due to the multi-study nature of this research, a combination of sampling techniques was used. For the sampling of healthcare facilities, a purposive sampling technique which requires selected facilities to have certain attributes was adopted (182). For a hospital to be selected, the following eligibility criteria were considered:

1. The facility must be providing secondary or tertiary healthcare and operate under the control of the Ministry of Health, Universities, the Military or private firms.
2. The facility must have a capacity of 100 beds or more with a functioning Emergency Care Department. This is because hospitals with this capacity are more likely to be used as reference centers during emergencies, which requires that they have a robust emergency preparedness program.

Based on these, healthcare facilities which provide only primary care or clinics without the capacity for emergency services, have less than 100 beds, are located outside the geographical area of Riyadh region, provide cosmetic or dental exclusively, and hospitals with polyclinics only without a functional emergency department were excluded from this study. The implementation of these criteria revealed that only 13 divisions of Riyadh region met this requirement (Figure 2.3). Therefore, the selection of hospitals was conducted in these divisions only.

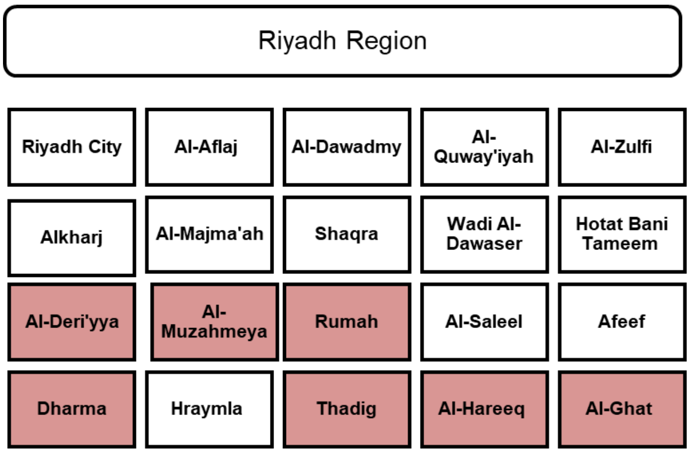

Figure 2. 3: Provinces in Riyadh Region with hospitals meeting the eligibility criteria. *Hospitals in the shaded regions were excluded due to the fact that they have capacity below 100 beds.*

2.5.3.3 Recruitment of healthcare facilities

Generally, the total number of state-owned healthcare facilities (under the control of the Ministry of Health) in Riyadh region stands at 436 primary care centres and 46 hospitals. In addition, there are 39 private healthcare facilities and 16 specialised healthcare facilities (such as military hospitals, University teaching hospital and other specialist hospitals) in the region. The distribution of hospitals based on whether they are state-owned or private hospitals is shown in Figure 2.4. All the healthcare facilities which met eligibility criteria stated earlier in this section were contacted for participation in this study. However, only 42 hospitals responded and were included in this study. There was no need for randomisation of hospitals, and the same sample of hospitals were used for all primary studies in this thesis. The distribution of locations where these hospitals are selected from are shown in Figure 2.3.

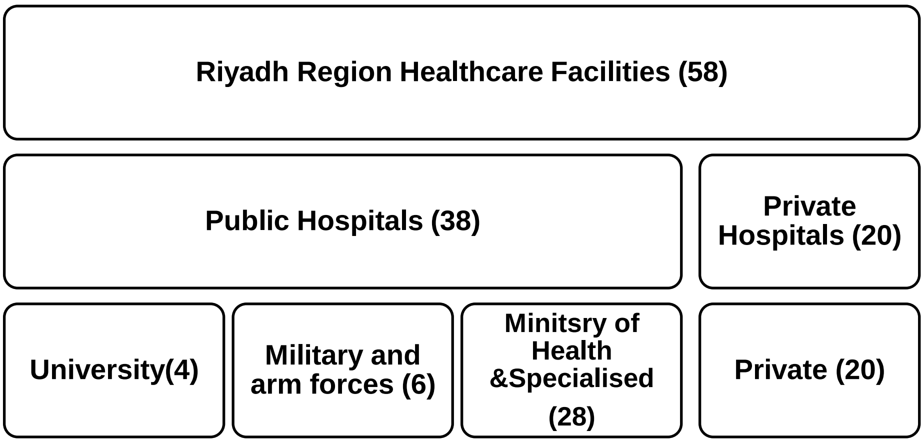

Figure 2. 4 Distribution of hospitals selected for the study

2.5.3.4 Participants' selection for the study

Different categories of participants were recruited for the different aspects of this study. For hazard vulnerability survey and the assessment of all-hazard preparedness of selected hospitals, respondents were Directors of Emergency services in all the 42 hospitals which participated in this study. Since all selected hospitals were included in this study, there was no need for the use of any sample selection technique. Moreover, Emergency Services Directors were selected as respondents for this aspect of the study as they represent the most appropriate member of staff with the best knowledge of emergency activities, policies, strategies, and tools within the hospital setting. Moreover, these directors were selected to respond on behalf of the hospitals since they are often responsible for drafting emergency response plans for the entire hospital.

For the qualitative interview, only Emergency Services Directors with up to 5 years and more of working experience were selected for interview. This criterion was essential as it ensured that managers to be interviewed would have experienced at least one form of disaster and will have required experience to provide useful information that is required for this aspect of the study. The six Emergency Services Directors who met this criterion were selected for this aspect of the study. These participants were recruited during the research visit made by the researcher to all the selected hospitals.

The total number of secondary and tertiary hospitals was 58, whereby a total of 16 healthcare facilities failed to respond to the questionnaire, mainly based on the management policy of the organization. These 16 healthcare facilities were therefore grouped as unit non-response; hence the response rate for the survey was 72.4%, with 42 respondents out of the 58 that were slated for in the study.

Table 2. 1 Distribution of respondents and non-respondents by type of healthcare facility (public or private)

Health facility type	Respondents	Non-Respondents	Total
Public	32 (84.2%)	6 (15.8%)	38
Private	10 (50%)	10 (50%)	20
Total	42 (72.4%)	16 (27.6%)	58

The researcher undertook the fieldwork and visited all the healthcare facilities to personally hand over the questionnaire to the Emergency Services manager of each healthcare facility. The completed questionnaires were thereafter personally retrieved by the researcher after three or more working days.

2.5.3.5 Instrument for data collection

(a) Hazard vulnerability assessment tool

In this study, the updated version of Kaiser Permanente Hazard Vulnerability Assessment (KP-HVA) tool (version 2017, Appendix 4.1) was used for the assessment of hazard vulnerability in line with the second objective of this thesis. This standardized KP-HVA toolkit (183) was used specifically to assess multiple hazard vulnerabilities and the level of preparedness in each health facilities against natural and technological hazards. The focus of this tool includes the identification of the top ten probable and ten observed hazards for each selected hospital. These data were used to calculate the level of preparedness, the probability, and risks of the probable and observed hazards. The rationale for the selection of tool is based on its comprehensiveness compared to other available tools for the assessment of all-hazard assessment. Specifically, several organizations have developed tools and methods for the assessment of hospital hazard vulnerabilities, including the American Society for Healthcare Engineering (ASHE) in 2001 (184, 185), the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and HCPro Limited (185). Available tools for hazard vulnerability assessment of hospitals include the Hazard Disaster Preparedness-ACEP (total score = 104) and the Hospital All-hazards Self-assessment (HAH-CDC, total score = 60). These are self-assessment tools based on four-point Likert scale which assess non-structural and functional aspects of all-hazard approach to emergency preparedness approach. However, they have been criticised to lack the comprehensiveness that make them inapplicable to different settings (186). The WHO Hospital Emergency Response Checklist 2011 is another tool which assists hospital administrators and emergency directors to respond effectively to the most likely disaster scenarios at the local level. Though this tool comprises of current hospital-based emergency management principles and best practices and integrates priority action required for an effective response to a critical event based on an all-hazards approach, it has been criticised also for its lack of comprehensiveness (186). The fact that the KP-HVA tool addresses all these challenges contributed significantly to its selection in this study. Details of the structure and content of the tool, how the tool was administered and how data collected were analysed are presented in Chapter 4.

(b) Instrument for the assessment of all-hazard preparedness of selected hospitals

The assessment of all-hazard preparedness of selected hospitals was carried out in two parts in this study to achieve the third objective of this thesis. In the first instance, the All-hazard Preparedness Assessment Questionnaire (APAQ, Appendix 5.1) was developed to assess functional and non-structural indicators of effective all-hazard emergency preparedness in selected hospitals. The content of the questionnaire was also informed by the information obtained from the systematic review reported in chapter 2 of this thesis which identified gaps in all-hazard preparedness in many hospitals. This new tool was developed as the systematic review conducted in this study indicates that there is no currently available questionnaire that can adequately address the type of investigation aimed at in this study (see Chapter Three). The major aim of this questionnaire is to assess available emergency management strategies and the adequacy of these strategies in reducing risks and emergencies arising from different hazards, including natural and technological sources.

The questionnaire used for this aspect of the project, APAQ, was created based on information contained in validated tools produced by the World Health Organisation (WHO)(187), the Centre for Disease Control (CDC)(188), and American College of Emergency Physician (ACEP)(189). Tools developed by these organizations have been used widely in the field of emergency management for a long time (187). However, a common limitation of these tools is that they lack the compartmentalisation that allows individual analysis of the different functional and non-structural components of all-hazard approach. Details of the structure and content of the questionnaire, how the question was administered and how data collected were analysed is presented in Chapter 5.

Data collection from participants was implemented through face-to face interviews. A semi structured guide was used during the interview sessions. The semi-structured interview guide was drafted based on the research aims and objectives. It was peer reviewed before its implementation during the study. The topics in the interview guide covered the methods that are used in hospitals to assess emergency plans and the challenges that are experienced in assessing the effectiveness of emergency plans. There were also questions covering the solutions to improve emergency plans and preparedness in hospitals in Riyadh. There were open-ended questions within the interview guide and the researcher used probing techniques to get deeper insights of some of the responses. A mock interview session was first conducted with one of the professionals before the real interview.

This pilot was used to test the appropriateness of the tool and corrections were made to ensure that it was effective for data collection. Details of how the pilot study was conducted and how data collected during the interview session were analysed and interpreted are presented in Chapter 6.

2.5.3 Ethical considerations

Ethical approval for this study was obtained from the University of Nottingham prior to the commencement of the study (Appendix 2.1). Moreover, all necessary approvals were obtained from the Ministry of Health and other relevant organisations in KSA prior to the conduct of aspects of this study involving health facilities or healthcare workers in KSA (Appendix 2.2). All participants recruited for all primary studies in this thesis were required to give written informed consent prior to participation in the study. Prior to the signing of the Informed Consent Form, participants were given the project information sheet which explained the objectives of the project and the level of participation required from participants. The Investigator explained the details of the project to participants, particularly during the visit to hospitals for the administration of APAQ. Participants were given sufficient time to consider their participating or otherwise in the study. The Investigator answered all questions that participants had about participating in the study. A copy of the consent form was also given to participant while the investigator kept the other copy (Appendix 2.3). For the aspect of this study involving questionnaire administration, the completion and subsequent return of the research questionnaire were taken as informed consent. Participants or healthcare facilities made aware that they can freely withdraw from this study at their own request at any time and without prejudice to any consequences. In adherence to the General Data Protection Regulation (GDPR), no personal data was collected in this project. To ensure this, all personal identifiers were removed from data collected. Participants' confidentialities were further ensured by using identification code numbers to correspond to treatment data in the computer files.

2.6 Conclusion

In the next chapter, a systematic review of the adoption of all-hazard approach to disaster preparedness and response in KSA was conducted. The focus was to identify gaps that are essential for consideration when designing other investigations conducted in this thesis.

CHAPTER THREE

THE EVIDENCE FOR THE USE OF ALL-HAZARDS APPROACH IN PUBLIC HEALTH DISASTER PREPAREDNESS: A SYSTEMATIC REVIEW

3.1 Introduction

Background information which delineates the meaning, scope and definitions of disaster as considered in this thesis as well as other issues which set the scene for this project, such as history of disasters in KSA, emergency services management in KSA, the structure of the healthcare system in KSA as well as sustainability issues relating to disaster management have been highlighted in Chapter One. Moreover, the general aim and objectives of the study have been stated in the previous chapter. This chapter presents the design and results of a systematic review aimed at gaining a better understanding of the adoption of the all-hazard approach in the conduct of vulnerability assessment and disaster response planning in KSA. Initially, this Chapter presents a brief overview of disasters and all-hazard approach. This was followed by a clear statement of the aim of the review as well as highlights of methods adopted in conducting the systematic review. Results obtained and implications of results of the review will subsequently be provided in this chapter.

3.2 Background of the review

As explained in Chapter One, disasters are natural or man-made events which are capable of causing death, harm, displacement of people, infrastructural destruction as well as the disruption of health and economic systems (2). Dar et al. (3) particularly indicated that events classified as disasters often have huge impact on the human society and are often at a magnitude that is beyond what the affected society can manage locally. Several factors have been implicated as contributors to increased risks of disasters. These include population growth, advances in technology as well as economic growth (17, 190). According to Chen et al (190) these factors largely contribute to the development of natural disasters such as storm, flood, earthquake and hurricane. However, studies have indicated that disasters could also happen as a result of human activities and that such disasters can equally wreak havoc on human beings and the environment(28, 191). These man-made disasters include accidents resulting from transportation systems or chemical, industrial or nuclear agents as well as conflicts of local, ethnic or national dimensions (29).

However, challenges around emergency preparedness in many countries has been recognised through a study conducted by the WHO in countries with previous experience of natural disasters (58). The study indicated that there is significant lack of recognition of other forms of hazards, such as technological hazards, which pose as much danger as those natural disasters previously experienced. This led to the recommendation for the adoption of “all-hazard” approach to emergency preparedness and response (58). The “all-hazard” approach to emergency preparedness involves developing a preparedness strategy that addresses all forms of hazards irrespective of their source. However, how this approach has been adopted and implemented in organisations across WHO member states is not fully understood.

The significant role played by hospitals in responding to disasters cannot be overemphasized. Hospitals have the unique responsibility of providing medical care for victims of disasters. Unfortunately, the hospital itself is not immune to disaster, which could be internal or external. It is therefore important that hospitals are adequately prepared for disasters of all types (60, 61, 192). For instance, in the case of a disaster involving chemicals, health institutions must be prepared and have the capacity to decontaminate casualties, treat acute stress reactions as well as be able to deal with the sudden surge in the number of patients (60). However, the thrust of the “all-hazard” concept is that emergency preparedness in such hospitals must be developed in a way that is applicable to all forms of hazards. However, detailed information on how the all-hazard approach to emergency preparedness has been adopted in health institutions across the globe is generally lacking. There is also a need to fully understand best practices that have worked in places where the approach has been implemented, as well as challenges facing the implementation of the approach where it has failed. In addition, there is also a need to understand approaches that were successfully used in places where the all-hazard approach has not been successfully used. Therefore, it is important to understand how other approaches such as “any hazard” and “top hazard” approaches to emergency preparedness and planning were used in KSA.

To address this problem, a review of studies which investigated the implementation of all-hazard, any-hazard and/or top-hazard approach towards emergency preparedness was conducted in this study. For the purpose of this review, the all-hazard approach was defined as a comprehensive and integrated strategy that encompasses the preparedness and response measures undertaken by healthcare facilities to address a wide spectrum of potential natural, technological, and human-induced hazards. These hazards include but are not limited to natural disasters (e.g., earthquakes, hurricanes, floods), technological emergencies (e.g., chemical spills, power outages), communicable disease outbreaks, and other unforeseen events that have the potential to disrupt normal healthcare operations. The all-hazard approach aims to develop adaptable and versatile strategies that ensure healthcare facilities are equipped to effectively manage and respond to various threats, enhancing their overall disaster resilience and safeguarding public health.

Specifically, this systematic review collated and assessed available empirical evidence on the use of these emergency preparedness and planning approaches of health care facilities globally. For the all-hazard approach, this review focused on the identification of functional and non-structural components of the all-hazard approach assessed in published studies for healthcare facilities. For the purposes of the review, functional capacity refers to how the emergency preparedness will ensure that the health facilities are able to perform their functions during a disaster and includes elements such as communication plan, hazard and vulnerability assessment, emergency management plan, command and control, human resources, safety and early warning systems, blood bank and fatality management. Moreover, non-structural capacity refers to the other requirements for effective response excluding physical infrastructure. Examples of such elements include the availability of equipment and supplies, utilities, and security systems amongst others. Also, findings of this review will inform the methods and approaches used for the assessment of all-hazard preparedness and response capacity of secondary and tertiary health facilities in Riyadh, KSA in the subsequent sections of this thesis.

3.3 Review aim

The aim of this review was to identify the core elements of the all-hazards approach in hospital settings as defined in this section. The review examined best practices that have been successful in implementing the all-hazards approach and review tools used with the aim of providing valuable insights for enhancing public health disaster preparedness. Specific objectives of this review were to:

1. Examine the geographical distribution of published studies implementing the all-hazards approach to emergency preparedness and response at the healthcare facility level worldwide.
2. Review published evidence of methodologies and strategies previously employed to implement the all-hazards approach in healthcare facilities across the globe.
3. Identify and categorize key components of the all-hazards approach as presented in the literature, such as risk assessment, planning, resource allocation, communication, and staff training.
4. Synthesize reported outcomes of the implementation of the all-hazards approach in healthcare facilities, including improvements in disaster response times, patient care, and staff safety.

5. Analyse variations in implementation strategies, challenges, and outcomes across different healthcare facility types.

3.4 Review Question

The following question guided the conduct of this literature review:

1. How has the All -hazards Approach to emergency preparedness and response been implemented at the health facility level in the published literature worldwide?

3.5 Systematic Review Methods

Systematic reviews generally involve the use of a protocol in the search, identification, selection, and collection of data from previously published articles relating to the topic under investigation (193). Mulrow particularly indicated that systematic reviews often require a scientific approach which makes the process reproducible (194). This is a key advantage of systematic review as a research method. Its effectiveness in identifying gaps in research has also been reported (194, 195). However, the approach is not without limitations. It is often liable to biases arising from preconceived ideas of researchers and a substantial level of expertise is required in conducting them successfully (195). Details of the design of the review, including databases searched, article selection strategy, inclusion and exclusion criteria, article quality assessment, and data analysis procedure are discussed in this section.

3.5.1 Article search strategy

This systematic review adopted the PRISMA Guidelines (109) and JBI Protocols for mixed methods systematic review (110). In order to conduct a comprehensive search for relevant articles, a systematic literature search was performed using a set of carefully chosen keywords. Keywords such as 'all-risk,' 'all-hazard,' 'multi-hazard,' 'emergency preparedness,' 'emergency services,' 'hospitals,' 'public health services,' 'disaster planning,' 'disaster response,' 'healthcare facility,' 'healthcare organization,' 'disaster management,' 'emergency management,' 'healthcare resilience,' 'healthcare capacity,' and 'healthcare vulnerability' were used to search four major databases, namely Ovid Medline, PubMed, CINAHL, and EMBASE, as well as Google Scholar. The search was not limited by date (Section 3.5.2). The selection of these keywords aimed to capture a wide range of studies that explore the implementation of the All-Hazards Approach to emergency preparedness and response at the healthcare facility level. By including terms like 'multi-hazard,' this study aimed to include studies that address the concept of facing multiple types of hazards and risks.

The search strategy employed both controlled vocabulary terms and natural language terms to ensure the retrieval of relevant articles. Specifically, a combination of Medical Subject Headings (MeSH) terms and free-text keywords were employed to ensure a thorough exploration of the literature. The keywords used in the search included 'all-risk,' 'all-hazard,' 'multi-hazard,' 'emergency preparedness,' 'emergency services,' 'hospitals,' 'public health services,' 'disaster planning,' 'disaster response,' 'healthcare facility,' 'healthcare organization,' 'disaster management,' 'emergency management,' 'healthcare resilience,' 'healthcare capacity,' and 'healthcare vulnerability'. Boolean operators (AND, OR) were used to combine and refine the search terms as needed. The search was conducted in titles, abstracts, and keywords of all databases.

Table 3.1 summarises the details of the keywords and syntax used in the search for each database. Three types of searches were conducted for each database, focusing specifically on all-hazard, emergency preparedness, hospital, emergency services, or a combination of these terms. The search strategy aimed to retrieve relevant qualitative and quantitative articles without restriction on publication date.

Table 3. 1 Details of search keywords and syntaxes for article identification

Database	Type of search	Keyword syntax
PubMed/ EMBASE/ CINAHL/Ovid Medline	1	"All-risk" or "All-hazard" or "All-hazards" or "All hazards" or "Multi-hazard" or "Any hazards"
	2	"Emergency preparedness" OR "Emergency Services" OR "Emergency management" OR "Healthcare resilience" OR "Healthcare capacity" OR "Healthcare capacity" OR “Healthcare vulnerability” OR “Disaster planning” OR “Disaster response”
	3	“Hospital” OR “Healthcare facility” OR “Healthcare facilities” OR “Healthcare organisation”
	Combined with AND	(("All-risk" or "All-hazard" or "All-hazards" or "All hazards" or "Multi-hazard" or "Any hazards") AND ("Emergency preparedness" OR "Emergency Services" OR "Emergency management" OR "Healthcare resilience" OR "Healthcare capacity" OR "Healthcare capacity" OR “Healthcare vulnerability” OR “Disaster planning” OR “Disaster response”) AND (“Hospital” OR “Healthcare facility” OR “Healthcare facilities” OR “Healthcare organisation”))

Articles which met specific inclusion and exclusion criteria stated in (Section 3.5.2) were included in this review. Identified articles were initially screened by the researcher and then by two independent researchers to eliminate selection biases. Data extraction and data synthesis were conducted using tools embedded in JBI SUMARI (192, 196, 197).

3.5.2 Inclusion and exclusion criteria

3.5.2.1 Inclusion criteria

All research studies (qualitative and quantitative), including electronic academic resources, such as articles, books, documents, and published reports which investigated all-hazards assessments of the healthcare facility level or local health department were included for review. To be eligible, articles must meet the following other criteria:

- Any publication that addressed any types of hazards from any disasters and implemented the all-hazard approach will be included.
- The study provides results on preparedness for at least one of the relevant hazards or disasters.
- Studies on health facilities using a single preparedness approach for multiple relevant hazards.
- The study must address preparedness for a hazard or disaster and adopt an approach akin to the all-hazard method in assessing the risk for the disaster and in planning for risk reduction and emergency preparedness.
- Studies reporting hospital facility level, regional, or national level assessments related to the all-hazard approach in disaster

preparedness, focusing on the assessment of structural or non-structural systems of a hospital, such as buildings, lifeline, or utility aspects like water, power, and fuel or gas or energy.

- Studies should present factors, indicators, variables, models, or instruments that contribute to understanding and enhancing the overall preparedness of the hospital.
- The article, guidelines, and grey literature’s full text manuscript must be written in English language.

In addition to these, articles were not limited by date of publication or location. No restriction was placed on study design. Studies with qualitative, quantitative, or mixed-method research design which describes primary data observations were included in the study.

3.5.2.2 Exclusion criteria

- Studies not adopting an all-hazard approach in assessing emergency preparedness and/or response at health facilities.
- Studies that do not relate to fields of emergency preparedness, such as individual, staff training and development, psychological, and economic preparedness.
- Articles that do not present the elements or indicators of hospital disaster preparedness.
- Studies for which the full text could not be located.
- Studies without primary data analyses

3.5.3 Article selection strategy

To ensure the selection of appropriate articles and to avoid article duplication, EndNote X9 was used to manage citations of all articles identified from database searches. Article screening was carried out by the lead researcher and the researcher supervisors using the PRISMA Guidelines (198) as summarised in Figure 3.1. Specifically, all duplicate articles identified from the different databases were removed. Titles and abstracts of the remaining articles were screened to identify those that used the all-hazard approach. This was followed by removing articles which did not adopt qualitative or quantitative approach in collecting data as well as articles which did not adopt all-hazard approach in hazard vulnerability assessment or emergency planning. Both the lead researcher and the research supervisor used the inclusion and exclusion criteria to select articles to be reviewed as well as to identify articles which did not meet these criteria. Both researchers documented reason for exclusion. Article selections were compared and disagreements in article selection between the reviewers were discussed. A third reviewer was engaged where no consensus was reached between the two reviewers.

3.5.4 Strategies for data extraction

In line with best practice, the researcher and one other independent reviewer carried out data extraction from selected articles and discrepancies were dealt with as highlighted in Sections 3.5.2. Differences were resolved through mutual consent following discussions. The initial phase of data extraction involved the recording of key characteristics of each study, including the study location, the context of the study, demographic characteristics of participants, the study's inclusion and exclusion criteria, its sample size and methods for data collection and analysis. A note of the conclusion for each included study was also made. This was followed by the extraction of key information on the type of hazard or disaster covered by the study, specific information about the_context and location of healthcare facilities in the study, details of core components of all–hazard approach as well as tools and data collection methods. Key findings from each study were extracted and where possible illustrative statements which clearly define the major finding of the study were extracted.

3.5.5 Data synthesis and integration

This review followed a convergent integrated approach according to the JBI methodology for mixed methods systematic reviews using JBI SUMAR (113). Briefly, data including the location of each study, number of hospitals covered, method of data collection, number and type of events/emergency covered, and the core components of the all-hazard emergency preparedness covered were collated in tables. Also, details of the aim, major findings, and the implications for all-hazard preparedness of each of the selected articles were recorded in another table.

3.6 Results

3.6.1 Search results

Details of the results of articles identified using each of the search terminologies syntaxes created for this study across the four databases is summarized in Appendix 2.1. The search terminology conducted altogether led to the identification of a total of 1181 articles (Table 3.2). Following the removal of duplicates, the remaining 814 articles were screened for the suitability of titles and abstract as well as the availability of full text for review. This screening led to the removal of 501 articles which are not relevant to this study. The 313 relevant articles were then screened in line with the eligibility criteria stated for this study. This final screening produced 22 articles which were reviewed in this chapter.

Table 3. 2 Number of articles retrieved from each database.

S/No	**Database**	**Result**
1	PubMed	334
2	Ovid Medline	515
3	EMBASE	7
4	CINAHL	324
Total		1181

3.6.2 Attributes of articles selected for review.

Attributes of articles selected for review are presented in Table 3.3. Articles reviewed were published in 2010 and in 2019. Articles published in 2016 (5 articles, 22%) and 2017 (5 articles, 22%) accounted for majority of the articles reviewed in this chapter. These are followed by articles published in 2012 (3 articles, 14%) and 2018 (3 articles, 14%). Two articles were published in each of 2014 and 2019 respectively while only 1 article were published in each of 2010 and 2015.

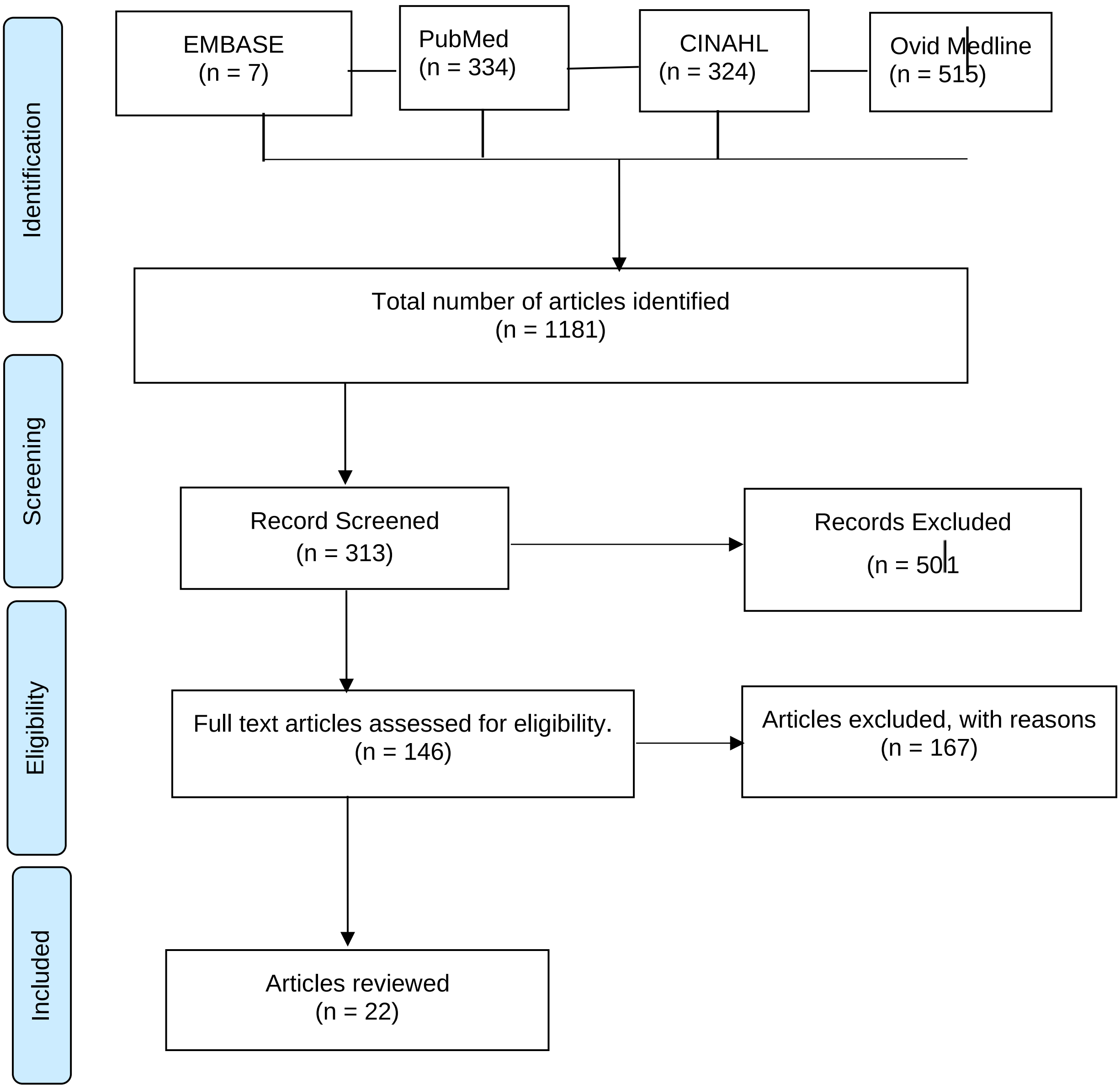

Figure 3.1: PRISMA flow chart for article screening

Table 3. 3 List of included studies with summary characteristics

S/N	Author (Year)	Location /context	Number of sample (Hospital)	Data collection tools	Methods of data collection	Number of event/ emergencies studied	Type of event /emergency studied	Core components in emergency preparedness studied
1	Lang, Verbicaro (199)	America and India	Numerous but unspecified	Rapid Visual Survey methods and Hospital Safety Index	Survey questionnaires based on WHO/PAHO standard checklist	1	Earthquake	Structural and non-structural
2	Miniati and Iasio (200)	Florence, Italy	5 hospitals	Bespoke based on WHO Framework	Document review, interviews	1	Earthquake	Structural and other unspecified elements
3	Norman et al (201)	Ghana	22 Hospitals	WHO (2007) Field Manual for Capacity Assessment of Health Facilities in Responding to Emergencies	Site visit, questionnaire Survey, literature, and internet review.	2	Road Traffic Accident, Burn	Non-structural. Hospital preparedness, equipment, manpower and surge capacity planning as best practices for the mitigation of public health emergencies.
4	Adini *et al* (79)	Israel	24 General hospitals / all-emergency acute care	Developed tools from MoH	MoH Survey, Review of the Standard Operating Procedures, Site visit for observation and measurements of other components.	3	Mass casualty events (MCEs), mass toxicological/chemical events (MTEs), and biological events (pandemics and bio-terror agents).	Non-structural. Standard operating procedures (SOP), Training and drills, Knowledge of staff, Infrastructure &Equipment

S/N	Author (Year)	Location /context	Number of sample (Hospital)	Data collection tools	Methods of data collection	Number of event/ emergencies studied	Type of event /emergency studied	Core components in emergency preparedness studied
5	Djalali et al (202)	Tehran, Iran and Stockholm, Sweden	9 hospitals	Hospital Safety Index (HIS)	Self-assessment using the PAHO/WHO standard questionnaire	7	Flood, earthquake, drought, frostbite, moto accident, landslide, and icy roads	Non-structural component
6	Jahangiri et al (203)	Tehran, Iran	1 hospital	Hospital Safety Index (HIS)	Self-assessment using the PAHO/WHO standard questionnaire	7	Flood, earthquake, drought, frostbite, moto accident, landslide, and icy roads	Structural, non-structural, and functional components
7	Perrone et al (204)	Italy	2 hospitals	Hospital Safety Index (HIS)	Rapid Visual Screening, PAHO/WHO checklist completion	1	Earthquake	Structural, non-structural, and functional components
8	Golabek-Goldman (205)	Israel-US	12 hospitals	Bespoke interview and observation tools.	Semi-Structured Interviews	2	Mass casualty incidents, both natural and man-made	Non-structural. Security protocol, lockdown, hospital procedure, defence and communication capabilities, mutual aid agreement, personal identification procedure, inclusion of security consideration in training and exercise emergency singing, and collaboration with outside low

S/N	Author (Year)	Location /context	Number of sample (Hospital)	Data collection tools	Methods of data collection	Number of event/ emergencies studied	Type of event /emergency studied	Core components in emergency preparedness studied
								enforcement agencies
9	Asefzadeh et al (206)	Iran	2 hospitals	Hospital Safety Index (HIS)	Observation, interviews, and completion of checklist	7	Flood, earthquake, drought, frostbite, moto accident, landslide, and icy roads	Structural, non-structural, and functional components
10	Ardalan et al (207)	Iran	421 hospitals	Hospital Safety Index (HIS)	Self-assessment questionnaire	7	Flood, earthquake, drought, frostbite, moto accident, landslide, and icy roads	Structural, non-structural, and functional components
11	Ahmadi et al (64)	Iran	12 hospitals	WHO standard checklist	Checklist completion, interviews	7	Flood, earthquake, drought, frostbite, moto accident, landslide, and icy roads.	Only functional capacity
12	Tabatabaei and Abassi (208)	Iran	3 hospitals	Hospital Safety Index (HIS)	Observation, interviews, and completion of checklist	5	Geological and climatic risk, environmental risks, technological disasters, social phenomena	Structural, non-structural, and functional components
13	Moghadam et al (209)	Iran	4 hospitals	WHO/PAHO Standard Checklist	Checklist completion	Several	Natural disasters such as earthquake	Non-structural elements including electrical systems, communication system, water supply system, fuel storage, heating, ventilation and cooling system,

S/N	Author (Year)	Location /context	Number of sample (Hospital)	Data collection tools	Methods of data collection	Number of event/ emergencies studied	Type of event /emergency studied	Core components in emergency preparedness studied
								office furniture, medical gases, medical equipment for diagnosis, architectural elements.
14	Monfared et al (210)	Iran	6 hospitals	WHO Standard Checklist	Observation, Interviews, checklist completion	7	Flood, earthquake, drought, frostbite, moto accident, landslide, and icy roads	Structural, non-structural, and functional components
15	Haryanto et al (211)	Indonesia	1 hospital	Rapid Visual Screening	Observation and completion of checklists	1	Earthquake	Structural and non-structural
16	Gargaro et al (212)	Italy	1 hospital	Structural Health Monitoring System (SHM)	Visual inspection of data	1	Earthquake	Structural elements
17	Santa-Cruz et al (213)	Peru	41 hospitals	Comprehensive Approach for Probabilistic Risk Assessment (CAPRA) using GIS tools	Review of previous published reports, review of building information, completion of digital forms, field data collection using mobile devices	1	Earthquake	Structural components including building vulnerability,
18	Nenkovic-Riznic et al (214)	Sebia	1 hospital	Hospital Safety Index (HSI)	HSI questionnaire, checklist, document	4	Transport accident, extreme temperature, earthquake, flood	Non-structural. Structural safety, risk management process, health

S/N	Author (Year)	Location /context	Number of sample (Hospital)	Data collection tools	Methods of data collection	Number of event/ emergencies studied	Type of event /emergency studied	Core components in emergency preparedness studied
					analysis, interview			centre's function, emergency, and disaster management
19	Moran-Rodriguez and Novelo-Casanova (215)	Mexico	4 hospitals	Hospital Safety Index (HIS)	Questionnaire, completion of checklist and interview	1	Earthquake	Structural, non-structural, functional and organisation of administrative activities.
20	Cruz-Vega et al (216)	Mexico	3 hospitals	Hospital Safety Index, PAHO/WHO Checklist	Administration of HIS questionnaire and completion of self-assessment checklist	1	Earthquake	Hospital structural elements
21	Lapzevic et al (217)	Serbia	1 hospital	Hospital Safety Index	Structured interviews	1	Flood	Non-structural. Architectural safety, infrastructure protection, access, physical securities, equipment and supplies, and critical systems
22	Aslani and Habibi (218)	Iran	1 hospital (15 hospital wards)	Fire Risk Assessment Method for Engineering (FRAME)	Use of checklist, observation, and interviews	1	Fire	Risk of fire for the building (structural), people (non-structural) and activities (functional)

With respect to the location of studies reported in reviewed articles, majority of articles reviewed (9 articles, 41%) covered studies conducted in Asia. Two (9%) articles reported studies conducted in America and Asia while 1 (4.5%) article reported studies conducted in Africa. Of the remaining 10 articles, 7 (32%%) covered studies conducted in Europe while the remaining 3 (14%) articles reported studies conducted in Latin America. The breakdown of articles by countries indicates that 8 articles (36%) reviewed reported studies conducted in Iran while another article reported a comparative study of Sweden and Iran (202). Studies by Lang et al (199) and Golabek-Goldman (205) were other multi-location studies which reported data collected from America/India and America/Israel respectively. The study reported by Norma et al (201) was the only study conducted in Africa. Studies reported by Miniati and Iasio (193), Perrone et al (204) , and Gargaro et al (212) were conducted in Italy. The two other European studies (conducted in Serbia) reviewed in this study were published by Nenkovic-Riznic et al (214) and Lapzevic et al (217). All other studies reviewed in this Chapter were conducted in South American countries of Peru and Mexico (215, 216). The analysis presented in Table 3.3 indicates that the number of health facilities covered in articles reviewed vary significantly. Jahangiri et al (203) , Haryanto et al (211), Gargaro et al (212) , Nenkovic-Riznic et al (214) , Lapzevic et al (217) and Aslani and Habibi (218) covered only 1 hospital, and the number of health facilities covered by the remaining studies ranged between 2 and 421 hospitals. The analysis of the distribution of articles reviewed based on the number of health facilities covered indicate that 15 articles (68.2%) covered 10 health facilities or less while 2 articles (9.1%) covered between 11 and 20 health facilities. Similarly, 2 articles (9.1%) covered between 21 and 30 health facilities while another 2 articles (9.1%) covered more than 30 health facilities. The number of health facilities covered by Lang et al (199) was not specified. It was simply reported as numerous.

It was also observed that tools used for data collection as well as the method of data collection adopted across reviewed articles differ significantly. Some of the articles used tools previously developed by renowned agencies such as the World Health Organisation while other developed bespoke tools and used such for data collection. The Hospital Safety Index developed by the World Health Organisation in collaboration with the Pan American Health Organisation (PAHO) was observed as the most commonly used tool for data collection (11 hospitals, 50%). Other checklists produced by the WHO were used by Ahmadi et al (64), Monfared et al (210), and Cruz-Vega et al (216). However, other studies reviewed used tools that are bespoke for the type of disaster event covered, such as the Fire Risk Assessment Method for Engineering (FRAME) used by Aslani and Habibi (218) and the Structural Health Monitoring System (SHM) used by Gargaro et al (212). In contrast, some other studies developed tools that are bespoke for the health facility to be assessed, such as the survey monitoring tool used by Adini et al (79) and the bespoke interview and observation tools used by Golabek-Goldman (205). For studies using the Hospital Safety Index and other tools developed by the WHO, questionnaire administration was the method used for data collection (15 articles, 68.2%). However, other data collection methods such as interviews (10 articles, 45.5%), site visit (4 articles, 18.2%), document analysis (4 articles, 18.2%) as well as observation and checklist completion (10 articles, 45.5%) were also used.

The distribution of reviewed articles based on the component of all-hazard covered indicates that 14 (63.6%) out of the 22 articles assessed all or some elements of functional components. Similarly, not articles reviewed assessed structural capacity of hospitals. Specifically, 15 (68.2%) out of the 22 articles assessed structural capacity either alone or in combination with other components of the all-hazard approach. Only Miniati and Iasio (200), Santa-Cruz et al (213), and Cruz-Vega et al (216) assessed only structural components. Non-structural component was the most commonly assessed components across all articles reviewed. In fact, 7 (31.8%) articles assessed only non-structural components while another 14 articles assessed non-structural components in combination with functional and/or structural components of the all-hazard approach. The analysis presented in Table 3.3 also indicated that disaster events covered in articles reviewed differ significantly. The majority of articles (12 articles, 54.5%) reviewed in this study covered multiple disaster events including road transport accident, extreme temperature, earthquake, flood, drought, frostbite, landslide, and icy roads. For articles which focused on single disaster events, earthquake was the most common disaster events covered (9 out of 10 articles).

3.6.3 Analysis of Functional Components of All-hazard Approach in Selected Articles

Components of the functional domains of the all-hazard approach covered in selected were analysed in this thesis. The summary of data presented in Table 3.4 indicates that 14 (63.6%) articles assessed components of the functional domain and components covered by these articles differ significantly. Hazard Vulnerability Assessment element of the functional component was assessed by only 7 articles (31.8%) while the emergency management element was assessed in 12 (54.5%) articles. The number of articles assessing functional components such as communication (9 articles, 40.9%), command and control (9 articles, 40.9%), human resources (9 articles, 40.9%), safety and early warning systems (6 articles, 27.3%), emergency operation and response (8 articles, 36.4%), triage (3 articles, 13.6%), training and drills (5 articles, 22.7%), decontamination (3 articles, 13.6%), mutual aid and networking (8 articles, 36.4%), evacuation and transportation (1 article, 4.5%), disease surveillance (5 articles, 22.7%) and fatalities management 3 articles, 13.6%) differ significantly. These data indicate that Hazard Vulnerability Assessment (HVA) was the most assessed element while none of the articles assessed hazards relating to laboratory and blood bank. Further analysis revealed that components of the functional domain assessed across selected articles ranged from one assessed by Gargaro et al (212) to 11 elements assessed by Moran-Rodriguez and Novelo-Casanova (215) . Also, 6 other articles assessed 8 out of the 15 components of the functional domain listed in Table 3.4.

Table 3. 4 Summary of the functional capacity assessment of selected articles

S/N	Author (Year)	All-hazard emergency management Component ((Functional capacity)														
		HVA	EM	C	CC	HR	S&E	LB	EOC	T	D	MA	E&T	DS	FM	T &D
1	Lang (199)	X	x	X	X	X	x	X	X	X	X	X	X	X	X	X
2	Miniati and Iasio (200)	x	x	X	X	X	x	X	X	X	X	X	X	X	X	X
3	Norman (201)	x	✓	X	X	✓	x	X	✓	✓	X	✓	✓	X	X	✓
4	Adini (79)	x	✓	X	X	✓	x	X	✓	X	X	X	X	X	X	✓
5	Djalali (202)	x	X	X	X	X	x	X	x	X	X	X	X	X	X	X
6	Jahangiri et al (203)	✓	✓	✓	✓	✓	X	X	X	X	✓	X	✓	X	✓	X
7	Perrone et al (204)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8	Golabek-Goldman (205)	x	✓	X	✓	X	✓	X	X	✓	X	✓	X	X	X	✓
9	Asefzadeh et al (206)	x	X	✓	✓	X	X	X	✓	X	X	X	X	X	X	X
10	Ardalan et al (207)	x	X	✓	✓	X	X	X	✓	X	X	X	X	X	X	X
11	Ahmadi et al (64)	✓	✓	✓	✓	✓	✓	X	✓	X	X	X	✓	X	X	X
12	Tabatabaei and Abassi (208)	✓	✓	✓	✓	✓	✓	X	✓	X	X	X	✓	X	X	X
13	Moghadam et al (209)	x	X	X	X	X	X	X	X	X	X	X	X	X	X	X
14	Monfared (210)	x	✓	X	X	X	✓	X	✓	X	X	X	X	X	X	X
15	Haryanto (211)	x	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16	Gargaro et al (212)	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X
17	Santa-Cruz et al (213)	x	X	X	X	X	X	X	X	X	X	X	X	X	X	X
18	Nenkovic-Riznic et al (214)	✓	✓	✓	✓	✓	X	X	X	X	✓	X	✓	X	✓	X
19	Moran-Rodriguez and Novelo-Casanova (215)	✓	✓	✓	X	✓	✓	X	X	✓	✓	✓	✓	✓	✓	X
20	Cruz-Vega et al (216) (208)	✓	✓	✓	✓	✓	X	X	X	X	✓	X	✓	X	✓	X
21	Lapzevic et al (217)	✓	✓	✓	✓	✓	X	X	X	X	✓	X	✓	X	✓	X
22	Aslani and Habibi (218)	X	✓	X	X	X	✓	X	✓	X	X	X	X	X	X	X

Key: HVA = Hazard Vulnerability Analysis, EM = Emergency Management, C= Communication, CC = Command and control, HR = Human resources, S&E = Safety and Early warning system, LB = Laboratory and blood bank, EOC = Emergency Operation and Response, T = Triage, T&D = Training and drills, D = Decontamination, MA = Mutual Aid and networking, E&T = Evacuation and transportation, DS = Disease Surveillance, FM = Fatalities Management, NA = Not applicable

3.6.4 Analysis of Structural Components of All-hazard Approach in Selected Articles

The summary of data on components of the structural domain of the all-hazard approach in selected articles is presented in Table 3.5. Generally, components relating to building integrity, the impact of previous of hazard/disaster events on the building and other structural components were assessed in some of the selected articles in this study. Specifically, 18 (81.8%) out of the 22 articles reviewed covered some components of the structural domain even though the extent of the coverage varies significantly. The highest number of components (9 components) of structural domains were assessed in the study by Lang (199), Haryanto (211) and Santa-Cruz et al (213). These include all the components on building integrity listed in Table 2,5 and the previous hazard component. The study by Jahangiri et al (203), Nenkovic-Riznic et al (214), Cruz-Vega et al (216) and Lapzevic et al (217) assessed all building integrity components except building defection. However, these studies except Lapzevic et al (217) also assessed structural effects of previous hazards. Majority of building integrity components were not assessed by other articles listed in Table 3.5 which covered the structural domain of all hazard approach. However, these articles covered a wide range of other building integrity components (other than those listed in Table 3.5), including alterations and remodelling, and structural systems, replacement costs and years of construction. Moreover, 10 (45.5%) of articles review also covered other structural elements which are not related to previous hazards or building integrity. These include architectural shape, replacement costs and years of construction.

Table 3. 5 Summary of the structural capacity assessment of selected articles

S/N	Author (Year)	All-Hazard Emergency Management Component ((Structural Capacity)									
		Building Integrity (BI)								PH	Others SE
		CK	CL	BM	WL	FS	FD	DF	Other BI		
1	Lang et al (199)	✓	✓	✓	✓	✓	✓	✓	✓	✓	x
2	Miniati and Iasio (200)	X	X	x	x	x	x	x	x	X	x
3	Norman *et al*. (201)	X	X	x	x	x	x	x	✓	✓	✓
4	Adini *et al*, (79)	X	X	x	x	x	x	x	✓	✓	✓
5	Djalali et al (202)	X	X	x	x	x	x	x	x	X	x
6	Jahangiri et al (203)	✓	✓	✓	✓	✓	✓	x	X	✓	X
7	Perrone t al (196)	X	X	x	x	x	x	x	✓	✓	✓
8	Golabek-Goldman (205)	X	X	x	x	x	x	x	✓	✓	✓
9	Asefzadeh et al (206)	X	X	x	x	x	x	x	✓	✓	x
10	Ardalan et al (207)	X	X	x	x	x	x	x	✓	✓	x
11	Ahmadi et al (64)	X	X	x	x	x	x	x	x	X	x
12	Tabatabaei and Abassi (208)	X	X	x	x	x	x	x	✓	✓	x
13	Moghadam et al(209)	X	X	x	x	x	x	x	x	X	x
14	Monfared et al (210)	X	X	x	x	x	x	x	x	✓	✓
15	Haryanto et al (211)	✓	✓	✓	✓	✓	✓	✓	✓	X	✓
16	Gargaro et al (212)	X	X	x	x	x	x	✓	✓	✓	✓
17	Santa-Cruz et al (213)	✓	✓	✓	✓	✓	✓	✓	✓	x	✓
18	Nenkovic-Riznic et al (214)	✓	✓	✓	✓	✓	✓	x	X	✓	X
19	Moran-Rodriguez and Novelo-Casanova (215)	X	✓	x	✓	✓	✓	x	✓	x	✓
20	Cruz-Vega et al (216)	✓	✓	✓	✓	✓	✓	x	X	✓	X
21	Lapzevic et al (217)	✓	✓	✓	✓	✓	✓	x	X	X	X
22	Aslani and Habibi (218)	X	X	x	x	x	x	x	x	✓	✓

Key: CK = Cracks, CL = Columns, BM = Beam, WL = Wall, FS = Floor Slabs, FD = Foundation, DF = Defections, BI = Building Integrity, PH = Previous Hazard which affected the building, SE = Structural Element

3.6.5 Analysis of Non-structural Components of All-hazard Approach in Selected Articles

The summary of data on components of the non-structural domain of the all-hazard approach in selected articles is presented in Table 3.6. All articles selected in this study except the study by Ahmadi et al (64) and Santa-Cruz et al (213) covered at least one component of the non-structural domain. Moreover, it was also observed that apart from Miniati and Iasio (200), Monfared et al (210), Haryanto et al(211) , Gargaro et al (212), and Aslani and Habibi (218), all other articles reviewed in this study assessed all the components of the non-structural domain listed in Table 3.6. Miniati and Iasio(200) did not cover AS, IP, CS, TS, WM, FS, HVAC and OF while Monfared et al (210) did not assess IP, CS, FP, and WM. Haryanto et al (211) assessed only 5 out of the 13 components of the non-structural domain while Gargaro et al (212) lacked all the components except one (Table 3.6).

3.6.6 Best Practices and Challenges Facing the Implementation of the All-Hazard Approach

Key findings of all articles selected for review in this study were collated and analysed with a view to understand best practices and challenges associated with the implementation of the all-hazard approach. Details of these findings summarised in Table 3.7. In the first instance, it was observed that the development of an appropriate tool for all hazard vulnerability assessment or the adoption of previously developed tools in a new setting was the central focus of some of the studies reviewed in this chapter. For example, Lang et al (199), Miniati and Iasio (200), Perrone et al(204) , Haryanto et al (211), and Moran-Rodriguez and Novelo-Casanova (215) developed new tools for hazard vulnerability assessment. The rationale behind the need for the development of new tools, as stated in these studies, ranged from the need to address challenges relating to the inappropriate nature of existing tools and the peculiar nature of the disaster event that the hospital is at risk of (199, 200) . Lang et al (199) and Perrone et al (204) particularly assessed seismic vulnerabilities of hospitals and indicated that existing tools are more sophisticated and advanced for the type of assessment needed. Moran-Rodriguez and Novelo-Casanova (215) on the other hand highlighted that challenges such as lack of basic technologies and poor knowledge among staff members are among factors which warranted the development of a new tool effective vulnerability assessment.

Table 3. 6 Summary of the non-structural capacity assessment of selected articles

S/N	Author (Year)	All-Hazard Emergency Management Component (Non-structural Capacity)													
		AS	IP	CS	TS	ES	FP	WS	WM	FS	MGS	HVAC	EQS	OF	Others
1	Lang et al (199)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
2	Miniati and Iasio (200)	x	X	x	X	✓	✓	✓	x	x	✓	x	✓	x	✓
3	Norman *et al*. (201) *et al*.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
4	Adini *et al*, (79)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
5	Djalali et al (202)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
6	Jahangiri et al (203)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
7	Perrone et al (204)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
8	Golabek-Goldman (205)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
9	Asefzadeh et al (206)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
10	Ardalan et al (207)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
11	Ahmadi et al (64)	x	X	x	X	X	x	x	x	x	x	x	x	x	x
12	Tabatabaei and Abassi(208)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
13	Moghadam et al (209)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
14	Monfared et al (210)	✓	X	x	✓	✓	x	✓	x	✓	✓	✓	✓	✓	✓
15	Haryanto et al (211)	✓	✓	x	X	✓	x	x	x	x	x	✓	✓	✓	✓
16	Gargaro et al (212)	x	X	x	X	X	x	x	x	x	x	x	x	x	✓
17	Santa-Cruz et al (213)	x	X	x	X	X	x	x	x	x	x	x	x	x	x
18	Nenkovic-Riznic et al (214)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
19	Moran-Rodriguez and Novelo-Casanova (215)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
20	Cruz-Vega et al(216)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
21	Lapzevic et al (217)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
22	Aslani and Habibi Aslani (218)	✓	X	x	✓	✓	x	✓	x	✓	✓	✓	✓	✓	✓

Key: AS = Architectural Safety, IP = Infrastructural Protection, CS – Critical System, TS = Telecommunication System, ES = Electrical System, FP = Fire Protection, WS = Water System, WM = Waste Management, FS = Fuel Storage, MGS = Medical Gas System, HVAC = Heating, Ventilation and Air Conditioning, EQS = Equipment and Supplies, OF = Office Furniture

Other rationales such as obsolete nature of existing tools and challenges associated with the administration of more complex tools were also highlighted in some of the studies reviewed as the need for the development of bespoke tools. For studies which used standard tools (questionnaires and checklists) developed by reputable organisations such as the WHO and PAHO for data collection, the trend observed was that these tools were used at locations where the implementation of all hazard approach were generally missing. This assertion is supported by key findings of studies, such as Norman et al. (201), Jahangiri et al.(203), Ardalan et al (207), Ahmadi et al(64), Tabatabaei and Abassi(208) and Gargaro et al (212) , which generally showed the lack or poor adoption of all hazard approach.

Careful perusal of data presented in Table 3.3 vis-à-vis findings presented in Table 3.7 revealed some best practices which contributed to effective all hazard vulnerability assessment in studies reviewed in this study. Majority of available all hazard vulnerability assessment tools are in the form of questionnaire. However, the combination of questionnaire administration with other data collection methods was observed in some of the articles reviewed in this study (64, 79, 199, 201, 202, 204, 206, 208, 210, 213, 215, 218). These studies combined methods such as site visit, document analysis, participants observation, semi-structured and structured interviews, and visual inspection with questionnaire administration to obtain findings presented in Table 3.7. Another important observation from the articles reviewed in this study is the fact that all hazard vulnerability assessments reported were tied to one or more types of disaster. The fact many studies reviewed considered multiple disaster events indicates that the hazard vulnerability assessment conducted may truly represent the all hazard approach (64, 79, 202, 203, 205-210, 214). However, other studies (199-201, 204, 211, 213, 215, 218) focused on one disaster events and this may cast doubt on whether the assessment conducted in these studies are true adoption of the all hazard approach.

With respect to challenges facing the adoption of all hazard approach to hazard vulnerability assessment, many of the studies reviewed did not explicitly highlight challenges or barriers. However, indicators of barriers could be observed in some of these studies. In the first instance, barriers relating to problems inherent in assessment tool could be inferred for all studies which developed and tested bespoke tools. Some of these studies specifically highlighted that available tools are either too advanced or inappropriate for the type of disaster event focused on (199, 204). Also, Cruz-Vega et al (216) indicated that biases that may be associated with self-assessment, which is often the data collection procedure when using questionnaire-based tools, is a major barrier to effective hazard vulnerability assessment across many hospital settings and a potential source of variability in results obtained when multiple tools were used to assess the same healthcare organisation. Furthermore, Nenkovic-Riznic et al (214) indicated that improper delineation and classification of disasters in some of the available tools may affect proper hazard vulnerability assessment.

Some of the studies reviewed in this chapter also highlighted the role leadership and management in effective disaster preparedness and response process. This was highlighted as a barrier to effective hazard vulnerability assessment where lacking. For instance, Jahangiri et al (203) indicated that important decisions by managers are necessary for effective HVA and in turn, good HVAs are essential in helping managers to make important decisions about hospital safety. Similarly, Santa-Cruz et al (213) indicated the need for a disaster management committee to ensure that regular hazard vulnerability assessments are conducted and that risks are constantly measured and prioritised in the interest of hospital safety. Moreover, challenges listed by Moran-Rodriguez and Novelo-Casanova (215), including the obsolete nature of emergency plans which makes response activities difficult, the lack of basic equipment, irregular nature of hazard vulnerability assessments and inadequacy of financial resources, are problems that an effective disaster management committee will address. Similarly, in a study which examined the level of preparedness of a hospital for fire hazard, Aslani and Habibi (218) also highlighted that the absence of a disaster management team is responsible for the poor level of fire safety observed in the hospital. The role of management highlighted by Nenkovic-Riznic et al (214) include the raising of awareness of regular hazard vulnerability assessment as well as the training of hospital staff members.

Table 3. 7 Summary of aims findings and implications of results of articles reviewed.

S/No	Author (Year)	Aim of the study	Major finding	Implications for all-hazard preparedness
1	Lang (199)	The study developed a questionnaire for seismic vulnerability assessment of schools and hospitals, and tested it in a case hospital	The study reported the utility of the questionnaire as an effective tool for HVA assessment of health facilities	The new tool is presented as a tool that could be used widely to overcome challenges associated with the need for an effective tool for all-hazard vulnerability assessment.
2	Miniati and Iasio (200)	The study developed and tested an integrated method for assessing safety of hospital systems in Italy	The study generally reported that the capacity of assessed hospitals is lower compared to what is required with only one hospital having the capacity for effective response to seismic disaster.	The study highlighted the importance of an all-hazard approach to vulnerability assessment. It suggests the need to place priorities on the safety of the most vulnerable hospital users when designing emergency response programs
3	Norman (201)	The study assessed the emergency preparedness programs of health facilities for all-risks but with focus on Road Traffic Accidents, (RTA) in Ghana	The study reported that many of the hospitals are not prepared for large scale emergencies. Pre-emergency and emergency preparedness plans are lacking	The study indicated that the implementation of all-hazard approach is missing. Most of the components of all-hazard approach are not present in the hospitals assessed
4	Adini (79)	To investigate the relationship existing among hospitals' preparedness for various emergency scenarios, and to evaluate whether components of one emergency scenario correlate with preparedness for other emergency scenarios	The study reported a significant relationship between preparedness for different emergencies. Correlation exists between the standard operating procedure for biological events and preparedness for other events, Correlation also exists between training and drills with preparedness for emergencies. SOPs, training, and skills improve preparedness.	This finding implied that emergency preparedness can be universal due to similarities in the different components of emergency preparedness for different disasters. The study highlighted the importance of functional elements such as drills, training, and development of standard operational protocols
5	Djalali (202)	The study compared non-structural safety of hospitals in Tehran and Stockholm	The study reported that the level of hospital safety is not related to local vulnerability.	The study points to the fact that other factors which have legal and financial implications may play key roles in determining the level of hazard preparedness of hospitals.
6	Jahangiri (203)	The study assessed the Hospital Safety Index of one hospital in Tehran	The assessment revealed that the level of safety of the hospital. is inadequate.	The study demonstrates the utility of the HSI tool in assessing hospital safety. It highlights the importance of HVA in helping managers to make important decisions about hospital safety.
7	Perrone(204)	The study assessed the level of seismic vulnerability of a	The study proposed a new method for assessing hospital safety index to	The report demonstrated the effectiveness of the tool used in conducting all-hazard assessment of

S/No	Author (Year)	Aim of the study	Major finding	Implications for all-hazard preparedness
		selected hospital using visual screening	address challenges associated with the use of more advanced techniques. The new method was successfully used to assess structural safety of hospital buildings.	vulnerabilities. However, it reported that for the method to be effective, non-structural, and functional domains must be assessed.
8	Golabek-Goldman (205)	The study examined lessons from Israelis experience for improving US hospital security preparedness for a wide range of mass casualty incidents, both natural and man-made	The study indicated that hospitals assessed lacked adequate preparation for large scale disaster events. There is a need for training, improved security, enhanced coordination, and installation of permanent and emergency signs. Documents such as the National Response Framework and the National Response Plan for America were also reviewed in the study	Inadequacies observed are clear indications of the need for an all-hazards approach towards emergency preparedness. Several functional and non-structural elements are indicated as missing.
9	Asefzadeh (206)	The study reviewed the level of hospital safety of two hospitals in Qazvin, Iran	High level of structural, non-structural, and functional safety was observed in the hospital. Levels of equipment, water supply, medicine supply and other related resources were high	The area experiences frequent disasters and the need for retrofitting was highlighted in the report. This is despite the report of a high level of non-structural safety. It is possible that the assessment tool used, or the implementation of the tool missed some key points.
10	Ardalan et al (207)	The study assessed the level of hospital safety of selected hospitals in Iran	Most of the hospitals in the region have an average level of safety while about 20% were not safe. The level of functional, structural, and non-structural capacities was also average	Though hospital safety in Iran is increasing, the tool used is effective in identifying where more improvements are needed. The all-hazard approach to safety assessment is effective.
11	Ahmadi et al (64)	The study investigated the functional disaster preparedness level of hospitals in Tehran	Generally, satisfactory levels of capacity and low level of vulnerability were reported. However, weakness in procedures, plans, human resources, monitoring, evaluation were observed.	This study demonstrated the utility of the WHO checklist. The need for an all-hazard approach is evident because weaknesses observed may have significant impact on other areas of vulnerability.
12	Tabatabaei and Abassi (208)	The study investigated factors influencing the level of disaster preparedness of selected hospitals in Iran	All hospitals assessed had a moderate level of preparedness. The need for improved planning, and some short-term measures to reduce damage was highlighted.	The reported demonstrated the effectiveness of the tool used in conducting all-hazard assessment of vulnerabilities
13	Moghadam et al (209)	The study evaluated non-structural retrofitting status of	The study identified key non-structural items where improvement is needed. The	The retrofitting status of hospitals assessed was observed to be inadequate. The study

S/No	Author (Year)	Aim of the study	Major finding	Implications for all-hazard preparedness
		Kerman teaching hospitals against natural disasters	lowest preparedness score was obtained for medical gas supply while office and warehouse furniture had the highest score	highlighted the importance of executive buy-in in ensuring effective hazard vulnerability assessment.
14	Monfared et al (210)	The study assessed the level of hazard preparedness of hospitals in Qazvin region of Iran	Hospitals in the region were assessed to have average levels of functional, structural, and non-structural hazard preparedness.	The study demonstrated the successful adoption of the all-hazard approach to hazard vulnerability assessment. It highlights the importance of regular assessment to ensure safety of hospital users and better preparedness for
15	Haryanto et al 2017 (211)	The study assessed the level of seismic vulnerability of a hospital in Indonesia	The rapid visual screening method used revealed deficient structural and non-structural capabilities	The report demonstrated the effectiveness of the tool used in conducting all-hazard assessment of vulnerabilities
16	Gargaro et al (212)	The study assessed structural and non-structural capabilities of a hospital following episodes of earthquakes	The report indicated the negative impact of earthquake on structural and non-structural capacities of the hospital. Retrofitting is needed	The reported demonstrated the effectiveness of the tool used in conducting all-hazard assessment of vulnerabilities
17	Santa-Cruz et al (213)	The study investigated the seismic risk of hospitals in Lima City	The study reported that majority (80%) of hospitals in the region experienced about 10% structural damage and about 2% loss of activity	The study highlights the importance of regular hazard vulnerability assessment with the aim of defining, measuring risks and prioritizing mitigation actions.
18	Nenkovic-Riznic et al (214)	The article gave an overview of methods for hospital hazard vulnerability assessment and examined the correlation between safety Index of healthcare facilities and climate change	The study recommended the evaluation of the HSI, and the highlighting of hazards affected by climate change in a way that facilitates effective assessment. It established direct correlation between hazards affecting hospital safety and the role of the hospital in emergency and disaster management	The article highlighted that improper delineation and classification may affect proper hazard assessment and proposed a way of addressing this. The important role of the hospital in disaster management was further highlighted, lending to why increased awareness and training of hospital staff members is essential.
19	Moran-Rodriguez and Novelo-Casanova (215)	The study developed and tested a new vulnerability assessment tool for hospitals based on all hazard approach	The study reported the effectiveness of the new tool in identifying and establishing the degree of vulnerabilities in hospitals assessed	The study indicated that challenges facing effective hazard vulnerabilities assessment include lack of basic technologies, disaster response plans that are not up-to-date, and lack of financial resources. It pointed out the need for regular maintenance of hospital buildings.
20	Cruz-Vega et al (216)	The study compared the utility of HSI and self-assessment for vulnerability in a hospital setting	The study reported variability in the result obtained using HSI and the WHO/PAHO checklist. This was attributed to self-assessment biases	This study underscores the importance of biases in assessing hazard vulnerability and why it is important to use the right tool. The study

S/No	Author (Year)	Aim of the study	Major finding	Implications for all-hazard preparedness
				recommends the utility of HSI in facilitating effective hazard vulnerability assessment.
21	Lapzevic et al (217)	The study assessed safety and disaster preparedness of primary healthcare centres in Obrenovac municipality of Serbia	The study obtained an overall safety index of 0.82 as well as functional, structural, and non-structural indices of 0.75, 0.95 and 0.74, respectively.	Values obtained indicated that primary healthcare centeres assessed are able to function during flood disaster. However, the need for improvement in key areas such as emergency power, water supply, telecommunication and emergency medical supply were observed. Moreover, modifying HSI by adjusting content to fit primary healthcare setting and language translation was pivotal to the successful adoption of the all-hazard approach in hazard vulnerability assessment.
22	Aslani and Habibi (218)	The study examined the level of preparedness of a hospital for fire hazard	The study revealed a poor level of fire safety in the hospital.	The study identified the absence of a disaster management team in the hospital. It further indicated the importance of concerted efforts in HVA assessment and emergency response/preparedness.

3.7. Discussion

The review conducted in this study has revealed that all-hazard approach has been adopted to some extent in assessing hazard vulnerabilities of healthcare facilities across many countries. However, several limitations and challenges have been associated with the adoption of this approach to hazard vulnerability assessment. It was observed that most of the studies adopting this approach were conducted in Asia and this is consistent with the previous observation that Asia and the Pacific are the most disaster prone regions of the globe (219) . In fact, Guha-Saphir and Hoyois (219) reported that there were 81 weathers, climate and/or water-related disasters in Asia in 2022 alone. These were reported to result in 5000 mortality and direct/indirect effects on over 50 million people. Consistent with this rate of disaster, the chance of healthcare facilities being affected by these disasters is very high. This may be responsible for increase in the awareness of hazard vulnerability assessment in hospitals across the region.

Challenges associated with the choice of appropriate tools for all hazard vulnerability assessment have been previously recognised (220). In fact, having a study which evaluated five hazard screening tools, Panko et al (221) indicated that reliability of tools to provide consistent and credible hazard scores has been a challenge. This previous observation is consistent with what the review reported in this chapter has shown. Many of the studies reviewed developed and tested new data collection tools as a way of addressing some of the challenges associated with available HVA tools. Though many of these new tools were reportedly successfully used to access hazard vulnerability of healthcare facilities in articles reviewed, it is not yet clear if these tools were significantly better than previously available tools.

The Hospital Safety Index was observed to be the most commonly used tool for HVA across studies reviewed. Originally, the tool was developed for the assessment of hazard vulnerability, to make recommendation for necessary actions as well as to promote measures that are affordable and have high impact on improving hospital safety and strengthening the capacity of healthcare facilities (222). However, limitations such as the lack of elements on the assessment of the availability and training of health workers as well as the security of hospital staff and patients were noticed in the original document, leading to some modifications implemented in 2015 (222). These additions notwithstanding, it is not yet clear if all the domains of all hazard approach are represented in the tool.

The lack of comprehensiveness of the HSI and other tools was also indicated by the observation that not all studies reviewed assessed all the domains of all hazard approach, despite the fact that they used these tools for data collection. Even in studies where both the functional, structural, and non-structural domains were assessed, several components of these different domains were conspicuously missing. This clearly points to one of the significant gaps in knowledge with respect to the implementation of the all-hazard approach.

The observation that functional elements were generally not assessed across many of the studies reviewed in this chapter is also an indication of the lack of comprehensiveness of tools commonly used for hazard vulnerability assessment. Generally, functional capacity of a hospital refers to those elements that relates to the day-to-day functioning of the hospital (223). Therefore, when the level of preparedness for hazards affecting these capacities are not assessed in HVA, the hospital is at a high risk of not being able to function in the event of a disaster. Consistent with this, the observation that the level of HVA preparedness (as a functional element) was assessed in only 9 articles points to the need for increased awareness and engagement with HVA-related activities. However, differences in the functional elements addressed across studies reviewed in this study may not be attributable only to the incomprehensive nature of the tool used. This assertion is supported by the fact that there are differences in the types of functional element covered even across studies that used exactly the same tool. Therefore, other factors, such as those relating to the organisation being assessed and/or skills of the staff member who is administering the tool, may be responsible for this observed difference. None of the articles reviewed in this Chapter assessed hazards relating to laboratory and blood bank services as well as triage. These are two elements of the functional domain that require specialist skills and the lack of skills may be responsible for why these elements were not assessed in any of the articles reviewed.

The trend observed for the assessment of functional and structural components of the all-hazard approach in articles reviewed is also similar.

In fact, elements of the structural domain were the least assessed across all the studies reviewed in this study. Structural elements often refer to the engineering aspect of the hospital infrastructure (buildings and other environmental structures) (224). It is in line with this that commonly assessed parameters often relate to impact of disasters on building. Consistent with this, elements assessed across all the articles reviewed were largely categorised under building integrity (which covered defects on the building or availability of structures which could make the building to withstand the impact of disasters). Also, buildings that have been affected by previous disaster events may have inherent defects that may not be immediately visible, and this is a clear indicator of future disaster risk (225). It is against this background that data on whether articles assessed history of disasters (PH) were collected in this review. However, it was evident that only 7 articles conducted thorough assessment of building integrity out of the 22 articles reviewed. Again, this observation could be due to problems inherent in tools used and/or skills of the people involved in the assessment. With respect to tools, it was observed that some of the studies reviewed developed new tools because they considered available tools to be too complicated for the analysis of structural components of the all-hazard approach. These complications could arise from the fact that terms used in these tools and engineering details required as part of the assessment process may be too technical for safety officers without an engineering background. Therefore, the utility and the accuracy of data collected using such tools may be limited. Less complicated tools developed and tested by in some studies (199, 200, 215, 216) were reportedly used to assess structural capacity of health facilities. However, indicators of how the level of success achieved compares to what is achieved with existing tools were not presented in these articles except in the study by Cruz-Vega et al (216) . The comparison of the utility of HSI and a new assessment tool developed by Cruz-Vega et al (216) revealed significant differences in the result obtained with biases inherent in the new assessment tool highlighted as the cause of the disparity. The observation points to challenges that may be associated with new tools and suggests the need for critical evaluation of these new tools before they are used widely for safety or hazard vulnerability assessments. Ostrom and Wilhelmsen also hinted that there are various commercially available tools for hazard vulnerability assessments(220). However, the level of reliability of these tools and how they compare to tools developed by agencies such as PAHO and the WHO are not known.

Non-structural capacity of healthcare facilities was more largely assessed in articles reviewed in this chapter compared to functional and structural capacities. The fact that all articles reviewed except (64, 213) , covered these components is an attestation to the fact that available tools may be more adaptable to non-structural capacities compared to functional and structural capacities. Moreover, many of the elements of the non-structural domain are items which can be easily assessed without the need for special or technical skills. In fact, many of the available tools simply requires the officer conducting the assessment to indicate whether items are present or not, and in most cases, these do not require technical expertise or advanced skills. Similar to what has been observed for other domains of the all-hazard approach, significant differences in the level of comprehensiveness of how non-structural components were assessed was also observed across all the studies reviewed in this chapter. While majority of studies which developed and tested new HVA data collection tools covered as many non-structural elements as those using existing tools, limited coverage was observed in some studies which implemented new HVA tools. A typical example is the study by Miniati and Iasio (200) which only assessed electrical systems, fire protection, water supply, medical gas system and equipment and supplies. However, the study by Miniati and Iasio (200) included other elements such as surgical department, ICU, internal connections, morgues, and diagnostics. These are items which are not commonly assessed by many new and existing tools.

The analysis of best practices in the implementation of all hazard approach across articles reviewed indicate that there is a wide adoption of existing tools, the focusing of hazard vulnerability assessment of key disaster events with higher risks in the location where assessments are being conducted, and the use of multiple methods for data collection to facilitate better accuracy. Issues relating to HVA tools have been extensively discussed in this chapter, but it is worthy of mention that the use of already validated tools, particularly at locations where knowledge of tool development is limited is a best practice. Advantages such as increased population generalisability, better reliability, and overall better trustworthiness of scores obtained have been identified for the use of validated tools in research (226). These advantages can also be attributed to HVA data generated using previously validated tools. HSI (the most commonly used previously validated tool) also have sections which provide recommendations and help hospital safety managers in making decisions. However, this advantage of the tool seems not be properly used in all the studies reviewed in this chapter. Even though some of the reviewed articles made some recommendations, these recommendations seem not to have emanated from actions proposed in the HSI tool.

Some barriers were also identified from reviewed articles as militating against the adoption or implementation of all hazard approach as well as reasons for which some of the hospitals assessed have poor safety indices. As summarised in Section 3.6.6, many of these barriers relate to challenges inherent in assessment tools plus lack of basic infrastructure as well as human and financial resources. Challenges associated with vulnerability assessment have been previously reported to largely relate to components of hazard vulnerability such as exposure and sensitivity which may have different implications for different healthcare organisations, methods and tools used in vulnerability assessment, and targets of vulnerability assessment (224, 226). These previously highlighted challenges are consistent with challenges that have been identified in the present study. This study also identified the role of proper management in effective disaster preparedness and response at the hospital level. This observation is also consistent with a previous report of role of hospital managers in facilitating patient safety(227). The study highlighted that good managerial activities characterised by good strategy, safety conscious culture, data-centred managerial activities, are positively correlated with improved patient safety within the hospital setting (227). To a large extent, these roles will also positively impact on hazard vulnerability assessment while also ensuring that hospitals are better prepared to response to various types of disasters.

The development of appropriate policies at both institutional and national levels to address some of the challenges associated with effective disaster management at the hospital levels was highlighted in some of the studies reviewed in this chapter. This is consistent with has been previously reported by Veenema et al (228). The lack of adequate all-hazard disaster preparedness plans in some of the hospitals assessed were highlighted in some of the articles reviewed. In addition to policy gaps, other factors such as the lack of adequate understanding of the process by people involved in the development of emergency response plans and lack of appropriate tools for the all-hazard vulnerability assessment may also be responsible for the lack of emergency plans (229). Adini et al (59, 230) indicated that significant relationship exists between the preparedness for one disaster and the level of preparedness for other disasters. The study highlighted that correlation exists between the standard operating procedure for biological event and preparedness for other events. It also highlighted that there exists a correlation between various components of HVA such as training and drills, SOPs development across different emergencies. These observations have been confirmed by previous studies (231, 232). As an example, in a study which discusses how hospital bioterrorism preparedness can be a basis for burns disaster preparedness, Kearns et al (231) emphasized that the whole essence of all-hazard approach is about how preparedness for disasters can be all encompassing and with wider impact. The report particularly narrated events that happened during a burns disaster and highlighted how preparedness for bioterrorism attack can be adapted to respond to burns disaster. The interrelatedness in emergency preparedness was the focus of the study by Evans et al.(232). The study, which describes the Ready framework of the US Department of Homeland Security for emergency preparedness, used fire incidence as a case study to demonstrate the effectiveness of the approach in developing an all-hazard approach towards different emergency scenarios.

To address challenges associated with the availability of tools, reports of several studies which investigated the effectiveness of bespoke tools were reviewed in this Chapter and observations reported in this chapter are consistent with previous reports. For instance, in a study which assessed the level of disaster preparedness as well as training needs of doctors and nurses in the emergency department in Hong Kong, Lam et al (233) reported that having a tool that is specifically designed for an organization can help in the identification of organisation-specific challenges towards the development of emergency plan.

Moreover, emergency preparedness in many of the hospitals assessed in articles reviewed were judged as lacking comprehensiveness with key aspects of functional and structural domains missing. However, the importance of these missing domains has been highlighted in the literature. For example, in a study which aimed at documenting the importance of hospital preparedness in responding to epidemic and pandemic respiratory disasters, Daugherty et al (234) specifically highlighted the importance of functional elements of an all-hazard approach for an institutions to be well-prepared for disasters of all types. Der-Martirosian et al (235) also highlighted that regular assessment of functional and non-structural capabilities of an organisation is essential for the improvement of the level of emergency preparedness of such an organisation. Consistently, Yoon et al (236) indicated that non-structural tool can be used as a core element of an all-hazard approach to emergency preparedness and this may be the reasons why non-structural domains were more readily assessed in many of the articles reviewed in this chapter. The same need for adequate development of adequate non-structural and functional capacities was highlighted by Steven Ross (237) in a report of the preparedness of hospitals for power outage. The importance of functional components of disaster response, particularly with respect to the outbreak of infectious diseases was the focus of the study by Sauer et al (238).

3.8 Strengths and limitations of the review

This study has provided some useful information with respect to the importance of all-hazard approach to emergency preparedness. One of the key strengths of this study is the fact that it has successfully harnessed available evidence and identified gaps which could be addressed by future research efforts. Moreover, the fact that all studies reviewed in this section of the thesis are empirical studies which specifically focused on the assessment of the adoption of all-hazard approach further makes the findings of the review relevant to the design of the studies conducted in the subsequent sections of this thesis. Also, the fact that this study identified a small number of articles means that it has uncovered a gap in knowledge and an area which future research need to focus on.

Despite these strengths, the study is not without some limitations. In the first instance, articles reviewed are not homogenous in location and in the nature of disaster that they focused on. This may bring some inconsistencies into the findings reported in this thesis. Moreover, it may have some effects on the generalisability of the findings of this review. This disparity in the scope of the components of the all-hazard approach covered by the studies reviewed makes the direct comparison of the findings of the studies slightly difficult and creates the need for a more comprehensive study involving articles with more similar scope. Also, it has been difficult to include some of the eligible articles in this review due to the inability to locate their full text despite all efforts made through the University library to locate them.

3.9 Conclusion and recommendations

The review reported in this chapter has clearly identified gaps in all-hazard HVA across hospitals in many parts of the world and highlighted the need for comprehensive assessment of functional and non-structural components of hazard preparedness. There was little standardisation in tools used in reviewed studies. Therefore, it is difficult to evaluate how elements recommended by available all-hazard emergency preparedness assessment tools (produced by organizations such as CDC, ACEP and WHO) were used as only one of the articles reviewed specifically used a standardised tool.

3.10 Recommendation for research

The result of this systematic review has provided an evidence-base to support the need for more primary research to further understanding the all-hazards approach in the field of emergency management. More primary research should be explicitly encouraged at the health facility level. Also, studies evaluating standard and bespoke tools in different settings are particularly needed to provide more data about the applicability of these tools. To this end, subsequent aspects of work carried out in this thesis focused on the adoption of all-hazard approach to assess hazard vulnerabilities of selected hospitals in the Kingdom of Saudi Arabia.

CHAPTER FOUR

HAZARD VULNERABILITY ANALYSIS FOR THE SECONDARY AND TERTIARY HEALTHCARE SETTING AT RIYADH REGION

4.1 Overview

In line with the objective of this study stated in Chapter 1, the implementation of research design stated in Chapter 2 and gaps identified in Chapter 3, this chapter presents the results obtained following the analysis of the data collected via the administration of the KP-HVA to all the selected hospitals (study 1). Prior to the presentation of results, a brief overview of the background leading to the investigations conducted will be presented. Data presented in this chapter were collected and analysed as detailed in Chapter 2 of this thesis. Following the presentation of results obtained for the probable and observed hazards, the discussion of the implications of the major findings as well as limitations and recommendations based on research findings will also be presented.

As highlighted earlier in this thesis, hazard vulnerability assessment (HVA) for an organisation, which involves HVA as well as the evaluation of the requirements needed for adequate preparedness, has been recognised as one of the first steps in the all-hazard approach to disaster preparedness and response for the organisation (239). According to Fuchs et al (240) , this often requires the use of standardised tools for rating the probability of hazards as well as the estimation of the impacts of identified hazards on human beings, properties and services rendered by the affected organisation. When properly conducted, HVA culminates in the computation of the relative risks of the organisation or area under consideration for the identified hazards (241, 242). Studies have identified the importance of HVA. For instance, McLaughlin et al (242) indicated that information obtained from HVA is critical to the development of effective emergency response plans, as well as strategies for mitigating and responding to different types of disasters. While recognising the importance of HVA, particularly within the healthcare sector, the Joint Commission on Hospital Accreditation recommended that hospitals should conduct annual HVA, and update reports generated through the assessment regularly (239).

This chapter focuses on the HVA assessment of secondary or tertiary healthcare institutions selected from Riyadh region of the Kingdom of Saudi Arabia. As described in the previous chapter, we identified that the KP-HVA is the best tool for the assessment of all-hazard vulnerabilities of selected hospitals. Hence this chapter will discuss results obtained following the administration of the tool.

4.2 Summary of Methods

4.2.1 Selection of hospitals for assessment

A total of 42 secondary and tertiary hospitals were selected for assessment in this study. Details of how these hospitals were identified and recruited have been described in Section 2.7.2.2.

4.2.2 Instrument for data collection

The modified KP-HVA tool, produced by Kaiser Permanente in 2001 (183, 184), was used in this study as briefly highlighted in Section 2.8.1 The tool includes the human, business, and property impact in the measure of risks. Also, this modified version changed the way events are rated and weighed in the calculation of the final vulnerability score compared with the original instrument (183). Moreover, the tool considers constituents of mitigation, such as preparedness as well as, internal and external responses separately. These characteristics give the KP-HVA an advantage over other tools which are commonly used for hazard vulnerability assessment (185). This comprehensive nature of the tool further motivated its selection as the HVA tool for the assessment of hospital hazard vulnerabilities in this study. Moreover, the rationale for the selection of this tool was based on reports of its previous successful usage for the assessment of hazard vulnerability of healthcare organizations (243, 244).

The KP-HVA is a tool containing 60-item which represent hazards that an organisation may be exposed to. The tool contains two major sections, with the first seeking information about the probability (likelihood of occurrence) of each hazard. Details of the response option for the likelihood section is contained in Table 4.1. The section also collects information about the number of alerts recorded for each hazard over a given period (usually a year), and the number of activations for the hazard. The second section of the tool collects information about the severity of disasters resulting from each hazard. Hazard severity is computed by subtracting the magnitude score from the mitigation score for each hazard. To estimate hazard magnitude, the tool requires respondents to rate the human impact, property impact, and business impact of each hazard while ratings for the preparedness, internal response and external response to the hazard were collected to estimate the mitigation for the hazard. Details of the rating for each of these parameters is contained in Table 4.1. Briefly, the tool used a 4-point scale (0 to 3) to rank responses obtained for each of these variables.

4.2.3 Respondents and administration of KP-HVA

According to Chang et al (66), the use of KP-HVA is often conducted by a multidisciplinary team including representatives from the emergency management; security/safety; facilities (such as the maintenance department), information technology and telecommunications unit, medical departments (by drafting professionals such as clinicians, nurses, laboratory staff, and radiologists as part of the team), and other ancillary services (e.g. kitchen). The team also often include administrators, personnel from the finance department and external stakeholders such as the police, fire officials and members of the community. In this study, the HVA respondent team for each health facility included the researcher, emergency department manager, the engineer and general utility managers, safety officer, infection control officer and the quality manager.

Table 4. 1 Attributes of the KP-HVA tool

Variables	Indicators	Outcomes
Probability	0= Not applicable 1= low probability 2= Moderate probability 3= High probability	High frequency of risk (Known risk), moderate frequency of risk (Historical data), low frequency of risk (Manufacturer/vendor statistics)
"Human impact"	0= Not applicable 1= low impact on human health(patient) 2=Moderate Impact on human (patient and staff) health 3=High impact on human health (Death)	Potential for staff death or injury, potential for patient death or injury
Property Impact	0= Not applicable 1= Low impact 2= moderate impact 3= high impact	Cost to replace, cost to set up temporary replacement, cost of repair, time to recover
Business Impact	0= Not applicable 1= low impact 2= moderate impact 3= High impact	Business interruption, employees unable to report to work, customers unable to reach facility, company in violation of contractual agreements, imposition of fines and penalties or legal costs, interruption of critical supplies, interruption of product distribution, reputation and public image, financial impact/burden.
Preparedness	0= Not applicable 1= High preparedness 2=Moderate preparedness 3= low preparedness	Status of current plans, Frequency of drills, Training status, Insurance, Availability of alternate sources for critical supplies/services
Response	Time, effectiveness, resources 0= not applicable 1= low response 2=Moderate response 3= High response	Types of supplies on hand/will they meet need? Volume of supplies on hand/will they meet need? Staff availability, Availability of back-up systems, Internal resource's ability to withstand, disasters/survivability
Resources	Community/Mutual Aid staff and supplies 0= not applicable 1= low response 2=moderate response 3= High response	Types of agreements with community agencies/drills? Coordination with local and state agencies, Coordination with proximal health care facilities, Coordination with treatment specific facilities, Community resources
Relative threat	Percentage 0-100%	It will be computed automatically for each hazard

These participants were selected based on the nature and relevance of their jobs in relation to emergency response within the hospital setting. Prior to the assessment day, a letter of invitation together with the project information sheet, was sent via the emergency department manager to each participant. Participants who were the most relevant for each of the KP-HVA questionnaire items were carefully selected to provide answers. However, as some of the roles within emergency response often overlap, some aspects of the questionnaire were answered collectively by the team. Specifically, questions relating to HVAC failure and supply chain were jointly answered by members of the team. However, the Infection Control Officer provided answers to questions relating to outbreak of infectious diseases and epidemics; the General Utility Manager and the Engineer provided answers to questions relating to IT systems, the Safety Officer provided answers to questions relating to fire and fire alarm; the Emergency Services Manager and Quality Officer provided answers to questions relating to workplace threat and trauma. This ensured that accurate data were accurate collected.

4.2.4 Data collection

Scores provided by the emergency team in each hospital to the KP-HVA administered were collated by the researcher. Data on subjective assessment of the probability of occurrence, impact (human, property, and business) of the disaster listed in the KP-HVA tool, level of preparedness as well as internal and external response to each emergency hazard were collated. In this study, a 4-point scale with High = 3, Moderate = 2, Low = 1 and 0 = Not Applicable was used for scoring the probability and the impact of disasters listed in the KP-HVA. Also, a 4-point scale was used for the scoring of the level of preparedness as well as the responses to disasters. However, in this case, 0 = Not applicable, 1 = High, 2 = Moderate and 3 = Low level of preparedness or response. Respondents were required to base scoring on available data within their organisation with respect to each hazard.

4.2.5 HVA data analysis

To assess the hazard vulnerability of selected hospitals, as stated in the objectives of this study, data collected were analysed as detailed in this section. Following the scoring detailed in Section 3.6.1, probability and preparedness scores were computed for each hazard listed in the KP-HVA tools for the 42 hospitals. Data collected using the KP-HVA were initially recorded in Microsoft Excel and the software was also used in ranking probability and preparedness scores obtained following the administration of the KP-HVA tool to identify the top ranked and the top 10 probable (hazards that could become a disaster) or observed (hazards that have developed into disasters previously) hazard for each hospital and for the region. Mean Probability Score, Mean Preparedness Score and percentage of occurrence were calculated for each of the top 10 hazards for the region. The mean probability score was computed using the formula:

$$Mean\ Probability = \frac{Sum\ of\ probability\ score}{Total\ number\ of\ hospitals\ having\ the\ hazards\ in\ the\ top\ 10 * 3}$$

Similarly, mean preparedness score was computed using the formula:

$$Mean\ Preparedness\ = \frac{Sum\ of\ preparedness\ score}{Total\ number\ of\ hospitals\ having\ the\ hazards\ in\ the\ top\ 10 * 3}$$

Mean Probability Scores were classified using the scale Low = 0.0 – 0.33, Moderate = 0.34 – 0.67 and High = 0.68 -1.00 while Mean Preparedness Scores were classified using the scale at High = 0.0 – 0.33, Moderate = 0.34 – 0.67 and Low = 0.68 -1.00 as recommended by the KP-HVA tool Fares *et al* (244). Moreover, the risk score for each of the selected hospitals was computed using the formula embedded in the KP HVA tool, which is Risk Score = Probability x Severity, as previously reported by Fares *et al* (244). Risk Score is an arbitrary quantification of the severity of a hazard. The KP-HVA tool has internal mechanisms for the estimation of severity (expressed as Magnitude minus Mitigation) based on scores awarded by respondents. Therefore, the formula embedded in the HVA tool computes the overall-hazards probability and severity for each of the organisation (by taking all identified hazards for each organization into consideration). The distribution of probability, severity and risk scores obtained for each of the selected hospitals across the region was classified using the scale Low = 0.0 – 0.33, Moderate = 0.34 – 0.67 and High = 0.68 -1.00, which is a modification of the classification previously reported by Fares *et al* (244) (divided by a factor of 3). The distribution of severity, probability and risk scores was also expressed as a bar chart. The number of hospitals reporting each top probable or observed hazard was recorded as frequency and this is expressed as a percentage of the total number of hospitals. The same analysis was carried out for each of the hazards in the top 10 probable or actual hazards. To investigate the correlation between hazard severity and hazard risk or hazard probability and hazard risk for each hospital, linear regression analysis was computed for each dataset using GraphPad Prism version 8.0. This was conducted to further understand the impact of hazard severity or hazard probability on hazard risk. A positive correlation indicates that efforts which reduces hazard severity or probability will also reduce hazard risk.

In addition, the history of actual (observed) hazards for the past three years for each of the hospitals was also obtained. Emergency managers were asked to identify hazards (listed in KP HVA) which have occurred in the last three years within their hospitals and the frequency (total number of alerts) of such events. These were used to identify the top observed hazard as well as the top 10 observed hazards for each of the 42 hospitals. From these, the top 10 observed hazards for Riyadh region were identified.

4.3 Results

4.3.1 Analysis of probable hazards in hospitals selected across Riyadh region, KSA.

The probability score, preparedness score and the ranking of all probable hazards listed in the KP HVA tool for the 42 hospitals selected from the Riyadh region is presented in Appendix 4.1. Table 4.2 presents the summary of probable hazards ranked first, mean probability score for the top 10 hazards and the mean preparedness score for the top 10 probable hazards obtained for all the 42 hospitals included in this study.

Following the analysis of the top 10 probable hazards from each of the 42 selected hospitals, the ten most commonly reported probable hazards (which represents the top probable 10 hazards for the Riyadh region) were identified. The details of these hazards, including their frequency of occurrence in the top 10 hazards across the hospitals, the mean probability, and the mean preparedness score for each of the hazards are presented in Table 4.2.

Table 4. 2 Summary of the frequently reported probable hazards across the Riyadh Region

Hazard	Ranking	Frequency	Mean Probability Score	Mean Preparedness Score	Percentage of hospitals reporting hazard
Internal fire	1	28	0.93	0.46	66.7
Epidemic	2	24	0.93	0.43	57.1
HVAC failure	2	24	0.94	0.57	57.1
Trauma	4	22	0.97	0.48	52.4
Infectious disease outbreak	5	20	0.95	0.43	47.6
Supply chain shortage/failure	6	19	0.93	0.67	45.2
Workplace violence/threat	7	17	0.94	0.73	40.5
Mass casualty >5	8	16	0.92	0.35	38.1
IT system outage	8	16	0.92	0.63	38.1
Fire alarm failure	10	15	0.96	0.62	35.7

Key: Frequency = The number of hospitals which have the particular hazard in the top 10 most probable hazards. Mean Probability Score = Average probability scores recorded for the hazard across all hospitals divided by a factor of 3. Mean Preparedness Score = Average preparedness scores recorded for the hazard across all hospitals divided by a factor of 3. Percentage = Frequency divided by the total of number of hospitals selected from the region.

Data presented in Table 4.2 showed that internal fire was the most frequently reported probable hazard in the Riyadh region, with 66.7% of the selected hospitals indicating the hazard in the top 10. Fire alarm failure was observed as the tenth most common probable hazard in the region as it was reported in 35.7% (15 out of 42) of the selected hospitals. Mean probability scores observed for the ten most frequently reported probable hazards in the region ranged between 0.92 and 0.97, The highest mean probability score (0.97) was observed for trauma with mass casualty >5 and IT outage had the lowest probability score of 0.92. The analysis of these scores using the scale earlier identified indicate that all the hazards have high probability scores. The range of mean preparedness scores (0.35 – 0.73) was much bigger compared to the range observed for mean probability scores. The lowest mean preparedness score was observed for mass casualty >5 while the highest score was observed for workplace violence/threat. Based on the classification scale earlier stated for preparedness scores, all the identified hazards, except supply chain failure (0.67) and workplace threat, which had low preparedness (0.73), had moderate preparedness. High level of preparedness was observed for none of the top ten hazards in the region.

4.3.2 Analysis of first-ranked probable hazards

The analysis of the most common (first-ranked) probable hazards for all the 42 selected hospitals across the region is presented in Table 4.3. The table shows that internal fire was ranked first in 11 out of 42 hospitals (26.2%). This was followed by trauma, supply chain failure and active shooter, which were each ranked first in 4 hospitals (9.5%). Sandstorm, IT system outage and communication failure were observed as first-ranked most probable hazards in 2 out of 42 hospitals. All other first-ranked most probable hazards were observed in 1 hospital each. The distribution of these first-ranked hazards is shown in Figure 4.1. Table 4.3 also provides information about probability and preparedness scores for all the first-ranked hazards. For internal fire, trauma, supply chain failure, sandstorm, and communication failure, probability scores ranged from 0.87 to 1.0, 0.73 to 1.00, 0.87 to 1.00, 0.70 to 0.93 and 0.87 to 0.90, respectively. probability scores for other first ranked probable hazard had values which are between 0.87 and 1.00. These values indicate that all these hazards have high probability scores.

However, the preparedness scores among first-ranked probable hazards across the 42 hospitals vary greatly. The preparedness score for internal fire, trauma, active shooter, supply chain failure, sandstorm, IT system outage, and communication failure ranged from 0.40 to 0.67, 0.33 to 0.60, 0.63 to 0.80, 0.53 to 0.67, 0.40 to 0.80 and 0.43 to 0.73, respectively. Other first-ranked probable hazards have preparedness scores which are between 0.33 and 0.77. These values indicated that the level of preparedness for internal fire in hospitals where it was ranked as the most probable hazard is moderate while the level of preparedness for trauma in hospitals where it was ranked as the most probable hazard is between moderate and high levels. For, active shooter, supply chain failure, sandstorm, IT system outage and communication failure, the level of preparedness lie between low and moderate in hospitals where they are ranked as most probable. For other probable hazards with single preparedness scores, the score for evacuation indicates high level of preparedness, scores for mass casualty >5, transport failure, chemical casualty >5, explosion, chemical exposure, infant abduction, and suspicious odour indicate moderate levels of preparedness. Scores for weapon, building move, fire alarm and bomb threat indicate low levels of preparedness (Table 4.3).

The analysis of preparedness scores for each first-ranked probable hazard across all the 42 hospitals specifically indicate that only 2 hospitals (4.8%) had preparedness scores between 0.68 and 1.0 (low) while 6 hospitals (14.3%) had high preparedness scores (between 0 and 0.33). The remaining 34 hospitals (80.9%) had moderate preparedness scores (scores ranging between 0.34 and 0.67; Figure 4.2).

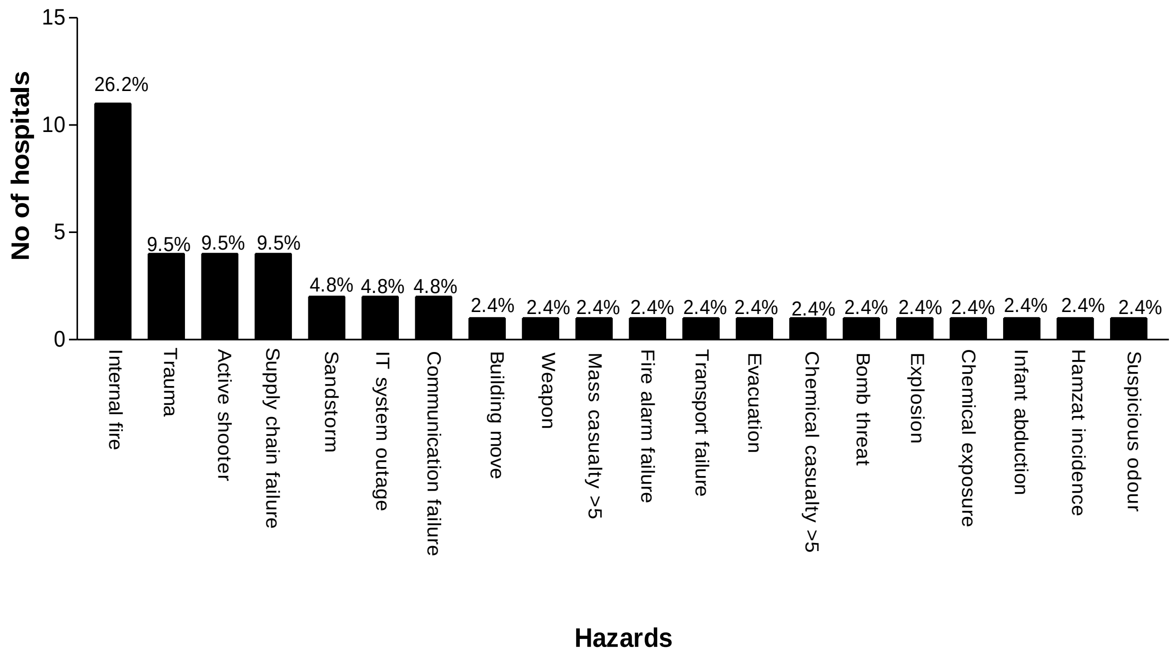

Figure 4. 1 Frequency of first-ranked probable hazards in all hospitals selected across Riyadh Region

Table 4. 3 Summary of the first ranked probable hazard in all the selected hospitals

S/No	First Ranked Hazard	No of Hospitals	Probability score (range)	Preparedness score (range)
1	Internal fire	11	0.87 – 1.00	0.40 – 0.67
2	Trauma	4	0.73 – 1.00	0.33 – 0.60
3	Active shooter	4	1.00	0.37 – 0.67
4	Supply chain failure	4	0.87 – 1.00	0.63 – 0.80
5	Sandstorm	2	0.70 – 0.93	0.53 – 0.67
6	IT system outage	2	1.00	0.40 – 0.80
7	Communication failure	2	0.87 – 0.90	0.43 – 0.73
8	Building move	1	1.00	0.70
9	Weapon	1	1.00	0.67
10	Mass casualty >5	1	1.00	0.43
11	Fire alarm failure	1	1.00	0.73
12	Transport failure	1	1.00	0.50
13	Evacuation	1	0.93	0.33
14	Chemical casualty >5	1	0.87	0.43
15	Bomb threat	1	0.87	0.77
16	Explosion	1	0.97	0.50
17	Chemical exposure	1	0.93	0.47
18	Infant abduction	1	1.00	0.47
19	Suspicious odour	1	0.97	0.43

Key: For probability score, Low = 0.0 – 0.33, Moderate = 0.34 – 0.67 and High = 0.68 - 1.00. For preparedness, High = 0.0 – 0.33, Moderate = 0.34 – 0.67 and Low = 0.68 -1.00.

4.3.3 Analysis of first-ranked probable hazard by hospital type

The analysis of data on first-ranked hazards based on the types of hospitals indicated that the mean probability of first-ranked hazards for tertiary hospitals (n=11, 0.77±0.17) is not significantly (P = 0.77) different from the mean probability of first-ranked hazards for secondary hospitals (n=33, 0.75±0.20).

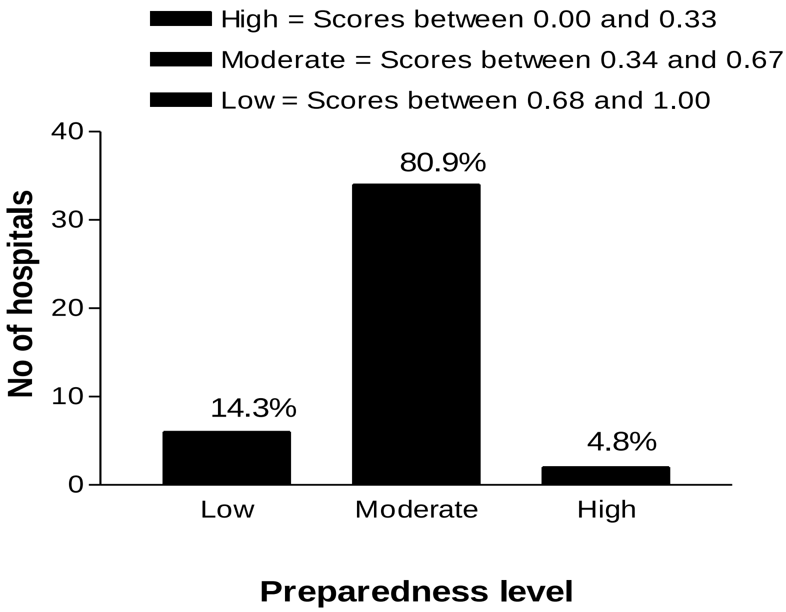

Figure 4. 2 Distribution of preparedness level for all first-ranked disasters in all selected hospitals. **Low = Score of 0.68 – 1.00; Moderate = Score of 0.34 – 0.67 and High = Scores of 0.00 – 0.33.**

4.3.4 Analysis of organisational risks for probable hazards

HVA risk scores obtained for all the 42 hospitals selected in this study were also computed using the KP HVA. Details of how the risk score is calculated has been provided in Section 3.8.1. Each organisation has a risk score, which is computed based on all the hazards (organisational hazard probability score multiplied by organisational severity score) identified for that organisation and the risk score is indicative of the general hazards risk for that organisation. A high score indicates that the hospital is at high risk of hazards which potentially have major impacts and vice versa. Data obtained for all the 42 selected hospitals is shown in Table 4.4.

The lowest probability score (0.27) was observed for H53 while the highest mean probability score of 1.00 was obtained for H17 and H18. For severity (which is an indication of the human, property, and service impacts of hazards) scores, the lowest score of (0.25) was obtained for (H02) while the highest score (0.66) was obtained for H06.

Table 4. 4 Probability, Severity and Risk Scores for all hospitals selected from Riyadh Region

S/No	Code	Organisational Probability Score	Organisational Severity Score	Risk Score
1	H01	0.60	0.58	0.35
2	H02	0.94	0.25	0.23
3	H03	0.66	0.37	0.24
4	H04	0.66	0.37	0.24
5	H06	0.86	0.38	0.33
6	H07	0.96	0.34	0.33
7	H08	0.74	0.34	0.25
8	H09	0.67	0.44	0.30
9	H10	0.80	0.50	0.40
10	H11	0.94	0.40	0.37
11	H12	0.72	0.29	0.21
12	H13	0.92	0.46	0.43
13	H15	0.74	0.38	0.28
14	H16	0.96	0.40	0.38
15	H17	1.02	0.41	0.42
16	H18	1.00	0.66	0.66
17	H19	0.81	0.41	0.33
18	H20	0.74	0.34	0.25
19	H21	0.79	0.39	0.31
20	H22	0.77	0.52	0.40
21	H25	0.97	0.37	0.36
22	H26	0.97	0.46	0.45
23	H27	0.87	0.44	0.38
24	H28	0.50	0.31	0.15
25	H32	0.47	0.34	0.16
26	H33	0.47	0.34	0.16
27	H34	0.74	0.31	0.23
28	H35	0.50	0.61	0.31
29	H36	0.72	0.49	0.35
30	H37	0.52	0.42	0.22
31	H39	0.90	0.35	0.32
32	H41	0.90	0.29	0.26
33	H42	0.52	0.58	0.30
34	H43	0.93	0.38	0.35
35	H45	0.79	0.31	0.25
36	H50	0.60	0.34	0.20
37	H51	0.67	0.39	0.26
38	H53	0.27	0.37	0.10
39	H54	0.92	0.43	0.39
40	H55	0.90	0.61	0.55
41	H56	0.28	0.29	0.08
42	H57	0.63	0.26	0.16

Key: All parameters are overall scores for each organisation. Low = Scores between 0.00 and 0.33, Moderate = Scores between 0.34 and 0.67 and High = Scores between 0.68 and 1.00. No high severity and risk scores were observed in this study.

Risk scores for these hospitals (computed as a product of organisational probability and organisational severity score) indicate that H56 has the lowest risk score (0.08) while the highest risk score (0.66) was obtained for the hospital with the code H18. The distribution (as low, moderate, or high) of these scores obtained for all the hospitals in Riyadh region is provided in Figure 4.3

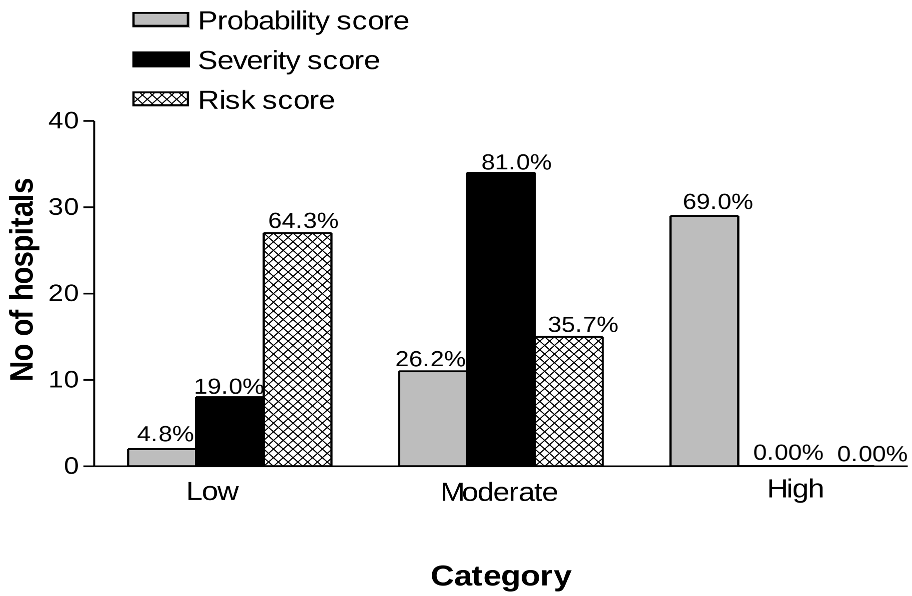

Figure 4. 3 Distribution of probability, severity, and risk scores for all selected hospitals

Scores between 0.00 and 0.33, Moderate = Scores between 0.34 and 0.67 and High = Scores between 0.68 and 1.00. No high severity and risk scores were observed in this study.

Data presented in Figure 4.3 indicate that the majority (69%) of the selected health facilities in Riyadh region have high hazard probability scores and few (4.8%) of these facilities have low hazard probabilities. However, the distribution of severity and risk scores was different from what was observed for probability scores. For instance, none of the 42 hospitals had high severity or risk score. However, 81% of the selected hospitals had moderate severity score while a larger proportion of the hospitals (64.3%) had low risk scores (Fig. 4.3). The implication of this data is that though the probability of all-hazards is high across the region because the hazards with high probability have low/moderate severity, the risk to the region is not high.

To further understand the contribution of probability and severity scores to the risk scores obtained for the selected hospitals across the region, regression analyses between probability score and severity scores was computed. Results obtained are shown in Figure 4.4. Figure 4.4 indicate a positive but very weak correlation between an organisation's risk probability and the organisation's severity scores (R^2 = 0.013), indicating a 1.3% contribution of severity scores to the observed probability score.

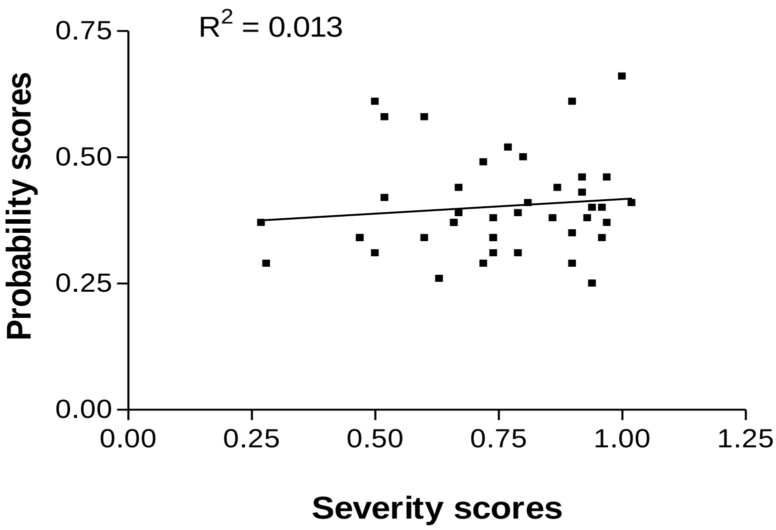

Figure 4. 4 Analysis of the relationship between probability and severity scores

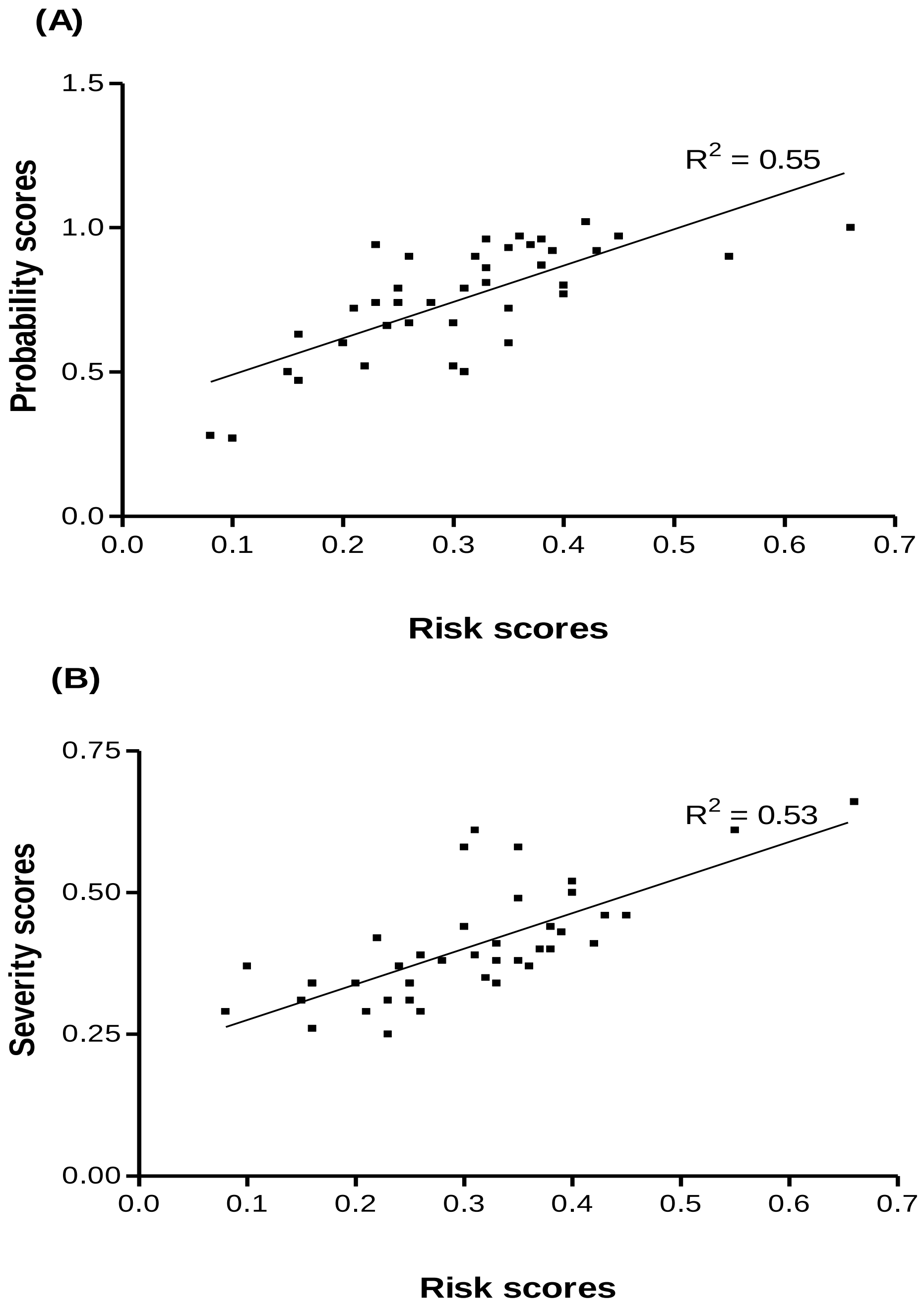

Figure 4. 5 Analysis of the relationship between probability and risk scores (A), severity and risk scores (B)

4.3.5 Analysis of observed hazards in hospitals selected across Riyadh region, KSA.

A list of the top 10 observed hazards from each of the selected hospitals from Riyadh region is presented in Appendix 4.3. Details of the most common actual hazard which occurred in each of the selected secondary or tertiary hospital across Riyadh region over the past three years is presented in Table 4.5.

Table 4.5 Summary of the first-ranked observed hazard across included hospitals

S/No	First-ranked hazard	No of hospitals	Total number of times hazard occurred
1	Several	15	40
2	No hazard	9	NA
3	Mass casualty >5	7	126
4	Patient surge	3	6
5	Infectious disease outbreak	3	7
6	Forensic admission	2	4
7	VIP situation/visit	2	18
8	Workplace violence	2	28
9	Suicide	1	2
10	Sandstorm	1	2
11	Sewer failure	1	15
12	Power outage	1	2
13	Hazmat event	1	2
14	Fire alarm failure	1	2

Key: Several = More than 2 hazards had the same number of occurrences, None = No hazard reported over 3 years, NA = Not applicable

Table 4.5 indicated that 15 (35.7%) selected hospitals had multiple observed hazards with each hazard occurring 1 to 5 times within the last three-year period. Across all the 42 selected hospitals, a total of 40 cases of these different observed hazards were reported in three years. However, mass casualty >5, which refers to hazards resulting in the death of 5 people or less, was observed as the most common first-ranked actual hazard in 7 (16.7%) hospitals. A total of 126 cases of this type of hazard was observed across the region over the period of three years. Workplace violence (28 cases in the past 3 years) and hazard resulting from VIP situation/visit (18 cases in the past 3 years) were each observed in 2 hospitals across the region. While one hospital had 15 cases of sewer failure, no hazards were reported in 9 (21.4%) of the selected hospitals.

4.3.6 Comparative analysis of probable and observed hazards.

The analysis conducted in this study indicates that some of the first-ranked probable hazards also featured as first-ranked observed hazards in hospitals across the region. These hazards include sandstorm which was indicated as first-ranked probable hazard in 2 (4.8%) out of the 42 hospitals but as first-ranked observed hazard in 1 (2.4%) out of 42 selected hospitals. Similarly, fire alarm failure was indicated as a first-ranked probable hazard and first-ranked observed hazard in 1 (2.4%) out of the 42 selected hospitals. However, mass casualty >5 which was ranked as the most probable hazard in only 1 (2.4%) out of the 42 selected hospitals featured as first-ranked observed hazards in 7 (16.7%) selected hospitals. Moreover, the comparison of first-ranked probable hazards to the top 10 actual hazards observed across the 42 selected hospitals indicate that probable hazards including IT system outage, internal fire, trauma, mass casualty >5 and communication failure translated to actual hazards in 18 (42.9%), 16 (38.1%), 14 (33.3%), 11 (26.2%) and 11 (26.2%) hospitals respectively.

4.3.7 Analysis of top ten actual disasters

Following the analysis of the top 10 actual disasters in the selected hospitals, the most common actual disaster in hospitals across the Riyadh region were identified (Table 4.6). This indicated that IT system outage was the most common observed disaster (reported by 18 hospitals in the top ten) while communication/telephone failure, mass casualty >5, mass casualty <5 and flood (reported by 11 hospitals) jointly occupied the last position in the top actual disasters observed in Riyadh region.

Table 4. 6 Summary of the top actual disasters across the Riyadh Region

Hazard	Ranking	Number of hospitals where hazard is reported	No of times disaster occurred (range)	Percentage
IT system outage	1	18	1-21	42.86
Patient surge	2	17	1-7	40.48
Internal fire	3	16	1-1	38.10
HVAC failure	3	16	1-11	38.10
Trauma	5	14	1-34	33.33
Planned power outage	6	13	1-4	30.95
Workplace violence/threat	7	12	1-20	28.57
Communication/telephone failure	8	11	1-4	26.19
Mass casualty <5	8	11	1-21	26.19
Mass casualty >5	8	11	1-100	26.19
Internal flood	8	11	1-1	26.19

In addition, the number of occurrences of each of the actual disaster detailed in Table 4.6 were analysed, and the result of the analysis is shown in Figure 4.6. The analysis revealed that mass casualty >5 accounted for 18.24% (153 occurrences) of all actual hazard occurrence within the region. This is followed by trauma which accounted for 10.25% of all actual hazard occurrence. Internal flood, with 11 occurrences, was observed as the top actual hazard with the least occurrence (Figure 4.6).

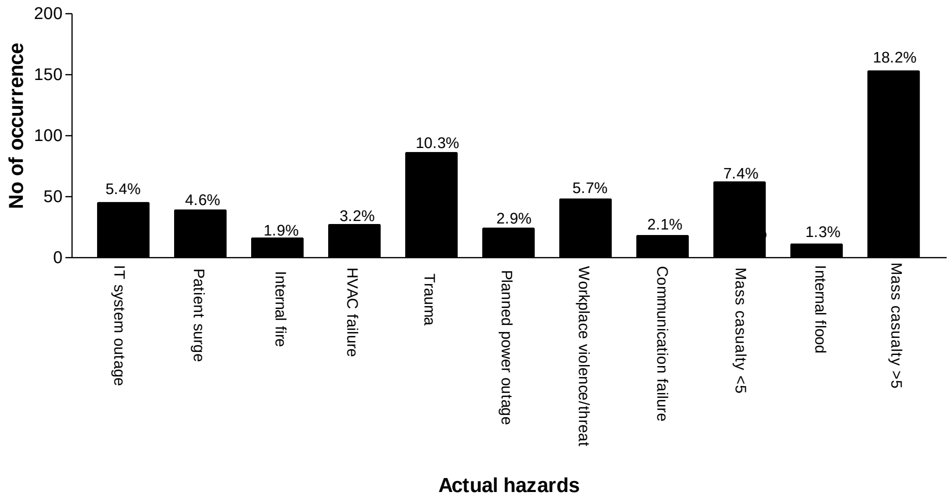

Figure 4. 6 Distribution of the occurrence of top observed hazards in Riyadh region

The total number of observed hazard occurrence obtained for all selected hospitals was 839. Data presented in Figure 4.6 indicate that mass casualty (hazard resulting in death of many people) has the highest occurrence (153), which accounts for 18.2% of all actual hazard occurrence for all 42 hospitals. This is followed by trauma which has 86 reported cases (10.3%). The lowest number of occurrences was observed for flood (11, 1.3%).

4.4 Discussion

4*.4.1 Summary of the main findings*

Following the analysis of probable hazards conducted in this study, it is observed that all the hospitals selected in Riyadh region have a high probability of hazard occurrence while the level of preparedness of these hospitals, at best, can be described as moderate. This study also indicates that the region is prone to a wide range of hazards (based on hazards ranked first by the different hospitals) with internal fire recognised as the most common probable hazard among these healthcare facilities. Similarly, the analysis of actual hazard conducted indicated that some of the identified probable hazards translate to actual hazards in many of the hospitals selected in this study. Specifically, mass casualty >5 was ranked as the first observed hazard in majority of the hospitals selected but IT outage was identified as the most common actual disaster within hospital settings across the region. In the first instance, various categories of data generated through the use of the questionnaire in this study confirmed the general applicability of the KP HVA in assessing hazard vulnerability of healthcare facilities in the Riyadh region as the tool was used successfully to collect interpretable data from the region. Moreover, due to the general lack of previous data on HVA for KSA, this study also represents a significant contribution to knowledge as it is the first study of a comprehensive HVA in secondary and tertiary hospitals in Riyadh region.

4.4.2 Discussion of findings

The applicability of KP-HVA tool in assessing hazard vulnerability and preparedness of hospital selected in this study confirms reports of several previous studies about the usefulness of the tool in this context (183-185, 243, 244), The implication of this is that capacity building for Emergency Services Directors in the routine usage of this tool for hazard vulnerability assessment may be a good step in improving hazard preparedness and response of hospitals across the Kingdom of Saudi Arabia.

The observation in this study that most of the healthcare facilities in the Riyadh region have moderate preparedness level is not surprising. Several studies have previously reported lack of preparedness of hospitals in the region against a variety of hazards. For instance, in a study which investigated the level of preparedness of 13 major private hospitals in the region against mass casualty, Shalhoub et al (245) reported significant lack of preparedness among these hospitals due to factors such as lack of disaster management education, inadequate staff monitoring and ineffective drill exercises. In a similar study conducted for hospitals in Makkah, Al-Shareef et al (246) reported that, despite the fact that Makkah has previously experienced a significant number of disasters, hospitals in the city are grossly unprepared for an effective response to future disasters. The study particularly implicated factors such as inadequate emergency planning, lack of recognition of some key hazards and the fact that most hospitals do not base their disaster response strategies on a properly conducted HVA. However, one major limitation of these previous studies is that they addressed only one type of hazard. The present study is different from previous studies as it adopted the all-hazard approach. Moreover, while these highlighted studies provide data on hazard preparedness, data on hazard vulnerability for the region are generally lacking. This study provided data on top probable and perceived (actual) hazards in Riyadh region.

The investigation of factors responsible for the inadequate disaster preparedness of hospitals in Riyadh region is examined in subsequent chapters of this study. However, it is possible that some of the factors highlighted in previous studies, such as disaster management education, inadequate staff, for the region may be applicable to hospitals included in this study.

Despite the high probability of hazards and low level of preparedness observed for selected hospitals, the HVA analysis conducted in this study indicated moderate severity for the majority of hospitals selected for this study. According to Miller (247), hazard severity largely describes the impact or damage that may result from the occurrence of hazards. In line with the best practice in the field, the analysis conducted in this study considered the impact of identified hazards on human, properties as well as services that organisations included in this study provide. The implication of the findings of the present study is that it is possible for an organisation to have high hazard probability but low severity due to the nature of the hazard or organisation's level of preparedness (248). In fact, the present study has shown that only a very weak positive correlation exists between an organisation's hazard probability and its hazard severity. Though according to Schwab et al (249), hazard preparedness is a key component of mitigation, other components such as internal and external response and previous exposure also play a key role in determining the severity of the hazard. The current outbreak of SARS-CoV-2 virus and the observation of less severity of the infection caused by the virus in countries which have experienced SARS virus outbreak is a good illustration of this role of previous exposure to hazards.

The risk score, which is a product of probability and severity of hazards, was observed to be low for majority of the hospitals in Riyadh region. This is understandable as, although the probability scores tended to be high, the moderate severity score obtained for these organisations will have a significant contribution to their risk scores. According to World Health Organisation (2020), the implication of a low-risk score is that it is unlikely that the hazard will become a disaster(250). However, it is possible for an event with a low-risk score to occur. How the observed low risk score informs the level of preparedness of hospitals in Riyadh region is not yet fully understood and it is hoped that the interviews conducted with emergency services directors will provide some insights in this regard (See Chapter 6). This notwithstanding, it is possible that the poor attitude and lack of adequate strategies for emergency response by selected hospitals may be as a result of the perception of their low risk with respect to certain disasters (251). For instance, while developing their emergency plans, it is possible for emergency managers to only pay close attention to hazards or disaster which they are familiar with (252). This, however, will be against the principle of all-hazard approach which demands that adequate preparation must be made for all hazards., and not just common hazards.

The analysis of observed hazard events which occurred within the region over the past three years conducted in this study partly corroborate our earlier assertion that it is possible for hazards with high probability not to occur. In this study, as opposed to internal fire which emanated as the hazard with the highest probability, IT system outage was actually the most common hazard in all hospitals across the region. Our study also indicated that mass casualty with the number of victims greater than 5 was the most frequent hazard within the region. This may not be surprising because the region hosts many people who visit annually for tourism (Riyadh season) and business. Though it is expected that the probable hazard identified via the HVA will correspond with the observed hazard, our observation in this study is the opposite. This may be due to perception of respondents about hazard severity. It is possible that respondents rely on their personal judgement in indicating what hazard they consider as having severe impact and what they consider as having no serious impact; particularly because such hazards do not occur frequently (see the strength and limitation section). Also, the perception of severity of a hazard may affect the level of preparedness for such hazard. This, by extension, can increase the probability for such hazard to become actual disaster.

4.5 Strengths and limitations

One of the limitations of this study is around the accuracy of the data provided by some of the emergency managers who participated in this study. It is possible that data on observed hazards (e.g., types of hazards and frequency of occurrence) provided by these managers are not accurate due to poor record-keeping. The lack of knowledge of certain disasters or the fact that such disasters has not occurred previously within the region may also affect the way that these managers responded to the KP HVA tool, particularly as a lot of the data are self-reported. While KP-HVA still remains the most versatile tool for collection of HVA data, hence its use in this study, the fact that it is heavily reliant on self-reported data represents one of its limitations. All these will have a significant impact on the accuracy of the prediction produced by the HVA. However, collection of data from documented sources (in organisations where accurate records are kept) to verify reported data will partly help to address this limitation. Unfortunately, record keeping in many of the settings selected for this study is poor.

Previous reports by Fares et al (244) corroborates this position. In a study which assessed the hazard vulnerability of healthcare facilities in Abu Dhabi, Fares et al (244) indicated inaccuracy of data as one of the major limitations of their study. Also, lack of congruence on same data collected from multiple sources, and lack of reference levels significantly affected the accuracy of data collection were reported by Fares et al (244). Though the present study did not experience challenges relating to inaccuracy of same data collected from multiple sources. As highlighted earlier in this section, it is also possible for the impact (severity) of a hazard to be underestimated (244). When this happens, the risk score obtained for such hazard will be incorrect, and this may partly be responsible for the lack of congruence between the probable hazard obtained from our HVA and the actual disasters experience by hospitals in the region. In spite of these limitations, scores obtained in this study are informative and help in identifying potential hazards that healthcare facilities in the region may be exposed to.

4.6 Recommendations

While this study represents an important first step towards in depth HVA for healthcare facilities in Riyadh region and the general applicability of the KP HVA to the settings within that region, there is a need to improve the accuracy of data collection. Capacity building of emergency managers with respect to adequate record keeping, probability assessment, impact scoring and severity assessment will represent a significant step in this direction. Also, prior to any HVA re-assessment for the region, it is important that emergency managers understand the concept of all-hazard approach to emergency planning with particular reference to improving their awareness of hazards which may not be commonly experienced within the region. This work serves as an important baseline for future assessments. Specifically, engagement of emergency managers across the region with the tool worked very well and respondents are able to understand the structure of the tool in a way that enables them to provide data that can be analysed. However, it is suspected that the level of understanding of key concepts covered in the tool may be shallow and subsequent studies will need to provide either additional document that provide education on these concepts or organise a pre-data collection training to improve respondents' understanding.

4.7 Conclusion

In conclusion, this study has indicated the usability of the modified KP-HVA tool in assessing hazard vulnerability for healthcare institutions across Riyadh region. It is evident from the analysis conducted in this study that perceived hazard probability across the region is generally high. However, the perceived severity of hazard across the region is generally moderate, making the risk score for the region to be generally low. Analysis conducted in this study also revealed that internal fire hazard was ranked first by majority of the hospitals included in the study. Also, mass casualty >5 and IT outage were the most frequently occurring observed hazard and observed hazard reported by most hospitals in the region, respectively. Further studies, which address challenges (such as those relating to inaccuracy of data) identified in this study (recommendation for research) as well as those that provide education of HVA assessment (recommendation for practice) to emergency managers in hospital settings across the region are needed.

CHAPTER FIVE

ASSESSMENT OF ALL-HAZARD EMERGENCY PREPAREDNESS AND RESPONSE CAPACITY IN THE HEALTH CARE IN RIYADH REGION

5.1 Overview

Chapter 1 of this thesis presented background information on the importance of all-hazard emergency preparedness of healthcare organisations. A detailed description of the methods adopted in the investigations conducted in this thesis has been presented in Chapter 2. The indication of gaps in evidence with respect to the adoption of the all-hazard preparedness was also presented in Chapter 3 of this thesis. All these culminated in the design of this study with objectives including: 1) the assessment of hazard vulnerability of selected hospitals in the region, 2) the assessment of the preparedness and response capability of selected secondary and tertiary health care facilities in Riyadh region, KSA using the all-hazards approach and 3) to review the understanding of all-hazard preparedness amongst emergency services directors with a view to identifying challenges associated with the adoption and implementation of the approach at the facility level. Results obtained following the analysis of the data collected via the administration of the KP-HVA to all the selected hospitals (study 1) has also been presented in Chapter 4 of this thesis. The KP-HVA was used in this study because it is comprehensive and is the industry-standard tool for the assessment of hazard vulnerability of several organisations (including hospitals used in this study). The key conclusion of the analysis presented in Chapter 4 clearly indicated the applicability of the modified KP-HVA tool in identifying probable and actual hazards as well as the level of preparedness of healthcare institutions across Riyadh region to identified hazards. The chapter also identified that the that perceived hazard probability across the region is generally high while the perceived severity is generally moderate, making the risk score to be generally low. Internal fire hazard was ranked first by majority of the hospitals and mass casualty >5 and IT outage were the most frequently occurring observed hazard and observed hazard in the region respectively. In this chapter, results of the assessment of the preparedness and response capability of selected secondary and tertiary hospitals in Riyadh region, KSA, using the all-hazard approach, will be presented. In the first instance, this chapter will present a brief recap of the methods adopted in collecting the data; followed by the results and discussion of the implications of the results obtained.

As indicated in earlier chapters, the concept of all-hazard preparedness largely relates to the development of plans and strategies which an organisation can use to respond to all types of disasters (253). According to Ahmadi et al(64), components of an all-hazard emergency plan can be largely divided into three categories: Functional, structural and non-structural components. The current study focuses on functional and non-structural components. In this study, functional capacity is defined as aspects of emergency preparedness of an organisation which covers the protection of facilities which the organisation needs to perform its functions during a disaster event (254). These components include communication plans, hazard and vulnerability assessment, emergency management plans, command and control, human resources, safety and early warning systems, blood bank and fatality management. This study defines non-structural capacity as including other requirements for effective response excluding physical infrastructure (65). These include elements such as the availability of equipment and supplies, utilities, and security systems. Structural components are those components such as reconstructing selected hospitals to increase their disaster resilience (infrastructural capacity building), installation of security systems as well as human resources (117). Structural components have been excluded from this study as available research evidence indicates that these strategies are sporadic, ill-planned and not backed with an appropriate plan for effective emergency response in many countries (121). Moreover, the ability to provide structural components may differ significantly across many hospitals due to their capital-intensive nature. Barbera et al (62) reports a lack of resources for constructing new facilities and inadequate or ineffective security for patients and health workers in poor disaster-prone countries. Kaji et al (48) states that even where policies and strategies are in place, there are challenges of adequate funding and human resources for effective implementation in some countries. Therefore, this study focused on components that do not require structure and that can be implemented in both high- and low-resource settings.

The focus of this chapter is the presentation of data on the assessment of all-hazard preparedness and response capacity of selected hospitals in Riyadh region. Generally, the Ministry of Health in the Kingdom of Saudi

Arabia operates a three-tier healthcare system through which healthcare facilities are divided into primary, secondary, and tertiary levels based on their capacity and the type of healthcare problems that can be handled at each level(145). Hospitals at the primary healthcare level provide basic care and are often found in rural settings while hospitals at the secondary healthcare level often serve as referral centres for primary healthcare centres and are often found in towns and cities. Tertiary healthcare facilities are hospitals which handle the most complex healthcare problems and are often more equipped and staffed with very highly qualified healthcare professionals. Moreover, the division of hospitals into these levels also allows the Ministry of Health to decentralise administrative structures and to facilitate effective strategic planning, formulation of health policies, supervision of health service delivery programmes and monitoring of all health-related activities (145). Only secondary and tertiary level hospitals were selected in this study. Therefore, the all-hazard preparedness and response capacities of secondary and tertiary hospitals, as well as hospitals located in the city versus hospitals located outside the city were compared. Inner city hospitals are often patronised by a larger number of people and the expectation is that the level of expertise and facilities within inner city should be significantly better compared to outer city hospitals. In addition, hospitals in KSA are either funded by the government (referred to as public hospitals) or funded by private owners (private hospitals). In this chapter, the all-hazard preparedness and response capacities of publicly funded and privately funded hospitals were also compared.

Based on the foregoing, key questions that the investigation conducted in this chapter seek to answer include:

1. What is the degree of all-hazard emergency preparedness among hospitals in Riyadh? What is the level of preparedness for indicators of functional and non-structural capacities in hospitals selected from Riyadh region for this study?
2. What is the impact of the levels of care provided (secondary or tertiary care) by selected hospitals on the level of their preparedness for indicators of functional and non-structural capacities?
3. How does the nature of funding (public or private hospitals) affect the level of preparedness for indicators of functional and non-structural capacities of selected hospitals?
4. How does location of the hospital (inner city versus outer city) affect the level of preparedness for indicators of functional and non-structural capacities of selected hospitals?
5. Is there a significant relationship between functional and non-structural emergency response capacities of hospitals selected for this study?

5.2 Summary of Methods

5.2.1 Selection of hospitals and participants

A total of 42 secondary and tertiary hospitals were selected for assessment in this study. Details of how these hospitals were identified and recruited have been described in Section 2.7.2.2. Moreover, all the Emergency

Services Directors in selected hospitals were recruited as respondents in this aspect of the study as briefly highlighted in Section 2.7.2.3.

5.2.2 Instrument for data collection

A new questionnaire named All-hazard Preparedness Assessment Questionnaire (APAQ) was developed and used for data collection in this study as highlighted in Section 2.8.2. The questionnaire developed in this study contains two main sections. The first section assesses functional vulnerability while the second section assesses emergency preparedness and the response capacity of all the secondary and tertiary hospitals selected for this study. Specific parameters measured in the first section include site and accessibility, areas in the health facility, equipment and supplies, utilities, warning system and safety equipment, security, transportation and communication, and public information. The second section of the questionnaire focused on the planning and actions that are critical and needed in most emergency and disaster events. These parameters are standard core components of the functional and the non-structural domains of all-hazard vulnerability assessment which any HVA tool must contain. In line with best practice with studies using the KP-HVA tool, all these parameters were also assessed in this study without selection, as there are no justifications for selecting some parameters and neglecting others(244). Respondents were required to tick ratings of 1, 2 or 3 provided for each questionnaire item. Details of core components of all hazard approach measured in the questionnaire is presented in Table 5.1.

The second section of APAQ assessed the availability of critical components such as emergency planning group/committee, subcommittees, human resources, response protocol, hazard and vulnerability analysis system, provisions for training and drills, procedure for evacuation, health facility networking arrangements, community involvement strategies, disease surveillance tools and strategies, and fatalities management system. Content validation of APAQ was carried out by giving the draft questionnaire to two independent experts in the field who reviewed the draft. Corrections were made to the draft based on this review.

5.2.3 Pilot testing of APAQ

The APAQ research instrument was tested in a pilot study in one healthcare facility at King Saud Medical City which is within the target study area. Specifically, APAQ was administered to the Emergency Services Director and two other staff members within the Emergency Services Department in this hospital. The results from the pilot study showed no need to further modify any of the questionnaire items. The pilot study was undertaken in June 2019. The content and layout of the questionnaire after the pilot study and the feedback obtained from the respondents in the pilot study were positive. The healthcare facility used for the pilot study did not participate in the main survey.

Table 5. 1 Core elements measured by APAQ.

Core element of All hazard emergency preparedness and response capacity Questionnaire	Number of Questions	Domain	Maximum Score Obtainable	References
Areas in the health facility	6	Non-structural	34	(187)
Security	5	Non-structural	15	(187, 189)
Utilities	14	Non-structural	42	(187, 189)
Evacuation	11	Non-structural	28	(187)
Site and accessibility	4	Functional	16	(187, 189)
Equipment and supplies - medical supply - Pharmacy supply - Blood bank services	14	Functional	56	(187)
Warning system and safety equipment	6	Functional	21	(189)
Transportation and communication	4	Functional	30	(188)
Public information	5	Functional	46	(187, 189)
Hazard and vulnerability analysis	1	Functional	63	(187)
Patient decontamination	1	Functional	18	(189)
Training and drills	5	Functional	7	(187, 189)
Emergency planning group/committee - Incident command	10	Functional	63	(187)
Subcommittees	1	Functional	18	(187, 189)
Response protocol -Triage	16	Functional	72	(187-189)
Health facility networking	3	Functional	16	(189)
Community involvement	2	Functional	9	(187, 189)
Human resources	4	Functional	7	(188)
Disease surveillance	7	Functional	15	(187)
Fatalities management	1	Functional	5	(187, 189)
Total	119		559	559

5.2.4 Administration of APAQ

APAQ was given to Emergency Services Directors to complete during a research visit to each of the selected hospitals by the researcher. This is because they have the overall responsibility for effective implementation of emergency prepared policies and development of the capacity of the hospital for effective emergency response. In addition, their role indicates that they represent the officer within the hospital setting with the most accurate and comprehensive information about the level of emergency preparedness of the hospital. Completed questionnaires were personally collected by the researcher. Questionnaires were self-completed by all selected participants and returned to the researcher within a duration of three working days.

5.2.5 Analysis of APAQ data

Data collected using APAQ were subjected to both descriptive and inferential statistical analysis. In the first instance, scores obtained for each element of the functional or non-structural components were recorded for each hospital. These scores were used to determine the total score for functional or total non-structural components for each hospital. The total score for functional domain (sum of scores for all functional elements) and total score for non-structural domain (sum of scores for all non-structural elements) were computed for each of the 42 selected hospitals. In addition, the sum of scores obtained for each element of functional and non-structural domains across all the 42 hospitals were also computed. These total scores as well as individual scores obtained by each hospital for each element measured were also expressed as a percentage of total obtainable scores (total obtainable functional score = 446, total obtainable non-structural score =113, total combined score = 559). Descriptive analysis, involving computation of mean, median, range, standard error of mean and assessment of the normal distribution, was conducted for data obtained for each component. To rate the levels of vulnerabilities for each hospital, the scale provided by Ahmadi et al (64), which used percentage scores, was adopted. This is because the context of the study reported by Ahmadi *et al(64)* is similar to the context of KSA. Specifically, the scale rated scores of 0 – 49% as unsatisfactory level of preparedness (high vulnerability); scores between 50 and 65 % as moderate level of preparedness (moderate vulnerability) and scores of 66% and above as satisfactory level of preparedness (low vulnerability).

Data collected for the selected hospitals were also divided into categories based on hospital ownership/type of funding (private or public), hospital location (inner city or outer city), and level of care provided (secondary or tertiary care hospitals). This is because the type of funding that a hospital receives may play a significant role in the availability of financial resources to put effective disaster response structures in place. Moreover, the location of a hospital could play a significant role in the number of disaster victims that the hospital may need to cater for, and or the type of disaster that the hospital may be exposed to. Descriptive statistics (mean, median, range, standard error of mean and assessment of normal distribution) were conducted for each hospital group. Percentage scores and rating of the level of preparedness based on percentage scores obtained for each element of the functional and non-structural domains were also conducted for each category of hospitals. Also, scores obtained for individual elements of the functional and non-structural domain by private and public hospitals, secondary and tertiary hospitals, and by inner city and outer city hospitals were compared using Students' t test. This was against the background that the location, level of care provided and the agency responsible for the funding of a health facility may significantly affect their ability to prepare effectively for emergencies and the type of hazards they are exposed to. For instance, hospitals in outer city may not be exposed to hazards relating to stampede or mass casualty as these locations may have small population sizes. Also, tertiary hospitals provide specialist care services and may not be the first point of call during emergencies. Therefore, the level of preparedness these hospitals will be different.

Finally, the correlation between scores obtained for functional domain and scores obtained for non-structural domains for all selected hospitals as well as each category of hospitals were also computed by linear regression in order to ascertain if the development of capacity in one domain affects the development of capacity of the other domain. All statistical analyses were conducted using GraphPad Prism Version 8 software. Values represented in column graphs represent mean ± SEM. Statistical significance was considered at $P<0.05$.

5.3 Results

5.3.1: Analysis of functional capacity of all selected hospitals

The distribution of scores obtained for individual hospitals for each element of the functional domain is presented in Appendix 5.2. To understand the contribution of each individual element to the observed level of functional preparedness across the region, responses to these individual elements were analysed separately. A summary of the statistical analysis of these individual scores is presented in Table 5.2. Prior to parametric analysis of data presented in Table 5.2, the D'Agostino-Pearson omnibus normality test was conducted to assess if the data collected for each element of the functional domain conforms to Gaussian normal distribution (with dataset having a $P<0.05$ value not normally distributed). Results obtained indicated that scores obtained for all elements, except subcommittees ($P<0.0001$), patient decontamination ($P<0.0001$), hazard and vulnerability assessment ($P<0.005$), and fatality management ($P<0.01$), were normally distributed. Therefore, scores for each of the element of the functional domain was presented as mean ± Standard Error of Mean. Moreover, since the total score for individual elements of the functional domain differ significantly, mean scores were expressed as a percentage of the total score for each element, as this will allow the comparison of the scores across all the elements of the functional domain.

The analysis of percentage values presented in Table 5.2 indicated that mean expressed as a percentage of total score ranged from 13.4% obtained for subcommittees to 86.0% obtained for site accessibility.

The rating of preparedness level using mean values expressed as a percentage of total score indicated that the average levels of preparedness for subcommittees (13.4%), patient decontamination (25.6%), hazard and vulnerability assessment (26.3%), health facility networking (23.5%), community involvement (30.7%), public information (36.2%), and transportation and communication (40.2%) across the 42 selected hospitals were rated as unsatisfactory. However, values obtained for response protocol (50.1%), human resources (55.4%), disease surveillance (61.7%), and areas in the health facility (62.9%) place these elements in the moderate level of preparedness on average. All other elements of the functional domain had mean as a percentage of total score values ranging from 66% to 86% were rated as satisfactory level of preparedness.

Table 5. 2 The distribution of preparedness scores of individual elements of the functional capacity domain

Elements	No of items	Maximum possible score	Range	Mean ±SEM	Mean as % of maximum possible score	Average rating across hospitals
Subcommittees	1	18	0 – 16	2.4±0.7	13.4%	Unsatisfactory
Health facility networking	3	16	0 – 11	3.8±0.5	23.5%	Unsatisfactory
Patient decontamination	1	8	0 – 8	2.1±0.4	25.6%	Unsatisfactory
Hazard and vulnerability analysis	1	19	0 – 16	5.0±1.0	26.3%	Unsatisfactory
Community involvement	2	10	0 – 10	3.1±0.4	30.7%	Unsatisfactory
Public information	5	46	6 – 30	16.6±1.0	36.2%	Unsatisfactory
Transportation and communication	4	30	6 – 19	12.1±0.5	40.2%	Unsatisfactory
Response protocol	16	72	18 – 55	37.1±1.6	50.1%	Moderate
Human resources	4	7	1 – 7	3.9±0.2	55.4%	Moderate
Disease surveillance	7	15	3 – 14	8.9±0.4	59.3%	Moderate
Training and drills	5	38	12 – 34	23.5±0.7	61.7%	Moderate
Areas in the health facility	6	34	12 – 29	21.4±0.7	62.9%	Moderate
Emergency planning group/committee	10	63	27 – 57	41.6±1.1	66.0%	Satisfactory
Evacuation	11	28	15 – 28	20.2±0.5	72.2%	Satisfactory
Fatality management	1	5	0 – 5	3.7±0.2	73.3%	Satisfactory
Warning system and safety equipment	6	21	11 – 20	16.9±0.4	80.3%	Satisfactory
Site accessibility	4	16	9 – 16	13.8±0.3	86.0%	Satisfactory

Preparedness rating scale: Unsatisfactory = 0 - 49%; Moderate = 50 - 65%; and Satisfactory = 66% and above. n= number of hospitals (also expressed as a percentage of the 42 hospitals selected for the study.

To further understand the nature of the level of preparedness for individual elements in each of the hospitals selected, scores obtained for each element in each hospital was expressed as a percentage of the total score for the individual element. The percentage value obtained was then used to rate the level of preparedness in each hospital. Table 5.3 presents the frequency of hospitals which rated each of the elements of the functional domain as satisfactory (66 – 100%), moderate (50 – 65%), or unsatisfactory (0 – 49%) based on their percentage values. Not applicable was recorded as the rating in hospitals where the responder indicates that an individual element is not relevant to their operations. Table 5.3 indicates that the majority of hospitals in the region have unsatisfactory levels of preparedness for subcommittees (81.0%), health facility networking (83.3%), patient decontamination (69.1%), hazard vulnerability assessment (66.7%), public information (85.0%), community involvement (64.3%), transportation and communication (78.6%), response protocol (50.0%) and human resources (35.7%). These values indicate that healthcare facilities in Riyadh region are generally lacking preparedness in these areas and these components represent areas to be targeted for interventions aimed at improving all-hazard preparedness in the region. However, the majority of selected hospitals had a moderate level of preparedness for disease surveillance (38.1%) and training drills (61.9%). Satisfactory levels of preparedness were also identified by the majority of the hospitals in the region for warning system and safety equipment (83.3%), fatality management (66.8%), evacuation (66.8%) and site accessibility (95.2%).

Moreover, half (50%) of selected hospitals showed satisfactory level of preparedness for areas in the health facility, while equal number of selected hospitals indicated satisfactory (45.2%) and moderate (45.2%) levels of preparedness for emergency planning group.

Table 5. 3 Rating of preparedness levels for elements of functional components across hospitals in Riyadh region.

Elements	Responses (n, % of hospitals)			
	Satisfactory	Moderate	Unsatisfactory	Not applicable
Subcommittees	2(4.7%)	6(14.3%)	34(81.0%)	
Health facility networking	1(2.4%)	6(14.3%)	35(83.3%)	
Patient decontamination	6(14.3%)	7(16.7%)	29(69.1%)	
Hazard vulnerability analysis	9(21.4%)	5(11.9%)	28(66.7%)	
Community involvement	5(11.9%)	10 (23.8%)	27 (64.3%)	
Public information	0(0.0%)	6(14.3%)	36(85.0%)	
Transportation and communication	0(0.0%)	9(21.4%)	33(78.6%)	
Response protocol	6(14.3%)	15(35.7%)	21(50.0%)	2 (4.8%)
Human resources	13(31.0%)	14(33.3%)	15(35.7%)	
Disease surveillance	14(33.3%)	16(38.1%)	12(28.6%)	1(2.4%)
Training and drills	12(28.5%)	26(61.9%)	4(9.5%)	
Areas in the health facility	21(50.0%)	15(35.7%)	6(14.3%)	
Emergency planning group	19(45.2%)	19(45.2%)	4(9.5%)	1(2.4%)
Evacuation	28(66.8%)	15(35.7%)	0(0.0%)	
Fatality management	28(66.8%)	5(11.9%)	9(21.4%)	4 (9.5%)
Warning system and safety equipment	35(83.3%)	7(16.7%)	0(0.0%)	
Site accessibility	40(95.2%)	2(4.8%)	0(0.0%)	

Preparedness rating scale: Unsatisfactory = 0 - 49%; Moderate = 50 - 65%; and Satisfactory = 66% and above. n= number of hospitals (also expressed as a percentage of the 42 hospitals selected for the study.

5.3.2 Analysis of non-structural capacity of all selected hospitals

The analysis of individual elements of the non-structural domain was conducted in a similar manner as described for the functional domain. Scores obtained for each component of the non-structural domain in each of the selected hospital is presented in Appendix 5.3. Individual scores obtained for securities ranged between 4 and 15 and similarly wide ranges were observed for equipment and supplies (29 – 52) and utilities (19 -41). The summary of the statistical analysis of these individual scores is presented in Table 5.4. Table 5.4 showed that all the datasets were normally distributed (P >0.05) and mean values obtained for securities, equipment and supplies, and utilities were 9.6±0.4, 40.6±0.8, and 34.7±0.7, respectively. These translated to percentage of total possible scores of 64.1%, 72.4%, and 82.6% for securities, equipment and supplies, and utilities respectively.

Table 5. 4 The distribution of preparedness scores of individual elements of the non-structural capacity

Elements	No of items	Maximum possible score	Range	Mean ±SEM	Mean as % of total score	Average Rating
Securities	5	15	4 – 15	9.6±0.4	64.1%	Satisfactory
Equipment and supplies	14	56	29 – 52	40.6±0.8	72.4%	Satisfactory
Utilities	14	42	19 – 41	34.7±0.7	82.6%	Satisfactory

Preparedness rating scale: Unsatisfactory = 0 - 49%; Moderate = 50 - 65%; and Satisfactory = 66% and above. n= number of hospitals (also expressed as a percentage of the 42 hospitals selected for the study.

As conducted for individual elements of the functional domain, the score obtained for each individual element of the non-structural domain was also expressed as a percentage of the total score for each element and values obtained were used in rating the level of prepared for these elements. Details of the distribution of hospitals based on these ratings, showing the frequency of hospitals where each of the elements of the non-structural domain can be rated as satisfactory, moderate, or unsatisfactory, are presented in Table 5.6. Table 5.6 showed that the level of preparedness for all the elements was observed as satisfactory or moderate. Specifically, majority of the selected hospitals indicated satisfactory levels of preparedness for equipment and supplies (29 hospitals, 69.1%), and utilities (39 hospitals, 92.9%). Moderate level of preparedness was observed in majority of the hospitals (17 hospitals, 40.5%) for securities.

Table 5. 5 Distribution of vulnerabilities of individual elements of non-structural capacity across selected hospitals in Riyadh region

Elements	Response n (%)		
	Satisfactory	Moderate	Unsatisfactory
Securities	16(38.1%)	17(40.5%)	9(21.4%)
Equipment and supplies	29(69.1%)	13(31.0%)	0(0%)
Utilities	39(92.9%)	2(4.8%)	1(2.4%)

Preparedness rating scale: Unsatisfactory = 0 - 49%; Moderate = 50 - 65%; and Satisfactory = 66% and above. n= number of hospitals (also expressed as a percentage of the 42 hospitals selected for the study.

5.3.3 Analysis of overall vulnerability across the region

To assess the overall level of preparedness for functional capacity for each of the selected hospitals, the sum of scores obtained for individual elements of the functional domain for each hospital was computed. Descriptive analysis (range, mean, standard error of mean) of values obtained were also carried out. Moreover, the sum of functional scores obtained for each individual hospital was also expressed as a percentage of total available functional score. Percentage values obtained was subsequently used to rate the overall functional preparedness of selected hospitals. Similar analyses were also carried out for scores obtained for the non-structural domain. Details of these analyses are presented in Table 5.6.

Table 5. 6 Analysis of total functional and total non-structural capacities of selected hospitals

Domain	No of elements	Maximum possible score	Range	Mean ±SEM	Mean as % of total score	Average Rating
Functional	17	446	115 – 336	233.7±6.4	52.4%	M
Non-structural	3	113	64 – 102	84.9±1.5	75.1%	S
Overall	20	559	181 – 432	318.0±7.7	56.9%	M

Keys for rating: S = Satisfactory, M = Moderate and U = Unsatisfactory

Data presented in Table 5.6 indicated that overall scores collected for functional, non-structural, and combined capacities of selected hospitals were normally distributed ($P>0.10$). Overall functional scores ranged from 115 obtained for H51 to 336 obtained for H43. For non-structural scores, the lowest overall score of 64 was observed for H18 and H26 while the highest value of 102 was observed for H28. The combined preparedness capacity score for all the hospitals ranged from 181 (H51) and 432 (H43). Mean value obtained for overall functional scores was 233.7±6.4, translating to 52.4% of total available functional score. Also, mean value obtained for non-structural capacity was 84.9±1.5 which is equivalent to 75.1% of total available score. The combines preparedness capacity score (the sum of functional and non-structural scores) had a mean of 318.0±7.7, translating to 56.9% of total combined scores. Ratings, based on these percentage scores, indicate moderate level of preparedness for functional capacity and satisfactory level of preparedness for non-structural capacity. The combined level of preparedness indicates a moderate preparedness rating.

Percentage values obtained for total functional, total non-structural and combined preparedness scores for each selected hospital were used to rate the level of preparedness of these hospitals. The distribution of these ratings is presented in Table 5.7. The majority of selected hospitals (24, 57.1%) showed a moderate level of functional preparedness while a satisfactory level of functional preparedness was observed in 3 (7.1%) selected hospitals. However, unsatisfactory levels of functional preparedness were observed in 15 (35.7%) hospitals. The trend observed for non-structural capacity was different with majority (34, 81.0%) of selected hospitals indicating satisfactory level of preparedness and no hospital with unsatisfactory level of preparedness was observed. Moderate preparedness levels were observed in 8 (19.1%) selected hospitals. For the combined level of preparedness, majority of selected hospitals (25, 59.5%) were rated to have moderate level of preparedness, 7 (16.7%) rated as having satisfactory preparedness levels and 10 (23.8%) having unsatisfactory level of preparedness.

Table 5. 7 Distribution of overall vulnerabilities of selected hospitals in Riyadh region

Domains	Response n (%)		
	Satisfactory	Moderate	Unsatisfactory
Functional	3(7.1%)	24(57.1%)	15(35.7%)
Non-structural	34(81.0%)	8(19.1%)	0(0%)
Overall	7(16.7%)	25(59.5%)	10(23.8%)

Preparedness rating scale: Unsatisfactory = 0 - 49%; Moderate = 50 - 65%; and Satisfactory = 66% and above. n= number of hospitals (also expressed as a percentage of the 42 hospitals selected for the study.

5.3.4 Comparison of the preparedness levels of private and public hospitals

To analyse the impact of the source of funding of selected hospitals on their level of preparedness, data obtained for functional, non-structural, and combined vulnerabilities of privately and government funded (public) hospitals were analysed separately. In the first instance, descriptive analysis of scores obtained by private hospitals for individual elements of the functional domain and individual elements of the functional domain for public hospitals (Table 5.8) were conducted. The analysis showed that data obtained for private and public hospitals are generally similar.

Mean ± SEM values obtained for private and public hospitals are also presented in Figure 5.1. The analysis of these values by Students' t-tests indicated no significant difference ($P = 0.829$) in the scores obtained by private and public hospitals for all the elements of the functional domain. However, the comparison of individual elements of the functional domain between private and public hospitals indicated significant difference for evacuation (P = 0.014) while other elements are statistically not significantly different.

Table 5. 8 Distribution of preparedness scores of individual elements of the functional capacity domain in selected private and public hospitals

Elements	Total score	Mean ±SEM			Mean as % of total score		Private Average Rating	Public Average Rating
		Private	Public	P value	Private	Public		
Subcommittees	18	2.1±1.4	2.5±0.8	0.802	11.7%	13.9%	U	U
Health facility networking	16	3.7±1.1	3.8±0.5	0.965	23.1%	23.8%	U	U
Patient decontamination	8	2.0±0.8	2.1±0.5	0.949	25.0%	26.3%	U	U
Hazard vulnerability analysis	19	4.7±2.0	5.1±1.1	0.867	24.7%	26.8%	U	U
Community involvement	10	2.1±1.1	3.4±0.5	0.185	21.0%	34.0%	U	U
Public information	46	18.2±2.4	16.1±1.0	0.339	39.6%	35.0%	U	U
Transportation and communication	30	11.3±0.5	12.3±0.6	0.340	37.6%	41.0%	U	U
Response protocol	72	40.1±3.1	34.5±1.8	0.101	55.7%	47.9%	M	M
Human resources	7	4.1±0.5	3.8±0.3	0.596	58.6%	54.3%	M	M
Disease surveillance	15	9.0±0.9	8.9±0.5	0.920	60.0%	59.3%	M	M
Training and drills	38	25.5±1.4	22.7±0.8	0.100	67.1%	59.7%	S	M
Areas in the health facility	34	21.6±1.4	21.3±0.8	0.830	63.5%	62.6%	M	M
Emergency planning group/committee	63	43.3±2.5	41.0±1.2	0.339	68.7%	65.1%	S	S
Evacuation	28	22.3±0.9	19.5±0.6	0.014	79.6%	69.6%	S	S
Fatality management	5	3.7±0.4	3.6±0.3	0.884	74.0%	72.0%	S	S
Warning system and safety equipment	21	17.3±0.7	16.7±0.5	0.520	82.3%	79.5%	S	S
Site accessibility	16	13.7±0.5	13.8±0.3	0.937	85.6%	86.3%	S	S

Keys for rating: S = Satisfactory, M = Moderate and U = Unsatisfactory.

Scores obtained for each individual private or public hospital were also expressed as a percentage of total score for each element. These percentage values were used to rate the level of preparedness for these elements as previously described in this chapter. These ratings indicate that the level of preparedness in both types of hospitals for subcommittee, health facility networking, patient decontamination, hazard vulnerability analysis, community involvement, public information, and transport and communication are rated as unsatisfactory. However, preparedness for emergency planning/committee, evacuation, fatality management, warning systems and safety equipment, and site accessibility in both private and public hospitals are rated as satisfactory. Preparedness levels for response protocol, human resources, disease surveillance and areas in the health facility were rated as moderate. For training and drills, satisfactory level of preparedness was observed in private hospitals while the preparedness level in public hospitals was rated as moderate.

The analysis of the impact of funding source on the elements of the non-structural domain in selected hospitals was also investigated in this study. Similar to the analysis conducted for functional elements of private and public hospitals, results of the descriptive analysis of scores obtained by private and public hospitals for individual elements of the non-structural domain is presented in Table 5.9.

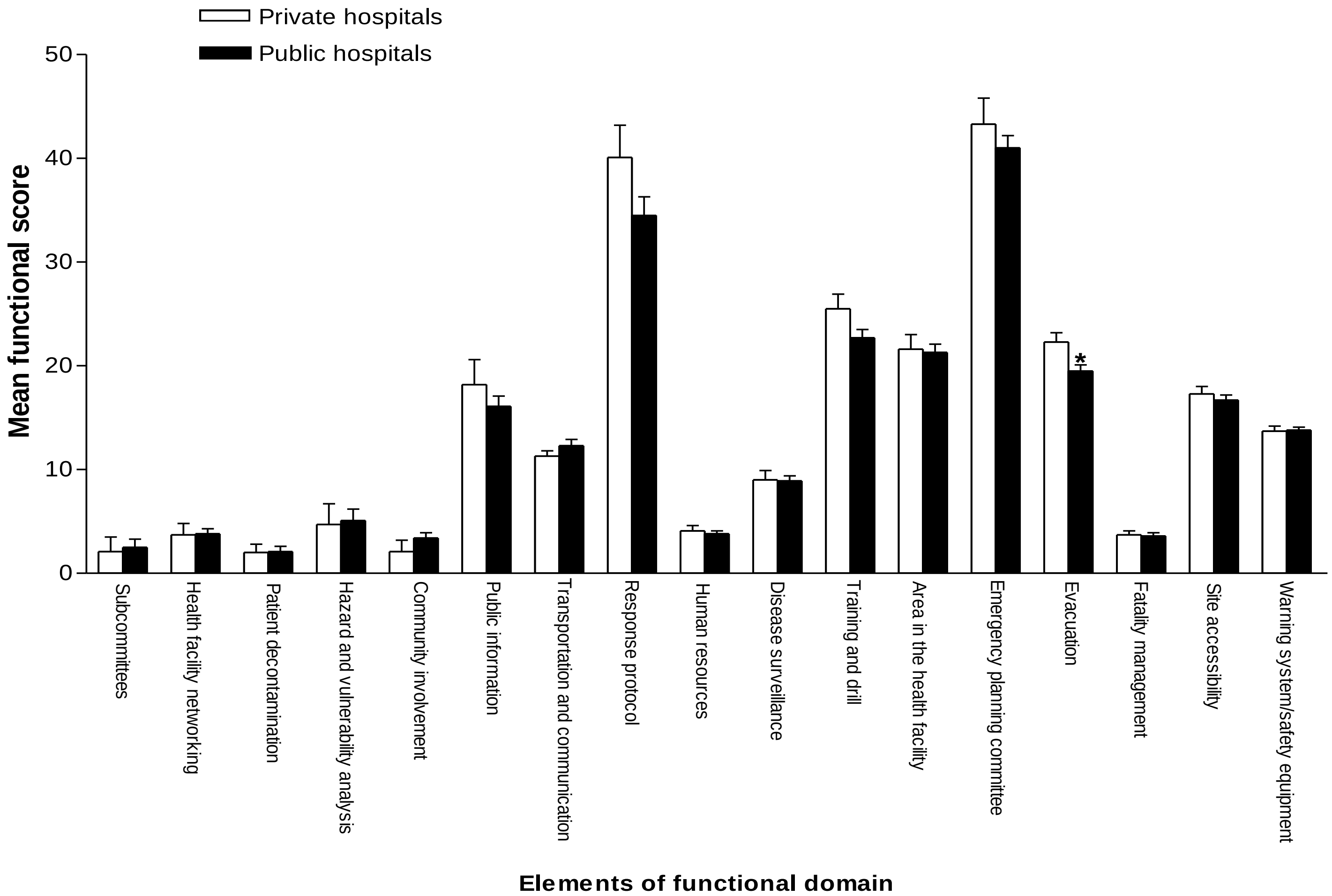

Figure 5. 1 Mean score for individual elements of the functional domain for private and public hospitals. Data presented are mean ± SEM. *P<0.05 compared to private hospital

Table 5. 9 Distribution of preparedness scores for individual elements of the non-structural domain obtained by private and public hospitals.

Elements	Total score	Mean ±SEM			Mean as % of total score		Private Average Rating	Public Average Rating
		Private	Public	P-value	Private	Public		
Equipment and supply	56	41.4±1.6	40.3±1.0	0.569	73.9%	72.0%	S	S
Security	15	9.1±0.7	9.8±0.5	0.442	60.7%	65.3%	M	S
Utilities	42	35.8±1.2	34.3±0.9	0.360	85.2%	81.7%	S	S

Keys for rating: S = Satisfactory, M = Moderate and U = Unsatisfactory

The comparison of mean values obtained for individual element of the non-structural domain (Figure 5.2) by students' t-test indicated no statistically significant difference between the data collected from private and public hospitals (p = 0.967). Scores obtained for each individual private or public hospital were also expressed as a percentage of total score for each element and these percentage values were used to rate the level of preparedness for these elements as highlight for elements of the functional domain earlier in this section. These ratings indicate that the level of preparedness for equipment and supplies, and utilities were rated as satisfactory in both private and public hospitals. However, moderate level of preparedness for securities was observed in private hospitals while satisfactory level of preparedness was observed for the parameter in public hospitals.

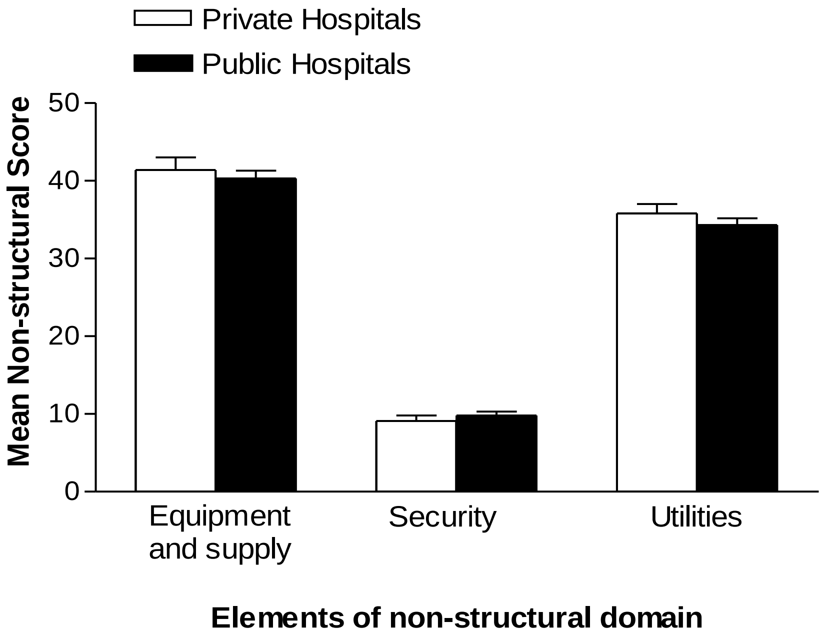

Figure 5. 2 Comparison of the mean values for individual elements of the non-structural domains for private and public hospitals. Values are mean ± SEM.

5.3.5 Comparison of the preparedness levels between secondary and tertiary hospitals

To examine the impact of level of care provided on the emergency preparedness levels of selected hospitals, the analysis of functional and non-structural capacities of secondary and tertiary hospitals were analysed separately. For functional capacities, details of the descriptive analysis of scores obtained by secondary and tertiary hospitals for individual elements of the functional domain are presented in Table 5.10. Mean ± SEM values obtained for secondary and tertiary hospitals are also presented in Figure 5.3. The analysis of these values by Students' t-tests indicated no significant difference ($P = 0.915$) in the scores obtained by secondary and tertiary hospitals for all functional elements. Comparison of the mean obtained for individual elements between secondary and tertiary hospitals however indicated significant differences for human resources (P = 0.001), fatality management (P = 0.001) and health facility management (P = 0.036).

Table 5. 10 Distribution of preparedness scores of individual elements of the functional capacity domain in selected secondary and tertiary hospitals

Elements	Total score	Mean ±SEM			Mean as % of total score		Secondary Average Rating	Tertiary Average Rating
		Secondary	Tertiary	P value	Secondary	Tertiary		
Subcommittees	18	1.5±0.7	4.2±1.6	0.081	8.3%	23.4%	U	U
Health facility networking	16	4.4±0.6	2.4±0.5	0.036	27.7%	15.2%	U	U
Patient decontamination	8	2.4±0.6	1.3±0.7	0.280	30.4%	16.1%	U	U
Hazard vulnerability analysis	19	4.2±1.1	6.6±1.7	0.228	22.0%	35.0%	U	U
Community involvement	10	3.2±0.6	2.9±0.7	0.733	31.8%	28.6%	U	U
Public information	46	17.5±1.2	14.9±1.4	0.204	38.0%	32.5%	U	U
Transportation and communication	30	12.0±0.5	12.1±1.1	0.972	40.1%	40.2%	U	U
Response protocol	72	37.1±1.9	34.0±3.1	0.372	51.5%	47.2%	M	U
Human resources	7	4.4±0.3	2.9±0.3	0.001	62.8%	40.8%	M	U
Disease surveillance	15	9.3±0.5	8.2±0.9	0.231	61.9%	54.8%	M	M
Training and drills	38	23.3±0.9	23.9±1.1	0.698	61.2%	62.8%	M	M
Areas in the health facility	34	21.8±0.8	20.6±1.5	0.417	64.1%	60.5%	M	M
Emergency planning group/committee	63	42.7±1.3	39.4±2.0	0.148	67.8%	62.5%	S	M
Evacuation	28	20.3±0.6	20.1±0.9	0.846	72.3%	71.5%	S	S
Fatality management	5	4.2±0.2	2.6±0.5	0.001	84.3%	51.4%	S	S
Warning system and safety equipment	21	16.9±0.5	16.8±0.7	0.896	80.4%	80.0%	S	S
Site accessibility	16	14.0±0.2	13.4±0.6	0.270	87.3%	83.5%	S	S

Keys For rating, S = Satisfactory, M = Moderate and U = Unsatisfactory.

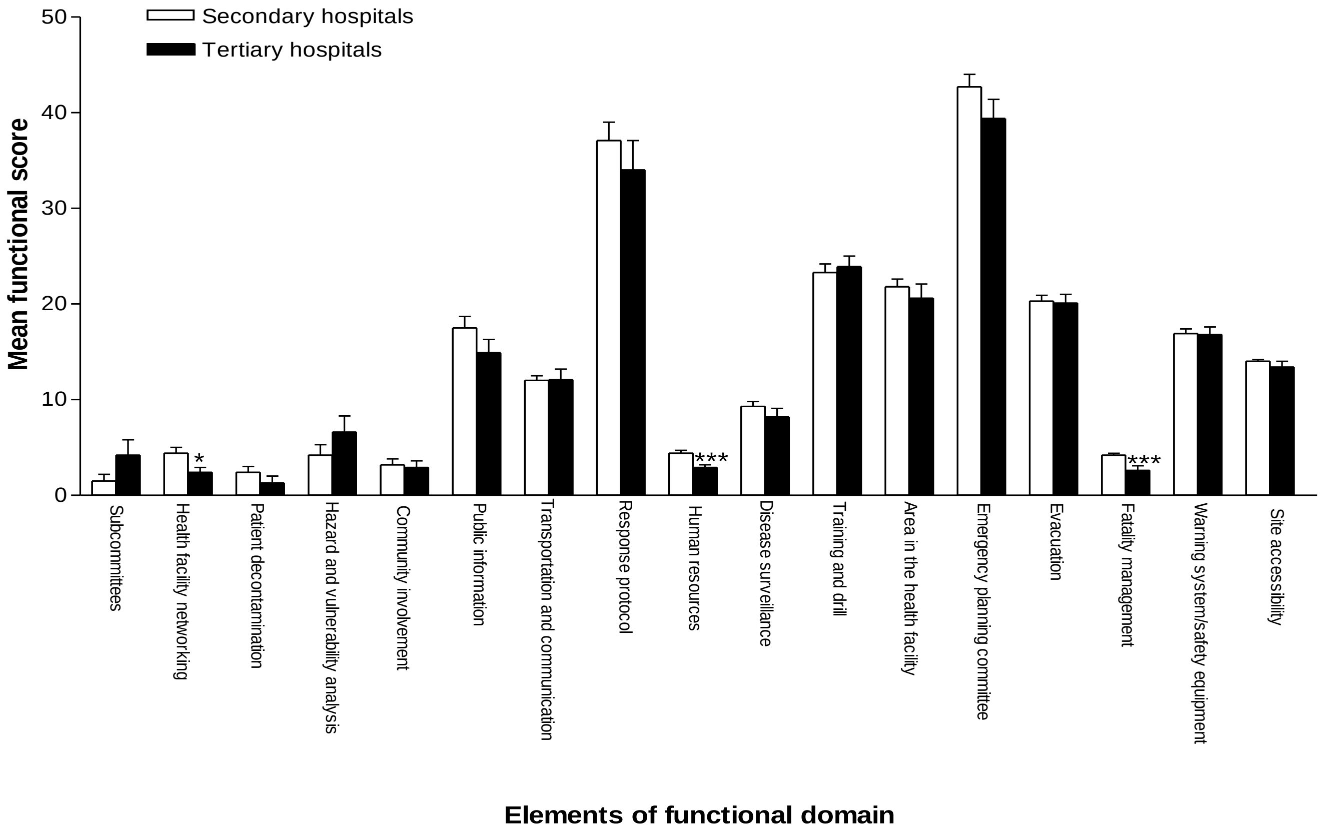

Figure 5. 3 Mean score for individual elements of the functional domain for secondary and tertiary hospitals.

Data presented are mean ± SEM. *P<0.05, ***P<0.001 compared to secondary hospitals to further investigate the impact of level of care provided on emergency preparedness levels, scores obtained for each individual secondary or tertiary hospital were also expressed as a percentage of total score for each element. Ratings based on these percentage values indicate that the level of preparedness in both secondary and tertiary of hospitals for subcommittee, health facility networking, patient decontamination, hazard vulnerability analysis, community involvement, public information, and transport and communication are unsatisfactory. For response protocol and human resources, moderate levels of preparedness were observed in secondary hospitals whereas the level of preparedness was unsatisfactory in tertiary hospitals. Moreover, ratings indicate moderate levels of preparedness for disease surveillance, areas in the health facility and training and drills in both secondary and tertiary hospitals. Satisfactory levels of preparedness were observed for other elements of the functional domain in both secondary and tertiary hospitals, except for emergency planning/committee which was observed to have moderate level of preparedness in tertiary hospitals (Table 5.10).

The analysis of the impact of level of care provided by selected hospitals on their preparedness for elements of the non-structural domain was also investigated. Results of the descriptive analysis of scores obtained by secondary and tertiary hospitals for individual elements of the non-structural domain is presented in Table 5.11.

Table 5. 11 Distribution of preparedness scores for individual elements of the non-structural domain obtained by secondary and tertiary hospitals.

Elements	Total score	Mean ±SEM			Mean as % of total score		Secondary Average Rating	Tertiary Average Rating
		Secondary	Tertiary	P value	Secondary	Tertiary		
Equipment and supply	56	41.5±0.8	38.6±1.8	0.110	74.1%	68.9%	S	S
Security	15	9.4±0.4	10.1±0.8	0.365	62.7%	67.3%	M	S
Utilities	42	35.2±0.8	33.8±1.4	0.361	83.8%	80.5%	S	S

Keys For rating, S = Satisfactory, M = Moderate and U = Unsatisfactory.

The comparison of mean values obtained for individual element of the non-structural domain (Figure 5.4) by students' t-test indicated no statistically significant (P = 0.935) difference between the data collected from secondary and tertiary hospitals.

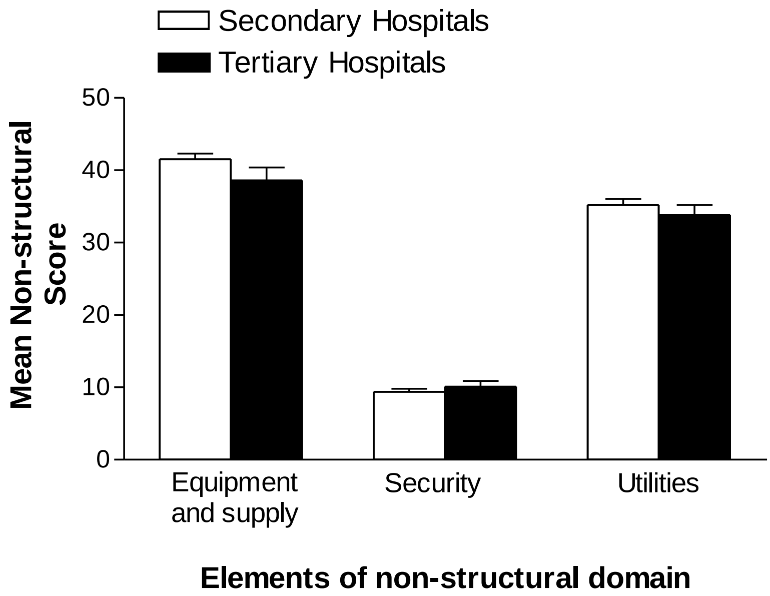

Figure 5. 4 Comparison of the mean values for individual elements of the non-structural domains for secondary and tertiary hospitals. Values are mean ± SEM.

Scores obtained for each individual secondary or tertiary hospital were also expressed as a percentage of total score for each element of the non-structural domain and values obtained were used to rate the level of preparedness. These ratings indicate that the level of preparedness for all components of the non-structural domain were rated as satisfactory in both secondary and tertiary hospitals except for security which was rated as having a moderate level of preparedness in secondary hospitals.

5.3.6 Analysis of preparedness levels of inner city and outer city hospitals

To examine the impact of location of selected hospitals on the emergency preparedness levels of selected hospitals, the analysis of functional and non-structural capacities of inner city and outer hospitals were analysed separately. For functional capacities, details of the descriptive analysis of scores obtained by secondary and tertiary hospitals for individual elements of the functional domain are presented in Tables 5.12.

The comparison of mean values obtained for each of the elements of the functional domains from outer-city and inner-city hospitals by students' t-test indicated no statistically significant (P = 0.742) difference in the mean values obtained for some elements (Figure 5.5). However, comparison of individual elements between inner city and outer city hospitals indicate that the mean score obtained for patient decontamination in inner city hospitals is 9.3-fold (P = 0.003) greater compared to the value obtained for outer city hospitals for that same component of the functional domain. Similarly, significantly greater mean scores were obtained in inner city hospitals for hazard vulnerability analysis (4.3-fold, P = 0.018) and disease surveillance (1.3-fold, P = 0.029). However, higher mean score values were obtained in outer city hospitals for human resources (1.4-fold, P = 0.016) and community involvement (2.0-fold, P = 0.019). Means score values obtained for other components of the functional domain are similar for inner city and outer city hospitals.

Table 5. 12 Distribution of preparedness scores of individual elements of the functional capacity domain in selected inner city and outer city hospitals

Elements	Total score	Mean ±SEM			Mean as % of total score		Inner city Average Rating	Outer City Average Rating
		Inner city	Outer city	P value	Inner City	Outer City		
Subcommittees	18	2.4±0.9	2.4±1.3	0.992	13.3%	13.4%	U	U
Health facility networking	16	3.7±0.5	4.0±0.8	0.745	22.9%	25.0%	U	U
Patient decontamination	8	2.8±0.6	0.3±0.2	0.003	34.6%	3.1%	U	U
Hazard vulnerability analysis	19	6.4±1.2	1.5±1.1	0.018	33.7%	7.9%	U	U
Community involvement	10	2.4±0.5	4.7±0.6	0.019	24.3%	46.7%	U	U
Public information	46	17.4±1.2	14.8±1.6	0.210	37.8%	32.1%	U	U
Transportation and communication	30	11.9±0.6	12.5±1.0	0.555	39.6%	41.7%	U	U
Response protocol	72	37.4±2.0	32.7±2.6	0.187	52.0%	45.4%	M	U
Human resources	7	3.5±0.2	4.8±0.5	0.016	50.7%	67.9%	M	S
Disease surveillance	15	9.5±0.5	7.5±0.7	0.029	63.3%	50.0%	M	M
Training and drills	38	24.2±0.9	21.5±1.2	0.089	63.8%	56.6%	M	M
Areas in the health facility	34	21.5±0.9	21.2±0.9	0.848	63.1%	62.3%	M	M
Emergency planning group/committee	63	42.4±1.3	39.5±1.8	0.227	67.3%	62.7%	S	M
Evacuation	28	20.8±0.6	18.8±0.8	0.087	74.2%	67.3%	S	S
Fatality management	5	3.7±0.3	3.7±0.4	1.00	73.3%	73.3%	S	S
Warning system and safety equipment	21	16.8±0.5	17.1±0.7	0.711	79.6%	81.3%	S	S
Site accessibility	16	14.1±0.3	13.0±0.5	0.060	87.9%	81.3%	S	S

Keys For rating, S = Satisfactory, M = Moderate and U = Unsatisfactory.

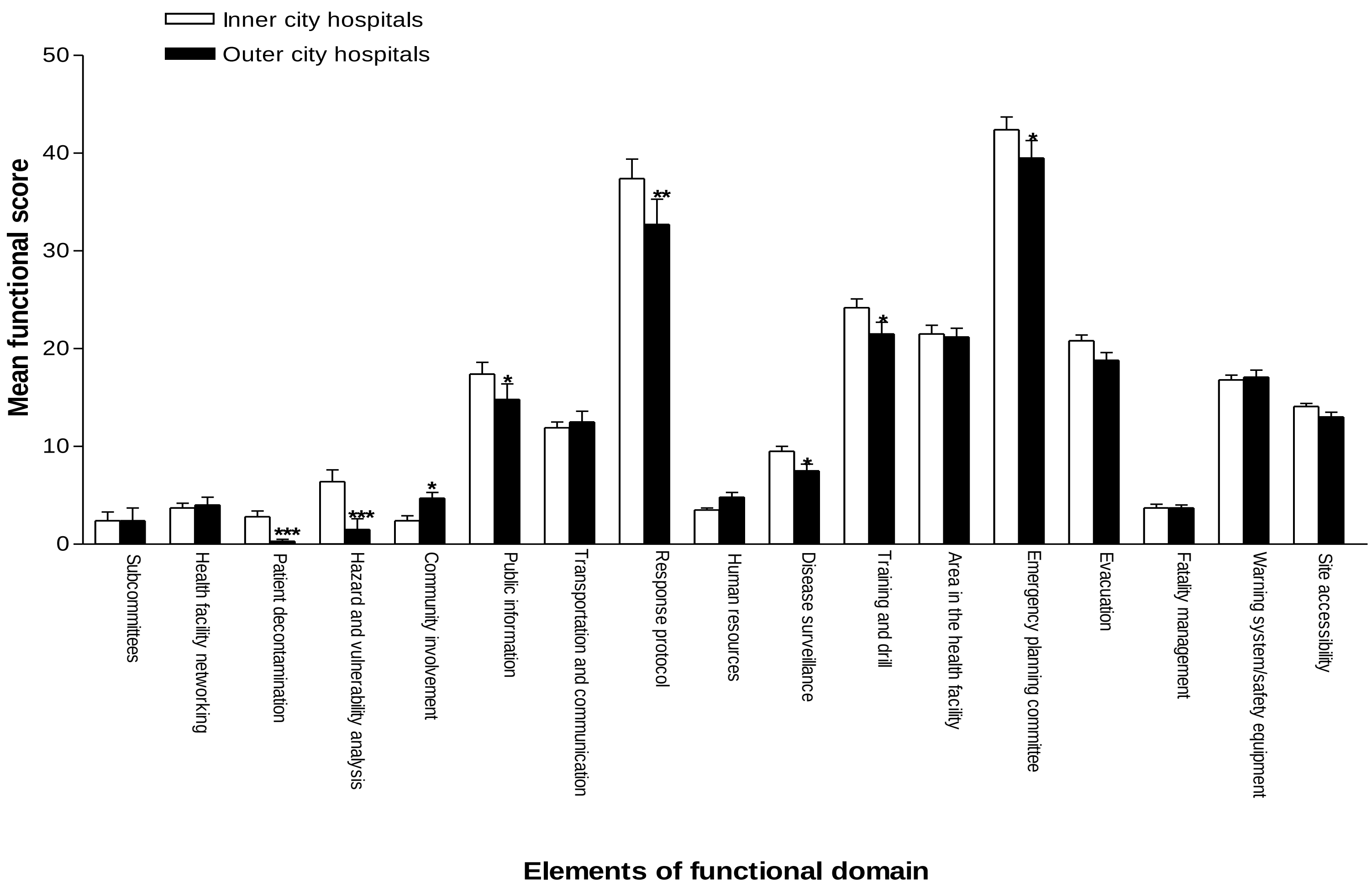

Figure 5. 5 Mean score for individual elements of the functional domain for inner city and outer city hospitals. Values are mean ± SEM. ***P<0.001, **P<0.01, and *P<0.05 compared to the same element in inner city hospital

Ratings based mean values expressed as a percentage of total score for each element on these percentage values indicate that the level of preparedness in both inner city and outer city hospitals for subcommittee, health facility networking, patient decontamination, hazard vulnerability analysis, community involvement, public information, and transport and communication are unsatisfactory. For response protocol, a moderate level of preparedness was observed in inner city hospitals whereas the level of preparedness in outer city hospitals was rated as unsatisfactory. For human resources, the level of preparedness in outer city hospitals was rated as satisfactory while inner city hospitals have moderate rating. Both types of hospitals were rated as having moderate level of preparedness for disease surveillance, areas in the health facility, and training and drills. Satisfactory levels of preparedness were observed for evacuation, warning system and safety equipment, and site accessibility in both inner city and outer city hospitals. However, though preparedness level for other fatality management and emergency planning/committee were rated as satisfactory in inner city hospitals, these elements were rated to have moderate levels of preparedness in outer city hospitals.

The analysis of the impact of the location of selected hospitals on their preparedness for elements of the non-structural domain was also investigated. Results of the descriptive analysis of scores obtained by secondary and tertiary hospitals for individual elements of the non-structural domain is presented in Table 5.13. The comparison of mean values obtained for individual elements of the non-structural domain (Figure 5.6) by students' t-test indicated no statistically significant (P = 0.923) difference between the data collected from inner city and outer city hospitals. Rating based on mean score expressed as percentage of total score also indicated that both inner city and outer city hospitals have similar ratings for all components of the non-structural domain (Table 5.13).

Table 5. 13 Distribution of preparedness scores for individual elements of the non-structural domain obtained by inner city and outer city hospitals.

Elements	Total score	Mean ±SEM			Mean as % of total score		Inner City Average Rating	Outer City Average Rating
		Inner city	Outer city	P value	Inner City	Outer city		
Equipment and supply	56	40.6±1.0	40.3±1.5	0.874	72.5%	72.0%	S	S
Security	15	10.1±0.5	8.5±0.7	0.148	67.3%	56.7%	M	M
Utilities	42	35.4±0.7	33.1±1.7	0.079	84.3%	78.8%	S	S

Keys For rating, S = Satisfactory, M = Moderate and U = Unsatisfactory

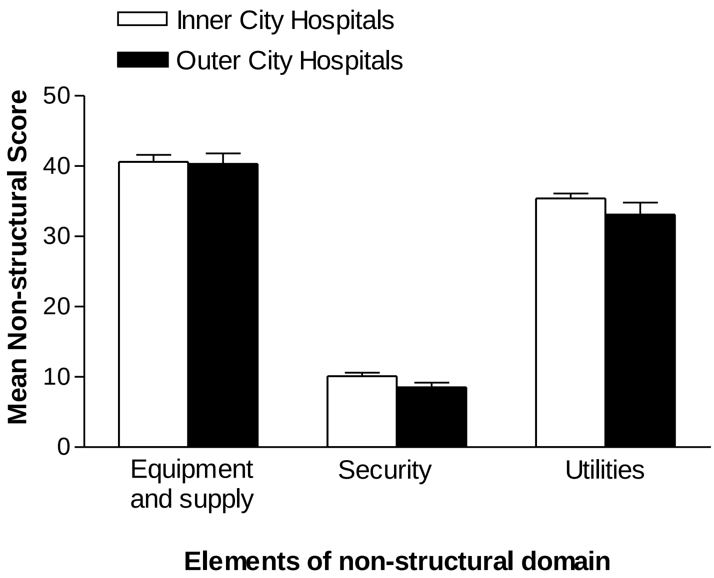

Figure 5. 6 The comparison of mean values obtained for individual elements of the non-structural domain for inner city and outer city hospitals. Values are mean ± SEM.

5.3.7: Analysis of the correlation between functional and non-structural capacities of selected hospitals

Data on the functional and non-structural capacity of selected hospitals were analysed to examine if there is a correlation between the two components of all-hazard preparedness. Figure 5.7 presents the analysis conducted for all the selected hospitals across Riyadh region.

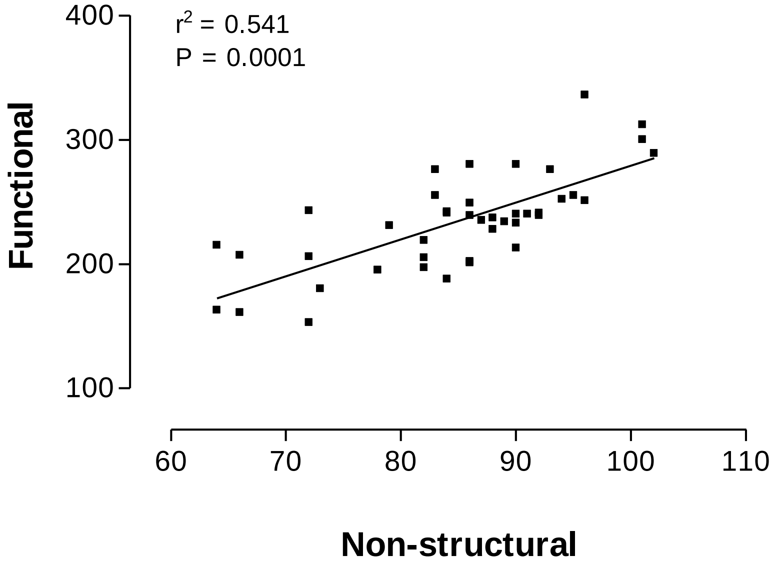

Figure 5. 7 Correlation between preparedness scores for functional and non-structural components of all-hazard preparedness for all selected hospitals across Riyadh region

The Coefficient of Pearson (r^2) obtained for the analysis was 0.541 (P<0.001) which is indicative of a positive relationship between the two components. This positive correlation indicates that hospitals with good levels of preparedness for functional components of the all-hazard approach will also have good levels of preparedness for non-structural components. The converse is also true based on this correlation. Therefore, if improvements in functional components are required in one hospital, it is also very likely that the hospital will also need improvements in non-structural components. The impact of how the hospital is funded on this relationship was investigated by analysing the correlation between functional and non-structural components of private and public hospitals separately. The result of the analysis presented in Figure 5.8 revealed Coefficient of Pearson (r^2) values of 0.629 ($P<0.001$) and 0.545 ($P<0.001$) for private(A) and public (B) hospitals, respectively. These values are indicative of a strong positive correlation.

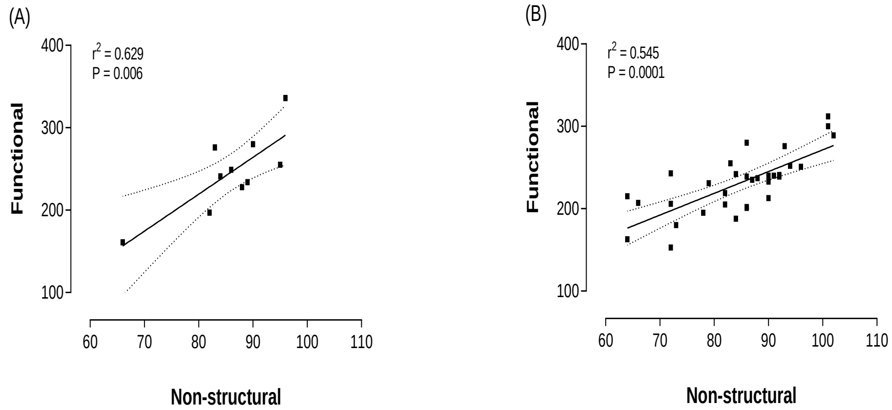

Figure 5. 8 Correlation between preparedness scores for functional and non-structural components of all-hazard preparedness for selected private (A) and public (B) hospitals.

Similarly, to investigate the impact of the level of care provided by each hospital is funded on this relationship, the correlation between functional and non-structural components of secondary and tertiary hospitals were analysed separately. The result of the analysis presented in Figure 5.9 revealed Coefficient of Pearson (r^2) values of 0.384 ($P<0.001$) and 0.729 ($P<0.001$) for secondary and tertiary hospitals, respectively. These values indicate a weak positive relationship between functional and non-structural capacities of secondary hospitals and a strong positive relationship between the two domains in tertiary hospitals. The implication of this for secondary hospitals is that level of preparedness in functional capacity does not produce equivalent level of preparedness in non-structural components in these hospitals.

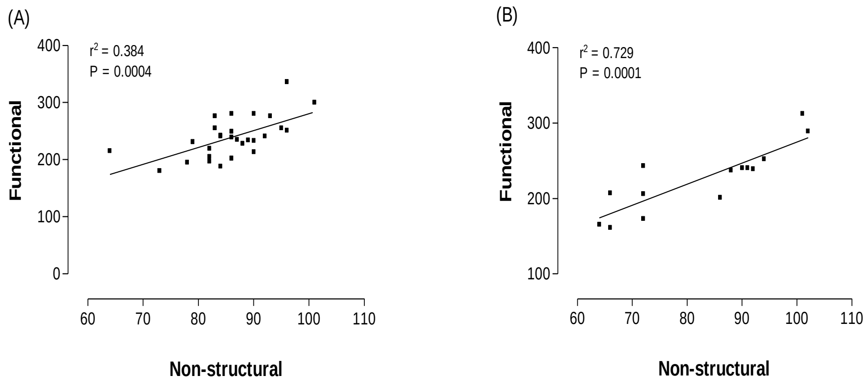

Figure 5. 9 Correlation between preparedness scores for functional and non-structural components of all-hazard preparedness for selected secondary (A) and tertiary (B) hospitals.

Also, the impact of the location of the hospital on the relationship between the functional and non-structural all-hazard preparedness capacities of inner city and out city hospitals were analysed separately. The result of the analysis presented in Figure 5.10 revealed Coefficient of Pearson (r^2) values of 0.543 ($P<0.001$) and 0.351 ($P<0.05$) for inner city and outer city hospitals, respectively. These values indicate a weak positive relationship between functional and non-structural capacities of outer city hospitals and a strong positive relationship between the two domains in inner city hospitals.

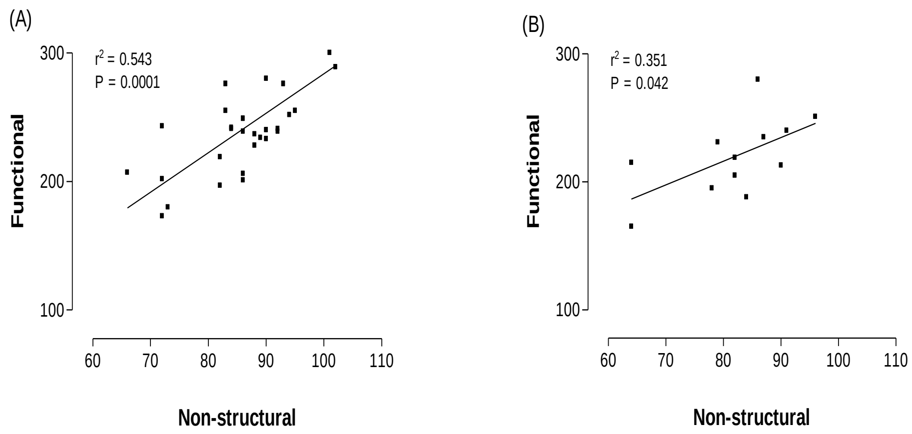

Figure 5. 10 Correlation between preparedness scores for functional and non-structural components of all-hazard preparedness for selected inner city (A) and outer city (B) hospitals.

5.4 Discussion

5.4.1 Summary of findings

This study involved the development of a new questionnaire for the assessment of the level of preparedness of selected hospitals for functional and non-structural components of all-hazard approach to disaster preparedness. This study is also the first attempt of using the new questionnaire to measure the level of preparedness of healthcare organisations within the context of Saudi Arabia. Results obtained indicate that the use of the questionnaire has helped in the identification of strengths and potential weaknesses in the level of preparedness for individual elements of the functional and non-structural domains and the overall level of preparedness across the region.

This chapter revealed that hospitals across the Riyadh region can be generally assessed as having moderate level of functional emergency response capacity, satisfactory non-structural emergency response capacity and an overall moderate level of emergency response capacity. With respect to individual elements of the functional domain, hospitals across the region were assessed as having satisfactory level of preparedness for functional elements such as emergency planning group/committee, evacuation, fatality management, warning systems and safety accessibility, and site accessibility. Also, a moderate level of preparedness (or capacity) was observed for functional elements such as response protocol, human resources, disease surveillance, training and drills, and area in the health facility, for all selected hospitals in the region.

However, unsatisfactory level of preparedness was observed for subcommittees, health facility networking, patients' decontamination, hazard and vulnerability assessment, community involvement, public information, and transportation and communication in these hospitals. Satisfactory level of preparedness was observed for all elements of non-structural domains.

Analysis conducted in this study also revealed that there are extensive similarities in the distribution of the levels of preparedness for the individual elements of functional domains in private and public hospitals. The study particularly indicated that the type of funding that a hospital receives does not significantly ($P = 0.840$) affect the level of overall preparedness for functional and non-structural domains. The only exception observed in this study relates to the level of preparedness for the evacuation during emergencies which was observed to be significantly ($P = 0.014$) better in private hospitals compared to public hospitals. Similarly, the analysis conducted in this study indicated that emergency preparedness capacity of hospitals within Riyadh region is not affected by the level of care (secondary or tertiary hospitals) provided by these hospitals even though better levels of preparedness for functional and non-structural ($P = 0.897$), even though some significant improvement in preparedness for individual elements such as health facility networking ($P = 0.036$), human resources ($P = 0.01$) and fatality management ($P = 0.01$) were observed in secondary hospitals compared to tertiary hospitals. Similarly, no significant difference in mean values for functional and non-structural domains was observed for inner city and outer city hospitals (P = 0.747). However, individual analysis of elements of the functional domain indicated that some significant difference in elements such as hazard vulnerability analysis (P = 0.018), patient decontamination (P = 0.003), community involvement (P = 0.019), human resources (P = 0.016) and disease surveillance (P = 0.029) between inner city and outer city hospitals across the region. Finally, this study revealed that there is a significant relationship between functional and non-structural emergency response capacity across the different categories of hospitals within the region except in outer city hospitals and in hospitals providing secondary care services.

5.4.2 Discussion of findings

Studies evaluating comprehensive all-hazard preparedness of health facilities in KSA, as conducted in this study, are very scarce. However, there are reports of studies which investigated the level of preparedness of hospitals in different parts of KSA with respect to one type of disaster or the other. For instance, in a study which investigated the level of preparedness of 13 selected hospitals in Central Region of KSA to mass casualty events, Shalhoub et al (245) reported that about 92% of these hospitals have same levels of preparedness for internal and external mass casualty events, and that there is a level of agreement between some of these hospitals to work synergistically to respond to emergency mass casualty events. Even though the study by Shalhoub et al (245) did not thoroughly investigate individual elements of emergency response capacity domains (as conducted in this study), the report of some level of preparedness reported corroborates the findings of this present study that some satisfactory levels of preparedness can be seen (particularly in non-structural domains) in hospitals across the region. In another study, Alruwaili et al (255), reported findings of a study which investigated the level of emergency preparedness of selected hospitals across the Eastern Region of KSA. The study indicated that while most of the hospitals assessed had sufficient resources for disaster response, the overall effectiveness of the level of preparedness of hospitals in the region can be adjudged as moderate. Though it is not clear how the study by Alruwaili et al (255), arrived at the conclusion with respect to the overall level of preparedness (particularly as the study did not conduct an all-hazard assessment), the finding is consistent with the results obtained by this study for the Riyadh region of KSA.

The study reported by Alsalem et al (256) was more comprehensive as it included the assessment of the level of preparedness for non-structural, structural, management, functional, human resources and planning elements of the all-hazard preparedness. In addition, the study also selected hospitals in Riyadh (in addition to Jeddah and Dammam) regions of KSA and reported that selected hospitals were most prepared for management while the level of preparedness for human resources was the least. Interestingly, the study indicated that Riyadh region has the highest level of preparedness compared to all regions included in that study. Compared to this present study, satisfactory levels of preparedness indicated for non-structural components by Alsalem et al (256) is consistent with our result.

Also, the score of 63% reported by Alsalem et al (256) for human resources falls within the moderate classification which was observed for that element in this study. However, this present study is more explicit as it analysed other individual elements of the functional domain separately unlike previous studies such as Alsalem et al(256) . While this present study focused only of Riyadh region, the indication by Alsalem et al (256) that Riyadh is the more prepared for emergency (compared to the two other regions included in that study) partially suggests that the level of preparedness reported in this present study may likely represent the best level of emergency preparedness that is available in KSA. However, a more elaborate study in the future which compares the level of emergency preparedness across different regions of KSA may be needed to prove this presumption. In addition, the method of data collection and analysis used by Alsalem et al (256) is somewhat similar to what was carried out in this study, though the instrument of data collection used in our study is more detailed. For example, data reported in Alsalem et al (256) were also self-reported and analysis was conducted by combining scores of individual elements measured in that study.

This study reports the impact of type of funding (private or public), hospital location (inner city or outer city) and type of care provided hospitals on their level of emergency preparedness for the first time. Several studies have compared the level and quality of care provided by public and private hospitals (257-259), against the background that how a hospital is funded may significantly affect the quality of care, types of services, staff training and development, staff retention and facilities available in the hospital. In developing countries, where government funding is often limited, it has been commonly observed that the quality of care and available facilities in public hospitals may be inadequate (259). On the other hand, the fact that private hospitals are run as businesses could also mean that the focus may be on money rather than patients' satisfaction and quality of care (258). With reference to emergency preparedness, it may also be possible that private hospitals may be more prepared for internal emergencies which have direct impact on their operations compared to external disasters (which may be considered a responsibility of the government) (62). However, the finding of this present study that private hospitals are not significantly better than public hospitals in terms of overall emergency preparedness clearly indicates that funding pattern may not be a significant determinant of the level of emergency preparedness in KSA. Preparedness for evacuation was observed to be better in private hospitals. It is possible that private hospitals are not usually the first point of call during an emergency and therefore, it is possible that facilities available in these hospitals may be underutilised, leading to the observation of better evacuation facilities as observed in this study. To support this suggestion, this study observed that some of the private hospitals assessed do not have emergency response plans, even though they have good facilities, and may have money to train staff members. Moreover, it is possible that public hospitals are overstretched by previous disaster events and have limited resources for ongoing training.

Further studies to investigate the exact contributions of these factors to our present observations are needed.

This study also revealed that secondary hospitals have a higher level of emergency preparedness compared with tertiary hospitals in some elements of the functional domain. By nature, tertiary hospitals are often created to handle specialist medical conditions, and by design, they are not the usual place for treating victims of emergencies, except those with complex cases which are referred. This may, to a large extent, contribute to the observation that secondary hospitals are more prepared across all domains compared to tertiary hospitals. It was observed in all secondary hospitals visited in this study that the majority have well-written emergency response plans, and staff members undergo regular drills to get them ready for real-time emergency situations. In addition, excellent channels for supply of medical supplies were also observed in secondary hospitals visited in this study. The situation is not the same in tertiary hospitals. Despite these observed differences, the general conclusion of this study is that the overall level of emergency preparedness in secondary and tertiary hospitals are not significantly different. The implication of this is that factors which promote the development of good emergency management systems in KSA may affect both secondary and tertiary hospitals in the country in a similar way. Moreover, at the individual hospital level, the impact of these factors may slightly differ, making one hospital better prepared than another.

Also, this study investigated the impact of hospital location on the level of preparedness for emergency. Due to the nature of Riyadh region and particularly the religious significance of the cities within the region, cities receive more visitors and often have increased potential for emergency situations (particularly mass casualty events). It is therefore not surprising that this study reveals that hospitals within the city are better prepared for certain elements of the functional domain compared to outer city hospitals. Observations during the conduct of this study revealed that the Ministry of Health in KSA often sends representatives to observe emergency drills performed by inner city hospitals and that these hospitals also have good pathways for obtaining emergency medical supplies. In addition, this study observed that the situation in outer city hospitals is different. This could partly be due to the fact that many of these hospitals are located in sub-urban areas with low population (low risk of mass casualty events even though they could be prone to other types of disasters). Moreover, it was observed that, unlike inner city hospitals, outer city hospitals hardly report issues relating to insufficient bed spaces, and other related issues that often face inner city facilities. These may contribute to the relaxed nature of emergency preparedness in these areas. However, as this study reports this observation for the first time, it is important to carefully study the dynamics of emergency preparedness and response in sub-urban areas in other to fully understand the observed phenomenon.

The observation that there exists a positive correlation between functional and non-structural domains in almost all categories of hospitals included in this study is an indication that all-hazard preparedness may be saliently practiced in some hospitals while other hospitals are lacking. Therefore, the identification of factors affecting the implementation of all-hazard approach in hospitals that are lacking may be necessary. It is also evident that, to a large extent, emergency planners in selected hospitals may have holistic view of emergency preparedness, even though their level of emergency or disaster education may be poor. Therefore, this finding also indicates that interventions which provide training in hospitals where the implementation of all-hazard approach is lacking may be necessary. The report by Shalhoub et al (245) clearly indicated that training and education is one of the major challenges against effective emergency preparedness in KSA. The study particularly highlighted that only few hospitals conduct emergency drills and even in hospitals where drills are performed, such as drills are not frequent (may be once a year). During the conduct of this study, the lack of drills and the fact that they are not frequently conducted was also observed, particularly in outer city and tertiary hospitals.

5.5 Strengths and limitations

One the key strengths of the investigation reported in this chapter is the comprehensiveness of the analysis of the individual elements of the functional and non-structural domains. The majority of previous studies often combine these elements together, making it difficult for the assessment of the failure or otherwise of each component, which can motivate targeted interventions to improve levels of preparedness. However, the new tool developed and used in this study was effective in measuring the level of preparedness for individual elements. Therefore, as this study has broken down the two main domains into their constituent elements and analysed these elements across the different categories of hospitals in the region, it becomes easier to know which element to focus on to improve the overall level of preparedness in each hospital and in the region at large. Another key strength of this study is that, unlike previous studies, it investigates the impact of funding source, hospital locations and level of care provided on hospitals' level of preparedness. This analysis has opened up new areas of investigation into the dynamics of and contributors to emergency preparedness.

However, this study is not without some limitations. In the first instance, only hospitals in Riyadh region are included in this investigation. The fact that previous studies have highlighted that the level of preparedness in Riyadh region to be generally good may make it difficult see other problems that may be affecting emergency preparedness in KSA (245, 255, 256). Moreover, the fact that Emergency Services Directors self-complete the APAQ questionnaire may introduce some biases and errors, which may affect the accuracy of data collected and analysed in this study. It is possible that some managers may rate certain elements high in other to cover inefficiencies within their facilities. Perhaps, a direct observation data collection method may be used in the future to supplement questionnaire administration in other to address this challenge. Validation of self-reported data may also be carried out. Also, more work is needed to understand elements of the tool that should be weighted more heavily.

In addition, an arbitrary scoring system was used in this study, particularly in rating the level of preparedness as satisfactory, moderate, and unsatisfactory. Though the cut-off points used in this study have been previously used in a similar study (64), the adaptation of this arbitrary scoring system within the context of our study (which is different from Ahmadi, Foroushani (64) may introduce some errors into results obtained in this study.

Data analysis by combining scores across individual elements is also used for the first time in this study and future studies which uses APAQ across many contexts may be needed to confirm that this technique does not introduce other inherent errors that are not obvious within the present study. However, this is the best approach in this case as this is the first time that this tool is being used. With the validation of self-reported data, and the use of other validation techniques may reveal some of the errors that are not currently obvious.

5.6 Recommendations

Based on findings reported in this chapter, the following recommendation are made:

1. The questionnaire developed was used for the first time in this study, the use of the questionnaire to collect data from hospitals selected from other regions of KSA is recommended. This will provide further evidence of the reliability of the questionnaire.

2. Generally, this study showed moderate and satisfactory levels of preparedness for some elements of the all-hazard approach. A compilation of these elements and efforts made by selected hospitals is necessary as this could be shared as evidence of best practice with other hospitals in the region. This will contribute to overall general improvement in the level of emergency preparedness in the area.
3. The rating scale used in this study was adopted from a similar study and is arbitrary in nature. Future studies using a different rating scale is recommended to see if a conclusion similar to what has been reported in this study will be arrived at. Other types of work to validate the result presented in this study is also recommended.

5.7 Conclusion

In conclusion, this chapter has indicated that the level of preparedness of hospitals in Riyadh regions is generally rated as moderate. It has also been highlighted that though the level of emergency preparedness across the different categories of hospitals in Riyadh regions is generally similar, preparedness for certain elements in private, inner city and secondary hospitals are better compared to their public, outer city and tertiary counterparts respectively. It is therefore important to investigate factors that may contribute to the observed disparity in the level of emergency preparedness among these hospitals, and to evaluate if this disparity has actually affected effective response during previous disaster occurrences in the region. In order to review the understanding of the all-hazard approach amongst Emergency Manager and identify the challenges associated with the adoption and implementation of the approach at the facility level, the next chapter of this thesis will report and analyse emerging themes from interviews conducted for selected Emergency Managers across hospitals in Riyadh region.

CHAPTER SIX
THE LEVEL OF UNDERSTANDING OF ALL-HAZARD APPROACH BY EMERGENCY SERVICES DIRECTORS AND CHALLENGES ASSOCIATED WITH THE ADOPTION AND IMPLEMENTATION OF THE APPROACH IN SELECTED SECONDARY AND TERTIARY HEALTH FACILITIES: A QUALITATIVE STUDY

6.1 Overview

This chapter articulates the views of hospital directors in Riyadh region on the adoption and implementation of the all-hazard approach. Secondary and tertiary hospitals in Riyadh have been studied to show their disaster preparedness and implementation of all-hazard approach. Qualitative data was collected through interviews with managers from the selected secondary and tertiary hospitals.

As highlighted in the previous chapters of this thesis, health facilities form an important part of a nation's response to emergency situations. Though the extent of the impact of various types of disasters vary significantly, it is known that the disasters within health facilities have similar medical and public health implications (260). Therefore, effective preparedness and disaster response require hospitals to have comprehensive disaster plans for effective risk assessment, hazard vulnerability assessment that aims at identifying all probable hazards, and disaster mitigation(261). Usually, emergency preparedness involves a range of activities including planning, the development of appropriate infrastructure, acquisition of requisite knowledge and capabilities as well as training/capacity building required for a sustained high level of preparedness (59). Moreover, there is also a need for health institutions to plan appropriately for adequate response during natural and technological disasters (62).

Based on this background, this thesis assessed the emergency preparedness and disaster response of selected healthcare facilities across the Riyadh region of KSA. Particularly, this study investigated how health institutions in the region have implemented the “all-hazard” approach to their emergency preparedness and disaster planning and response activities (261). However, it is important to investigate the views of Emergency Directors who are responsible for the adoption of the all-hazard approach and its implementation, particularly to understand challenges associated with the adoption of the technique and how these could be addressed.

6.2 Summary of methods

6.2.1 Participants’ selection and recruitment

The selection of participants for this aspect of the study was carried as highlighted in Section 2.7.2.3. Briefly, Emergency Services Directors with up to 5 years and more of working experience where selected participants were selected using purposive sampling technique. The purposive nature of the sampling technique is because only managers are deemed eligible for this aspect of the study. Selecting specific group of respondents due to their special attributes is a key characteristic of purposive sampling, and this is consistent with its application in this thesis. Working experience of 5 years or more was set as the cut-off as this is thought to be long enough for Directors selected to have experienced a disaster and have the opportunity to coordinate disaster response actions. Directors were asked to indicate their experience of disaster response during the recruitment process. Even in the occasion that a director has not experienced disaster, 5 years is deemed long enough for managers to have an in-depth understanding and on the job experience of the processes involved in the development of emergency response plans and how to execute such plans. In addition, the selection was based on the level of qualification and position in the organization. The position in the organisation was also considered as important because the aim is to recruit people who contribute to the making of important decisions with respect to disaster preparedness and response at the hospital level. A summary of eligibility criteria used in the selection process is presented in Table 6.1.

Table 6. 1 Inclusion and exclusion criteria for the qualitative interview study

Inclusion criteria	Exclusion criteria
• Professional working in emergency management or emergency care unit directors. • Both Saudi national and expatriate. • Possession of 5 + years of experience working in the field of emergency management	• Professionals working in other healthcare departments and not leaders. • Professionals unable to consent for research. • Professionals without years of experience in the field of emergency management.

To identify these participants, Emergency Directors in all the 42 hospitals selected were asked to provide relevant information during the research visit made by the researcher to all the selected hospitals to administer HVA and APAQ. All the 24 participants who met these requirements were contacted via telephone calls, text messages and emails to inform them about the study and recruit them for interview sessions. However, only 6 of these directors agreed to be interviewed. Though the sample size was small, it was deemed sufficient to generate data that ensures the saturation of themes without becoming repetitive. All the interviews were scheduled based on participants' availability and convenience and all interviews were held as face-to-face sessions.

6.2.2 Instrument for data collection

A peer-reviewed semi-structured guide drafted based on the research aim and objectives was used during interview sessions. The instrument covered three major areas including methods for assessing the effectiveness if emergency response process, factors/challenges associated with the capacity of hospitals to effectively respond to emergency situations, and strategies for improving the capacity of hospitals to respond effectively to emergency situations (See Appendix 6.1 and Appendix 6.2). A mock interview session was also conducted to validate the interview guide.

6.2.3 Interview data collection

Data collection from participants was implemented through face-to face interviews. This ensured in-depth exploration of their perspectives and experiences. The choice of a one-to-one approach was guided by the need to elicit detailed and context-specific information from each participant, ensuring a comprehensive understanding of their views on emergency preparedness. In addition, the semi-structured format provided a flexible framework that allowed for consistency in key topics while also allowing for spontaneous exploration of emergent themes. This approach enabled the interviewer to adapt the questioning and delve deeper into relevant areas based on the participant's responses. The decision to use a semi-structured approach was informed by its suitability for capturing rich qualitative data while providing some level of standardization across interviews. The semi-structured interview guide underwent a rigorous peer review process to enhance its clarity, comprehensiveness, and alignment with the research objectives. By employing a one-to-one and semi-structured approach, this study aimed to obtain nuanced insights and perspectives from participants, fostering a deeper understanding of their experiences, challenges, and perceptions related to emergency preparedness. This approach allowed for flexibility in data collection while maintaining a level of consistency in the topics covered, ensuring both depth and breadth in the information obtained.

Following recruitment and the observation of all ethical procedures, suitable interview periods were arranged with each of the selected managers for the interview. All interviews were conducted within the premises of the selected hospitals. However, the interview schedule differs from one hospital to another. In some hospitals, managers were interviewed immediately after the administration of all quantitative research questions (KP-HVA and APAQ). In some locations, the interview was conducted on a separate day and at times convenient for the directors. These interviews provided opportunities for selected managers to indicate their understanding of the concept of HVA and all-hazard approach to HVA, as well as the level of implementation of HVA together with associated challenges in their various hospitals. Each interview sessions lasted between 12 to 31 minutes. Each interview session was tape recorded for transcription and analysis.

6.2.4 Analysis of interview data

All interviews were in conducted in English language. Therefore, a verbatim transcription was needed. Recordings of all interview sessions were transcribed by the lead researcher. The approach to transcription was a good opportunity for the researcher to be immersed in the data. The transcripts were carefully examined by two independent researchers, the lead researcher, and the academic supervisor. Transcripts were checked against the audio recordings to ensure accuracy. Transcripts of all interview sessions were subjected to a thematic analysis using framework analysis approach, which allowed the researcher to identify themes that runs through each area of focus for all interview sessions. Data were coded using inductive approach and themes and sub-themes were identified. Themes and sub-themes were discussed between the principal investigator and the supervisor. This allowed clarification of the final framework.

This analysis approach was selected based on its advantages over other thematic analysis approaches. According to Gale *et al* (262), advantages of thematic analysis generally include the ability to provide clear steps to follow in identifying themes from interview transcripts, its applicability to studies involving the management of large text data and its usability in occasions where qualitative data analysis skills are limited. However, framework analysis was specifically used in this study due to its reported advantages including the ability to aid the identification, description, and interpretation of patterns across themes emerging from the different interviews conducted in this study (263).

The Framework Method was developed by Jane Ritchie and Liz Spencer from the Qualitative Research Unit at the National Centre for Social Research in the late 1980s (264). Though it was originally designed for large-scale policy research, it has since gained widespread use in various fields, including health research (262, 265, 266). A distinctive feature of this method is its matrix output, which organizes data into rows (cases), columns (codes), and summarized cells. This structured format enables researchers to systematically analyse and condense the data, examining it by both case and code (262).

Typically, a “case” refers to an individual interviewee, although the method can be adapted to other units of analysis, such as predefined groups or organizations. While the method allows for in-depth analysis of key themes across the entire dataset, it also ensures that the views of each research participant remain connected to other elements of their account within the matrix. This approach preserves the context of individual perspectives (262, 267, 268).

Framework analysis is a systematic strategy for managing qualitative data that involves charting the generated codes alongside the summarised data to enable for interpretation and synthesis. Gale et al (262) defined framework as a flexible analysis tool that may be utilised to develop themes regardless of the research's epistemological, philosophical, or theoretical basis. Framework provides a systematic method of analysing qualitative data by producing a highly structured data output that allows researchers to compare and contrast the various perspectives and experiences of participants in order to develop interpretive concepts that describe aspects of data known as "themes" (262).

In this study, the framework analysis approach was employed to develop interpretive concepts that capture key aspects of the data. The utilization of the framework analysis approach aligned with the research's epistemological, philosophical, and theoretical underpinnings. The study adopted a constructivist paradigm, emphasizing the significance of comprehending participants' unique perspectives. By employing the framework analysis approach, the study was able to effectively compare the diverse viewpoints of the participants, thereby aligning with the research objective of understanding the breadth of experiences within the study population (262).

The seven steps of framework analysis described by Gale et al (262) were followed in the analysis. The first step was transcription. Transcripts were stored in the university drive for management and analysis.

At the second stage of framework analysis, the researcher familiarized herself with the data by listening repeatedly to the audio recordings. While familiarising with the data, the researcher recorded arising analytical notes, thoughts, and impressions. The third stage involved coding of the data. The transcripts were carefully examined by two independent researchers, the lead researcher, and the academic supervisor. They coded the six interviews using the same transcripts to provide different perspectives and improve the validity of the generated themes. This process involved double coding or triangulation, where various researchers independently analysed the data to identify patterns, themes, and interpretations from the collected data. Patton, Morse et al, Denzin and Lincoln (269-271) have elaborately discussed the significance of double coding/ triangulation in qualitative research. The use of multiple researchers in the coding process enhances the reliability of the findings by creating an inter-rater agreement and minimising the risk of individual subjectivity. This methodological rigor adds to the general validity and trustworthiness of the outcomes of the study.

The fourth step involved development of a working analytical framework. Researchers made a comparison between the identified codes and grouped them into categories that were clearly defined. The fifth step was the application of the analytical framework where more of the agreed codes were assigned on the transcripts. Finally, a framework matrix was used to chart the data. Charting involved summarizing data for each code/theme from each transcript into a spreadsheet. The process was done with precision to retain the original meaning of the data while reducing the size where possible. Some direct quotes from the participants were included in the matrix (262).

The qualitative study was not a purely technical process and was influenced by critical reflection through the research process. The researcher kept a research diary and recorded reflexive notes on the impressions arising from the data and thoughts about the analysis. Firstly, the diary provided a space for recording reflexive notes on the researcher's impressions and thoughts that emerged while engaging with the data. By regularly documenting these reflexive notes, the researcher was able to gain insights into their own subjectivity and positionality within the research. This heightened self-awareness facilitated a more rigorous and thoughtful analysis of the data, enabling the researcher to navigate and interpret the findings in a more objective manner. Furthermore, the research diary also served as a valuable tool for capturing methodological choices, challenges encountered, and key decisions made during the analysis process. It provided a written record of the researcher's analytical journey, facilitating transparency, and allowing for the traceability of decisions made at various stages of the analysis.

6.3 Results

6.3.1 Participant demographics

A total of 6 directors were interviewed in this study. Details of years of experience of interviewed managers is presented in Table 6.1. The data indicate that 2 (33.3%) interviewed directors have more than 10 years working experience while majority of these directors (4 managers, 66.7%) have between 5- and 10-years working experience. All interviewed directors were male and 5 (83.3%) are of KSA nationality while only 1 (16.7%) manager is an expatriate (Table 6.2).

Table 6. 2 Participant demographics

Code of the hospital	gender		Years of experience	Managerial level	Nationality
H01	Male		10+ years	Senior manager	Non-Saudi
H03	Male		10+ years	Senior manager	Saudi
H027	Male		7 years	Senior manager	Saudi
H032	Male		9 years	Senior manager	Saudi
H034	Male		5 years	Senior manager	Saudi
H035	Male		8 years	Senior manager	Saudi

6.3.2 Emerging themes

Emerging themes were identified from transcript of interview recordings for all participants under the areas previously highlighted in this chapter. These areas include methods for assessing the effectiveness of emergency plans, challenges associated with the evaluation of the response capability of healthcare facilities and strategies for improving emergency response capability of healthcare facilities. A summary of sub-themes emerging under each of these themes is provided in Table 6.3. Details of how participants' responses indicate these themes are presented in the mapping table presented in the Appendix 6.2.

Table 6. 3 Themes emerging from semi-structured interviews.

Theme No.	Theme Title	Identified sub-themes
Theme one	Methods for assessing the effectiveness of emergency response process	a) Emergency response plan assessment method b) Evaluation of emergency response facilities and equipment c) Assessment of warning system
Theme two	Factors and challenges associated with effective emergency response capability of hospitals	a) Shortage of human resources. b) Challenges associated with training and drills. c) Leadership challenges d) Communication challenges e) Location-related challenges
Theme Three	Strategies for improving the emergency response capability of healthcare facilities	a) Use of private sector and volunteers b) Cooperation between organizations within the health sector

6.3.2.1 Theme one: Methods for assessing the effectiveness of emergency response process.

Respondents were asked series of questions to investigate their opinions about methods used for the assessment of the effectiveness of emergency plans within the selected hospitals in this study. Three themes were identified from the responses of participants, and these relate to the effectiveness of the emergency response plan, assessment of the emergency preparedness level, and the assessment of warning systems.

(a) Assessment of emergency response plans

With respect to the assessment of emergency response plans, respondents indicated that drills were used regularly to evaluate the level of understanding of the emergency plan and how emergency staff can implement emergency plans within their hospitals. This assertion is consistent with the intended use of and training and drills with respect to the building of capacity for effective disaster response. Drills generally refer to mock exercises conducted as a demonstration of how staff needs to act during actual disaster events. This provide opportunities for trainees to assess the understanding and skills of people being trained. However, drills must be consistent and be carried out regularly. This seems to be the case in hospitals from which respondents are recruited from. This is evident from what one of the respondents stated:

"…we do some drills for the internal disaster this is frequently, and this probably for all the employee and department and sections… (Senior Manager at H027, Male)"

Despite the indication that drills are carried out in selected hospitals, it was also evident from the responses obtained from these respondents that the interval at which drills were performed differ significantly from one selected hospital to another. Responses obtained showed that drills were conducted on a monthly basis at one hospital whereas it was conducted annually at another hospital. This disparity in the intervals at which drills are conducted could contribute to differences in the level of emergency preparedness as well as the emergency response capabilities of different hospitals, even though this is not explicitly stated in responses obtained from respondents. However, with respect to the frequency of drills, examples of statements made during interviews include:

"…we do drills monthly to ensure everyone is ready and understand how to respond during the disaster…" (Senior Manager, H03, Male, Saudi origin)

"For now, the only thing that we used to measure are drills, we do one the external drills and one internal drill every year and of course if we have the real activation…" (Senior Manager, H34, Male, Saudi origin)

In addition to the conduct of regular drills, it was evident from interview conducted that regular review of emergency plans to ensure that such plans are up-to-date and relevant to the needs of the hospital is regularly conducted in hospitals where respondents were selected from. In addition, many other factors could necessitate regular review of emergency plans. For instance, hospitals often experience regular staff turnover. Therefore, when an officer who has been given a responsibility in the emergency plan leaves, it is incumbent on the Emergency Services Director to review emergency plans and reassign responsibilities. This observation is consistent with respondents in this study stated. For instance, some of the managers interviewed indicated regular review of the emergency plan to ensure that plans up to date with the status of emergencies within their location. These managers also indicated that changes within the hospital (such as changes within the staff members) often necessitate the need to assign roles to new members of staff for the plan to be up to date. In addition, the standard practice is to put a validity date on emergency response plans and this with the aim of forcing regular reviews of the emergency plan. It was observed that some of the hospitals selected in this study adhere to this practice. For instance, one of the participants indicated *that:*

"…usually, each plan and policy have a valid date which is one to two years. After two years we need to update it. After two years, we usually set and try to review it. We see if there is anything is happening within the two years…" (Senior Manager at H01, non-Saudi origin)

In addition to change in staff strength, changes in the level of available resources may also necessitate the need for regular review of emergency response plans. Often, emergency response plans are often developed based on available resources, and when more resources became available (or vice versa), reviewing the emergency response plan is necessary to make the plan relevant and up to date. Consistent with this, some of the respondents also indicated that they audit the resources needed for effective implementation of the emergency response plan (such as medicines and other medical supplies) and test them. The respondent opined that*:*

"…we do sometimes round to check our equipment and the other one by testing them by doing drills…" (Senior Manager at H32, Male, Saudi Origin)

This observation also linked the review of resources with drills. In fact, it was indicated that after drills, feedback/observations are discussed and suggestions from these discussions are used in reviewing the emergency response plan. In addition to feedback provided by staff after drills, several organisations also have oversight responsibilities and conduct regular visit to organisations such as hospitals to assess their level of disaster preparedness. It is expected that feedback provided after such visits will be used to review emergency plans and make the hospital better prepared for emergencies. Respondents also indicated the use of feedback provided by external agencies such as CBAHI for the review and validation of their emergency response plans. These respondents opined that:

"…we need help from others, when the CBAHI came, or the Canadian accreditation came they give us some feedback based on the feedback we try to update our external and internal plans..." (Senior Manager at H35, Male, Saudi origin)

In summary, responses from respondents indicate that to some extent, assessment and review emergency response plans are conducted, and that factor such as staff changes, expiry dates incorporated into emergency plans as well as feedback obtained from staff members during drills plus feedback from external auditors often inform the review of emergency plans.

(b) Evaluation of emergency response facilities and equipment

In addition to the evaluation of emergency response plans, it emerged from participant's responses that directors assessed the availability of equipment, facilities and other resources needed for effective emergency response (such as medical supplies). While the importance of this type of assessment is important to facilitate effective review of emergency plans, it is also essential in ascertaining the level of preparedness of hospitals. Therefore, in hospitals where this is not carried out, this may have grave consequences with regard to the safety of such hospitals for staff members and patients using the hospitals. Responses obtained indicated that this is commonly conducted through manual resources check to ensure that facilities and equipment are available for emergency response. Respondents particularly indicated the use of check lists of materials in conducting this task. An indicative statement in this regard is:

"…about the resources we all the time check, we have a list, and we have people who will have to check daily the resources, the medical resources and medical supplies to ensure we have enough resources in case of disaster at any time…" (Senior Manager at H32, Male, Saudi Origin)

Several factors could necessitate the need for regular assessment of the level of resources and equipment. For example, if an organisation has just recovered from a disaster event or has recently provided care to victims of disaster events, it is possible that resources and materials may have been depleted, making a review leading to restocking of materials essential. This and other factors were also identified in the responses obtained from respondent. Review of stock levels as part of the process of previous disasters, advice from the Ministry of Health, and observations from drills were indicated by one of the respondents:

"…The evaluation of resources usually based on our evaluation of the previous incidents that have happened in the past, plus the drills and the disaster plans. Then we list the current hazard and the needed resources. Also, sometimes we receive some advice from higher management level at the MoH about the necessary action to prepare for the disasters…" (Senior Manager at H03, Male, Saudi Origin).

While after disaster review of resources is essential, it is also advisable that regular review, even in the absence of disasters are carried out. This is because some of the resources may be expired and needs replacement. In fact, one of the respondents indicated challenges associated with conducting reviews only after disaster events by stating that:

"…usually, we do analysis after any event this is the main issue, plus we have a committee in our department, we have regular meetings every three to four months to evaluate the situation…" (Senior Manager at H27, Male, Saudi Origin).

However, of the respondents supported the view of having regular meetings to review the level of equipment and resources, and the use of disaster committee which meets regularly to review the level of materials and resources represents a good practice in this regard. The director responded:

“…we do have a disaster committee…, the committee reports to the internal audit and disaster unit section is under the medical services directly….” (Senior Manager at H35, Saudi origin).

However, only one of the managers mentioned the use of proper Hazard Vulnerability Assessment tools in the assessment of resources. This manager includes the use of drills and support from larger hospitals within the region as part of strategies for reviewing available of resources. The manager stated that:

“…there is a lot of ways that we use some of it we do once per a year like of HVA score…” (Senior Manager at H01, Male, Non-Saudi origin).

(c) Assessment of warning systems

Responses from participants indicated that warning systems represent key components of a good emergency response process. Participants reported different approaches in this regard. These include the use of code warning systems in majority of the hospitals and getting staff members to be familiar with the code warning systems through drills and training programmes was identified as the commonly used strategy for internal disasters. The use of a standard number to call in the case of internal disaster was also recommended. In addition, the use of a dedicated officer who uses the hospitals central communication system to announce the code for the emergency that is happening was another identified approach. An example of statements indicating these strategies is:

"... for the incidence inside the hospital, the notification will be by the hospital operator, he will announce the code over the hospital headphones, there is special code for each problem and the manager on duty will be notified, and he will take the needed action. The manager on duty will decide if he needs to inform the director of the hospital or scale it up with the other health sectors (MoH general directorate, SRCA) and civil defence (Firefighter) or not…" (Senior Manager at H27, Male, Saudi Origin)

In addition, the availability of a dedicated department within the hospital for the maintenance of all emergency warning systems to ensure that they are adequate and remain connected to all necessary support departments whose services will be needed in the event of a disaster was also recommended. It was observed from some of the responses during interviews conducted that some hospitals have dedicated department for utility and maintenance which check all the facility procedures and make sure that everything is good and in good shape for effective disaster response.

For external disasters, reliance on information from external agencies and social media were indicated as the most common warning system in many of the hospitals selected for this study. Many of the directors interviewed however indicated the unreliability of these warning communication approaches. It was also evident from interviews conducted that the Ministry of Health represents a major source of reliable warning information for external disasters and that some hospitals have good communication networks for receiving reliable information from the Ministry of Health. Examples of statements indicating these observations include:

"…to receive the warning from the other agencies, sometimes we receive it from the social media, or the civil defence or the Saudi Red Crescent authority ...sometimes we receive it from the Health affairs at the Ministry of Health…" (Senior Manager at H01, Male, Non-Saudi origin).

"…the early warning system notification from outside the hospital, there is a wireless communication linked with the general directorate at the health affairs (MoH). As well we do have a device that connects the Saudi red crescent with us throughout the wireless communication to inform us..." (Senior Manager at H03, Male, Saudi Origin).

With respect to receiving information from external sources, it was observed that information is mostly received via telephone conversations or through mass media platforms (such as the television). The dispatch centre was identified as the main target of most telephone conversations in this *regard.* Regular testing of the communication technology between external agencies such as the Saudi Red Crescent Authority, Civil defence, and the MoH is also conducted in many of the selected hospitals in the region. However, it was also observed that receiving warning information from external agencies is associated with many challenges. Directors particularly identified lack of clarity in the information received through these channels. An example of statements indicating these challenges is:

"…but still, we have a lot of difficulties to understand what type of disaster particularly the explosion of building collapse. the message is usually not clear and not complete information about the type of disaster that's why this make the hospital less prepared and not fully aware with the cases that will be coming to us, especially with the explosion events or Building collapse (Mass casualty event). The data is not clear enough to activate the disaster plan in the hospital…" (Senior Manager at H34, Male, Saudi origin).

6.3.2.2: Theme two: Factors and challenges associated with effective emergency response capability of hospitals.

Themes emerging from responses of participants with respect to challenges associate emergency response in KSA are discussed in this section.

(a) ***Shortage of human resources.***

It is known that effective disaster response is often associated with challenges. It is against this background that directors were asked to talk about challenges associated with effective emergency response based on their experiences. Challenges relating to human resources were identified by some of the managers interviewed. These challenges largely relate to staff shortage and lack of expertise in specific types of emergency situations (such as those related biological and chemical hazards) were particularly highlighted. In addition, it was observed that mechanisms for building human capacity in areas where expertise are lacking are also not available. This was evident in statements, such as:

> *"…no lack of exercise or focusing on someone scenarios in specific areas like fire or trauma patient only, without focusing on the scenarios of patient who come to hospital and needs de contamination with chemical or biological hazard, we need to do different exercise different program deferent drills to be able to response effectively to all type of disaster…" (Senior Manager at H35, Male, Saudi origin).*

Other challenges identified include those relating to staff shortage and lack of experience among available staff members. The dearth of staff members with expertise in the evaluation of drills or the disaster plan was also highlighted.

> *"…the major challenges that we faced are the shortage in staff; we don't have a lot of the specialized staff and usually the people who's evaluating the drills or the disaster plan are not capable to evaluate thoroughly because of the lack of the experience…"* (Senior Manager at Male, General hospital of a general hospital.

(b) Challenges associated with training and drills

While respondents were unanimous in their opinion of training and drills as a good approach for ensuring the effectiveness of the disaster response process, their responses also indicated that training and drills are also associated with several challenges. The fact that there is no standard drill format and significant differences in the frequency of drills across these organisations were highlighted as challenges affecting the effectiveness of drill exercises. It was also indicated that for drills to be effective, there must be sufficient observers who are able to give feedback about the process and point out aspects that need improvement. However, the general view among managers is that there is often shortage of observers during these drill exercises. Directors further indicated that even when some observers are present, feedback provided is often not constructive and inadequate to help the identification of areas that needs improvement. This finding underscores the importance of ensuring that observers involved in the evaluation of drills and exercises possess the necessary competence and expertise. Observers should have a comprehensive understanding of emergency response protocols, best practices, and the specific objectives of the drills. With this knowledge, they can provide informed and constructive feedback that helps identify both strengths and weaknesses in the hospital's emergency preparedness. They indicated this by saying that:

> *"…we have shortage on the observers, because when they can provide us with their opinion, we can catch our real deficiencies…"* Male, Senior disaster management specialist/ deputy of the disaster manager.

"…observers themselves are not always competent they are making everything good and giving a lot of complementary and they don't say what is good for us…" (Senior Manager at H03, Male, Saudi Origin)

(c) Leadership challenges

Another challenge indicated by directors interviewed relates to leadership and coordination of the emergency response process. Majority of the respondents particularly indicated that the lack of leadership results in the lack of ability to produce post-disaster follow-up reports, improper guidance, and assignment of responsibilities during disaster events and poor collection and reporting of post-disaster events data. It was specifically indicated that this has led to poor communication, ineffective coordination of disaster response activities as well as defective ability for patient tracing and management of medical report. An example of statements in this regard is:

"…*the challenges, I would say the leadership again and ICS, the correct implementation arises yes, communication with other entity and agency still an issue, coordination still an issue, Patient tracing management of media report*…" (Senior Manager at H27, Male, Saudi Origin)

(d) Communication challenges

Directors interviewed highlighted the importance of effective communication during emergency response process and how this is essential to the success of the process. They however reported several communication challenges in their various hospitals. According to these directors, communication challenges affect the coordination of response services internally within the hospital as well as the interaction of the hospital with external agencies. They also indicate that this affects the monitoring of post-disaster processes such as patient tracing.

"…the major changes I think is the biggest challenge we have in our facility is the space I can see the space we are considered small space compared to our community. And the other thing is the communication…" (Senior Manager at H32, Male, Saudi Origin)

(e) Location-related challenges

It was evident from the analysis of interview data that space available within the hospital for emergency response activities and the location of the hospital may also pose some challenges to the implementation of effective disaster management strategies. Responses indicated that the lack of space significantly negatively impact on response activities, particularly when the number of victims is large, and the hospital is located in a community with large population. In addition, lack of access to external emergency services (such as the Red Crescent Authority) due to the location of the hospital in a heavily populated urban area was also highlighted by emergency managers of hospitals located in urban areas. Their responses include statements such as:

"…challenges !! okay, there is a lot of challenges, mainly the way and location of the hospital, our hospital is located in a very congested area,

difficult to access from the main agencies like Saudi red crescent (Ambulance) the civil defence (Rescue vehicle). this affects our drills because they cannot come and participate effectively during the drills. This is the major challenge, other challenges I can think of umm ... usually the ability of a disaster-oriented people for 24 hours. So, those people can be the eyes to evaluate the can guide the Hospital evaluation capacity in each disaster or incident…" (Senior Manager at H27, Male, Saudi origin).

6.3.2.3 Theme three: Strategies for effective disaster response activities

Directors recruited for this aspect of the study were also asked to identify strategies that could be adopted in facilitating effective emergency response. Two common strategies were consistent in the responses of managers interviewed and these are summarised below:

(a) Collaboration among healthcare organisation and with external agencies

Majority of directors interviewed indicated that collaboration among healthcare institutions will significantly improve the effectiveness and efficiency of disaster response in KSA. In fact, they suggested the need for the establishment of a disaster centre for the coordination of disaster response activities. Directors further highlighted the importance of collaboration between healthcare facilities and specialist health care organisations such as military and university hospitals in responding to disasters. It was highlighted that this will improve the efficiency and effectiveness of disaster response generally in the region. Moreover, directors opined that the collaborative efforts will be fostered by the implementation of a unified emergency communication system. It was also highlighted that such unified system will help in planning, training, and facilitation of effective disaster response at individual hospital levels. These assertions were communicated through statements such as:

"…I believe we need to do coalition as hospital, now we have cluster one and cluster two that new strategy for the ministry of health, but we need to do this with the university and military hospitals too. to ensure there is a very high cooperation and coordination with these sectors, and to expose the medical staff to different types of disaster scenarios (natural or technological) disasters. this will facilitate that will help to facilitate the work between all the sectors. even for the evacuation scenario we must ensure there is an agreement and cooperation during and pre and post the disaster event…" (Senior Manage at H34, Male, Saudi origin)

"…my suggestion is to have a unified emergency number that links all the sector together at the regional level. the important thing is to keep this number active between the health sectors this include the Saudi red crescent Authority, other ministries…" Senior Manager at H35, Male, Saudi origin.

In line with the suggestion for a unified emergency response system, managers suggested the need for increased openness between organisations, setting of clearer goals for the collaboration between healthcare organisations, and the development of a mutual agreement for coordination of the central disaster response cluster. Moreover, it was observed that partnership with private agencies as well as the use of volunteers in emergency response activities is generally lacking at majority of the hospitals selected hospitals. Directors interviewed therefore suggested the establishment of platforms for the recruitment and training of volunteers, as well as agreement with private companies for the supply of key materials that are needed during disaster response.

(**b). The use of volunteers**

As a strategy for addressing the problem of lack of human resources, managers suggested the use of volunteers who could be trained to provide some essential services during a disaster event. Recognizing the value of volunteers, some managers indicated that they have already utilized them in previous disasters, primarily for tasks such as blood donation and assisting with victim identification. The managers acknowledged that the concept of volunteers in the context of disaster response is relatively new in Saudi Arabia, and there is currently a lack of detailed plans, committees, standards, policies, and defined roles to regulate volunteer management. While civil defence agencies have made progress in this area, having established a volunteer section over a decade ago, the Ministry of Health (MoH) has only recently initiated efforts in this regard. The absence of guidelines, standard operating procedures, and an overarching framework for incorporating volunteers into disaster response poses a significant challenge. Some of the managers indicated that they are already using this strategy and recommended the establishment of a volunteer's department by the KSA government to coordinate the activities of volunteers. However, the conversation with managers indicated that there are some challenges associated with this strategy. For instance, one of the managers indicated that hospitals do not have detailed plans on how volunteers could be managed even though volunteers who donated blood for disaster victims have been recruited in the hospital that the Manager worked for previously. The lack of committees to regular actions of volunteers, as well as guidelines, standard and policies upon which engagement with volunteers could be based are also generally lacking. It was highlighted that the use of volunteer's mimics what external agencies such as National Guards and Civil Defence have used previously, but it is a new strategy for the Ministry of Health. These were conveyed through statements such as:

"… there is no plan for the concept of volunteers as whole is still new in Saudi Arabia, still we don't have committee, standards or policy, or roles to regulate the volunteer management, civil defence they are doing a great work, and they have a volunteer section. I know they have it for ten or 15 years now, The MoH just started this year last year. the big problem is none of them proposed with any billows or guideline or standard operating procedures for incorporating volunteer into disaster. This needs to go first to the MoH, approved from MoH and then probably with go to Saudi health council and then approved by the Saudi health council. whatever we are doing is not given by anyone…" (Senior Manager at H03, Male, Saudi origin)

6.4 Discussion

6.4.1 Summary of findings

The first theme studied in this study focused on methods for assessing the effectiveness of emergency response processes. Three sub-themes were further assessed under this theme, including the method for emergency plan assessment, assessment of warning system, and evaluation of emergency response facilities and equipment. Common methods for emergency plan assessment identified in the thesis included the use of regular drills, regular review of emergency plans, and audit of resources. Regular drills were more common, though the interval differed from one hospital to the other, ranging from monthly to annually. Reflections on how the managers assess the availability of equipment, facilities, and other resources needed for effective emergency response identified the manual resources check as the most common approach. Other means identified include the review of past disasters, use of internal committees, use of drills, and the use of proper Hazard Vulnerability Assessment tools. These findings align with existing literature, which emphasizes the importance of preparedness activities such as drills and plan reviews in ensuring effective emergency response. However, the interval of drills varied among the hospitals, highlighting the need for standardized guidelines for drill frequency and consistency. Regarding the assessment of warning systems, most of the respondents resonated with the use of code warning systems in their hospitals. The most common strategy used for internal disasters was getting the staff members to understand the code warning system using drills and regular training programmes. However, very few had used the proper hazard vulnerability assessment tools, this Afterall was the purpose of this thesis.

The second theme highlighted the factors and challenges associated with effective emergency response capability of hospitals. Key sub-themes investigated include governance and leadership, emergency management planning, logistics and supplies, communication and health information system, human resources, finance, training and drills, and coordination with other facilities. The study participants rated their perception of the significance of each of these sub-themes based on the effectiveness of the emergency response services provided in their institution. Among the sub-themes, communication and health information system was rated the most important and needed, while governance and leadership and emergency management planning were rated the least important by most managers.

The respondents identified various challenges associated with the effective emergency response capacity of their hospitals. Issues relating to human resources, staff shortage, and lack of experience were identified as the most common. Other challenges arising from the interviews focused on leadership structure and the lines of reporting, communication, use of external agencies, coordination of services, patient tracing, lack of post-disaster follow-up reports, lack of proper guidelines and assignment of responsibilities, space within the healthcare facility, and limited access to external emergency services.

The third theme sought to understand the perspective of the recruited managers concerning strategies that can facilitate effective disaster response activities. Their responses were mostly aligned with the sub-themes of use of private sector and volunteers, and cooperation between organisations within the health sector. Suggestions from the respondents aligning with these themes include the establishment of collaborative disaster centres and the use of unified emergency numbers. One strategy proposed by most managers entailed the creation of platforms to recruit and train volunteers, who can eventually become useful during disaster response. These findings contribute to the existing literature by emphasizing the significance of inter-organizational coordination and unified systems in enhancing emergency response capabilities.

In summary, this study provides valuable insights into the effectiveness of emergency response processes in healthcare facilities. The findings align with existing knowledge and add depth to our understanding of the challenges, priorities, and strategies associated with emergency response. By highlighting the need for standardized practices, comprehensive hazard assessments, and inter-organizational collaboration, this research offers practical implications for improving emergency response capabilities in the healthcare sector.

6.4.3 Discussion of findings

The thesis identifies the use of regular drills as a common method for emergency plan assessment. Performance of drills within healthcare facilities is a finding that ties well with previous studies on disaster preparedness in the United States. Specifically, the findings in this study can be compared to those of Kaji et al(272) and Skryabina et al(273) who characterized the value of health emergency preparedness in contexts outside the KSA. The study findings by Kaji et al(272) demonstrated that most of the hospitals in Los Angeles County took part in drills involving multiple agencies, and that this tool was effective in assessing emergency plans and preparing for both natural and human-made disasters. At the same time, Skryabina et al.(273) identified drills as the most reported emergency exercise. It is clear from this study that the interval of implementation differed from one hospital to the other. Moreover, general lack of skills in conducting drills and trainings was also indicated in the responses of managers. Therefore, the effectiveness of drills conducted and the expertise of people who currently conduct these drills may be doubtful. Among others, this observation clearly suggests the need for urgent training of staff in drills and training of staff who could effectively perform emergency drills. Maybe, future research could be conducted in KSA to specifically examine the most appropriate interval of drills that would encourage better disaster preparedness.

Another promising finding was that most hospitals in Riyadh, KSA use manual resources checklists to assess the availability of equipment, facilities, and other resources needed to facilitate effective emergency response. Overall, the findings of the study are in accordance with previous findings identifying the use of checklists, along with other approaches such as reviewing past disasters, using internal committees, use of drills, and the use of proper Hazard Vulnerability Assessment tools. One earlier study by Higgins et al (274) identified the Mass Casualty Disaster Plan Checklist as a basis for assessing the preparedness of hospitals for weapon of mass destruction events in Kentucky. In a different study, Bajow et al (275) showed that healthcare facilities in Jeddah have well-organised committees in charge of disaster management and response. While all the tools identified in this study were considered effective, none included all the dimensions needed for suitable evaluation of hospital preparedness. Moreover, the comprehensiveness of checklist used across these hospitals as well as how these checklists compare from one hospital to another is not known. The WHO produced a check list with has been extensively used in the assessment of hospital safety(203), it is also not certain how checklists used across hospitals in Riyadh region compare to the WHO checklist. This is something that future studies could investigate.

Though many factors and challenges associated with effective emergency response capability were identified, communication and coordination were rated as the most important and needed by most directors. The results suggested the need for unified flow of information during disasters and efficient organisation by the key actors during crisis events. A similar conclusion was reached by Li et al (276), noting that hospitals in Beijing

China were not well prepared to handle crisis events because of communication and coordination problems among the hospital staff and other personnel involved in crisis situations. The current study further identified the leadership structure and the lines of reporting as crucial factors to addressing the communication problem observed in most facilities. This means that those in-charge of emergency departments and committees need to improve their communication to make their emergency plans effective. This is consistent with what has been found in the study by Shalhoub et al (245) pointing to the significance of leadership in improving disaster preparedness in KSA.

Strategies such as the establishment of collaboration between hospitals in the region, and particularly with specialist hospitals such as university teaching hospitals (which may have better research and training facilities) and military hospitals (which may have better experts in drills) may help in reducing may of the challenges that have been highlighted in this study. Across KSA, working collaboratively to address healthcare delivery challenges has not been extensively reported in the literature and if implements, this may be the beginning of efforts that are capable of strengthening the entire health system in the country.

In addition, the establishment of a command centre for the region was highlighted as a solution to facilitate improved communication during emergencies and disasters. The use of command centres within the organisation is one of the key elements of the all-hazard approach to disaster preparedness and management (159). Therefore, it is possible to extend the structure beyond the hospital and expand it at the community level. The immense importance of such efforts is likely to have far reaching effects.

6.4.4 Strengths and limitations

This is the first qualitative study to investigate the challenges and potential solutions to emergency preparedness in Riyadh, KSA from the perspective of the key players. This study, therefore, stands out as a major research effort to help address issues affecting emergency preparedness in Riyadh, KSA. In future, researchers could use the outcome of this qualitative study to inform more rigorous quantitative studies seeking to address the challenges and potential solutions to emergency preparedness in Riyadh from an empirical perspective. Hence, this qualitative study helps other researchers see the big picture on emergency preparedness in Riyadh, KSA.

The qualitative study used purposeful sampling, which enabled the participation of six managers in Riyadh hospitals. Selection of participants using this approach facilitated access to credible first-hand information from major stakeholders involved in planning and implementation of emergency plans in their facilities. Purposive sampling was a strength to the current study since the approach helped make the most out of a small population of interest who helped arrive at valuable research outcomes.

The qualitative study is also novel since there is deficient literature on the utilisation of the all-hazard approach in disaster and emergency preparedness in the KSA. As such, the qualitative study is likely to receive more exposure in KSA and inspire more researchers to explore the all-hazard approach further within their cities and in the Kingdom as a whole. Overall, it could stimulate interest and facilitate further research into certain challenges to emergency preparedness addressed in this qualitative research. Another key strength of this study is the methodological approach employed for data analysis, particularly the use of double coding to reduce bias that could come from the researcher.

The study was limited in the use of a small sample size. Sample sizes for qualitative research tend to be smaller and mostly depend on saturation. Saturation refers to the point at which little or no suitable new codes and categories can be found in data, when participants begin to repeat issues with no further contribution to the phenomenon under study (277). According to Morse and Sandelowski (278, 279), saturation is the most common guiding principle for analysing the adequacy of purposive samples used in qualitative studies. Hennink et al (277) empirically identify the sample size for saturation as ranging between 5 and 24 interviews. The sample size of six managers used in this study falls on the lower end of this range, but it is unlikely that their views reached saturation especially since they were quite disparate.

A second limitation could arise from the possibility that the researcher did not cover all the relevant questions deeply in the interviews with the managers. The researcher acknowledges that they could have pushed more to attain all the benefits of in-depth interviews. Some factors that may have contributed to this limitation include the researcher's inexperience, and the time required to transcribe, organise, and analyse in-depth interviews. Conducting successful in-depth interviews can be difficult to achieve since the researcher must maintain focus on the objectives of the study and the features of the interviewee's previous comments at the same time, an engagement that requires experience. Moreover, interviews were restricted to only emergency managers. However, it is possible that there are other hospital staff members with additional information which could contribute to the findings of this study that were not interviewed.

6.6 Conclusions and recommendations

Hospitals in this region are expected to be prepared to handle disasters whenever they occur. Most of the hospitals have written emergency plans and managers are aware of them. Regular drills are used to evaluate and facilitate the implementation of the emergency plans within the hospitals. Drills came out as a useful tool even though they are performed at varying intervals across the hospitals in Riyadh, SA. These findings imply that there must be increased emphasis on disaster drills in hospitals in Riyadh, SA. Drills must include an external disaster along with an influx of volunteer or simulated patients being treated in the facility at the time of the drill. Besides, hospitals in Riyadh, SA must also consider participating in community drills to assess their communication, coordination, and effectiveness in relation to the command structures set by the surrounding community.

It was clear from the study that hospitals in Riyadh face numerous challenges ranging from governance and leadership to emergency management planning, logistics and supplies, communication and health information system, human resources, finance, training, and drills, along with coordination with other facilities. These challenges undermine the effectiveness of emergency plans that have been well drafted to facilitate the preparedness of hospitals to handle disasters. From a general perspective, this qualitative study recommends that hospitals invest more in other equipment apart from drills to enhance the capability of hospitals in Riyadh and increase their level of preparedness in line with the requirements of the all-hazard approach. It is also important for hospitals to consider increased training opportunities for staff, especially concerning new techniques. This can enhance their capacity to manage crisis situations whenever they happen. Further studies should focus on leadership and communication protocols within hospitals in Riyadh to establish ways of collaborating and cooperating and improve the effectiveness of emergency plans.

CHAPTER SEVEN

DISCUSSION AND CONCLUSION

7.1 Overview

This thesis sought to collate available evidence on the use of all hazard assessment within the context of health care institutions, assess hazard vulnerability of selected healthcare organisations across Riyadh region of KSA while also assessing the response capacity as well as challenges facing disaster management in selected hospitals across the region. This thesis initially provided background information on disaster, all hazard vulnerability assessments, the relationship between disaster management and international development as well as historical perspectives on the health system and disaster in KSA. This was followed by a summary of general description of methods adopted for the three major studies conducted. Details of the methods and findings of the systematic review conducted was presented prior to the presentation of methods, findings and the implication of the all-hazard vulnerability assessment conducted for hospitals selected in this study. Moreover, details of methods and results obtained following the administration of a bespoke tool developed for the assessment of response capacity of hospitals was presented. View of emergency services directors in terms of best practices and challenges associated with the disaster management in selected hospitals were also presented.

The focus of this chapter is to harness all the findings from the various studies to provide a general overview of the key findings of this thesis. In the first instance, a brief summary of key findings of each study conducted will be presented. This will be followed by highlights of the implications of the various studies in line with existing literature to bring the entire thesis into context. Furthermore, the overall strength and limitations of the entire thesis, recommendations, and the impact of the outbreak of Covid-19 on this research programme will be presented.

7.2 Summary of findings

7.2.1 Findings from systematic review

In this thesis, a systematic review aimed at the investigation of geographical distribution of the implementation of the all-hazard approach to hazard vulnerability assessment, methods and strategies commonly used in implementing the approach, components of the approach that are commonly assessed as well as best practices and challenges associated with the adoption of the all-hazard approach. Following the review of the 22 articles identified after database search, the following are the key findings:

1. Articles reporting the implementation of the all-hazard approach has a wide geographical coverage, spanning countries in Asia, Africa, Europe, and America. However, the adoption of the approach was observed to be highest in Asia. This is consistent with the observation that Asia has experience more disasters lately compared to other parts of the globe.

2. Quantitative assessment approach which largely involves the administration of bespoke or previously developed and validated questionnaires (such as the WHO Checklist and the HSI tool) was observed as the most commonly used method in studies which adopted the all-hazard approach to hazard vulnerability assessment. All tools used in data collection of all hazard approach had one inherent flaw or the other. However, it is unclear if the use of previously validated tools developed by agencies such as the WHO are significantly better than bespoke tools tested across some of the studies reviewed.
3. Non-structural domain of the all-hazard approach was observed to be more readily assessed across all studies reviewed. This is followed by the assessment of the functional domain while the structural domain is only sparingly assessed across all articles reviewed. Technical skills and expertise that may be required for effective assessment of the structural domain was observed as the reason for the sparing assessment of the structural domain. Several elements of functional domain were also not assessed in many of the articles reviewed.
4. Best practices including the development of bespoke and tailored data collection tools when a good tool is lacking, the use of previously validated tools where applicable, the use of multiple data collection methods (such as the combination of surveys,

interviews, site visit and document analysis) and the focus of assessment on multiple disaster events were observed.

5. The lack of appropriate tools, biases that may be associated with self-assessment/self-reported data, the lack of effective management of the HVA process, poor leadership of the assessment process, the lack of expertise among staff members, inadequate financial resources and the lack of basic equipment were observed as barriers facing the adoption and implementation of the all-hazard approach.
6. Following assessment reported in articles reviewed, there is a great disparity in the level of hazard vulnerability and/or safety indices of healthcare facilities reviewed in these articles. However, the lack of comparability between tools used as well as the fact that number of elements of all hazard approach assessed differ significantly across articles reviewed made it difficult to ascertain whether hospitals in a particular part of the world are safer than hospitals in other regions.

7.2.2 Summary of findings from hazard vulnerability assessment of selected hospitals

The KP-HVA tool was used to assess hazard vulnerability of 42 selected hospitals across the Riyadh region of KSA. The following are the findings of the assessment:

1. The analysis of the probable hazards of selected hospitals in Riyadh region revealed that hospitals in the region have a high

probability of hazard occurrence while the level of preparedness of these hospitals, at best, can be described as moderate.

2. Riyadh region is prone to a wide range of hazards (based on hazards ranked first by the different hospitals) and internal fire recognised as the most common probable hazard among these healthcare facilities.
3. The analysis of actual hazard conducted indicated that some of the identified probable hazards translate to actual hazards in many of the hospitals selected in this study. Specifically, mass casualty >5 was ranked as the first observed hazard in majority of the hospitals selected but IT outage was identified as the most common actual disaster within hospital settings across the region.

7.2.3 Assessment of all hazard preparedness and response capacity of selected hospitals

Following the analysis of the all-hazard preparedness and response capacity of 42 hospitals selected from Riyadh region, the following are the findings:

1. Hospitals across the Riyadh region can be generally assessed as having moderate level of functional emergency response capacity, satisfactory non-structural emergency response capacity and an overall moderate level of emergency response capacity.
2. With respect to individual elements of the functional domain, hospitals across the region were assessed as having satisfactory

or moderate level of preparedness for most of the components of the functional domain except subcommittees, health facility networking, patients' decontamination, hazard and vulnerability assessment, community involvement, public information, and transportation and communication.

3. There are extensive similarities in the distribution of the levels of preparedness for the individual elements of functional domains in private and public hospitals. Therefore, the funding source of a hospital does not significantly affect its overall preparedness for functional and non-structural domains of the all-hazard approach.
4. Emergency preparedness capacity of hospitals within Riyadh region is not affected by the level of care (secondary or tertiary hospitals) provided by these hospitals.
5. Similarly, no significant difference in the level of preparedness for functional and non-structural domains observed for inner city and outer city hospitals.
6. There is a significant relationship between functional and non-structural emergency response capacity across the different categories of hospitals within the region except in outer city hospitals and in hospitals providing secondary care services.

7.2.4 Assessment of the level of understanding, best practices and challenges associated with disaster preparedness and response.

Following the conduct of a semi-structured interview with selected Emergency Services Directors from selected hospitals, the following are the findings:

1. Common methods for emergency plan assessment identified in the thesis include the use of regular drills, regular review of emergency plans, and audit of resources.
2. Manual resources check, the review of past disasters, use of internal committees, use of drills, and the use of proper Hazard Vulnerability Assessment tools were identified as strategies used by managers to assess the availability of equipment, facilities, and other resources needed for effective emergency response.
3. Challenges associated with the effective emergency response capacity include inadequate human resources, staff shortage, lack of experience, poor leadership structure, poor communication, poor engagement with external agencies, improper coordination of services, poor patient tracing, lack of post-disaster follow-up reports, lack of proper guidelines and assignment of responsibilities, space within the healthcare facility, and limited access to external emergency services.

7.3 General Discussions

The importance of good level of emergency preparedness and response capacity of healthcare providing institutions cannot be overemphasised. In the first instance, hospitals themselves are not immune to both internal and external disasters (280). Moreover importantly, the fact that hospitals play significant roles in providing care for victims of disaster further highlights why it is important to ensure that hospitals are safe and have good capacity to respond to both internal and external disasters (281). The process of ensuring that hospitals are safe, better prepared for emergencies and are able to respond to disasters effectively begins the assessment of hazards vulnerabilities of hospitals with the aim and using information obtained to develop systems which ensures that the hospital is safe. However, the fact that, such assessments are often single hazard focused necessitates the adoption of a process that is multi-hazard in nature. The all-hazard approach is one of such methods. However, there is a need to understand how this approach has been adopted globally as well as challenges associated with its adoption.

Against this background, findings of the systematic review conducted as part of this thesis has clearly shown that all hazard approach is widely recognised and has been implemented in almost all parts of the globe, even though the extent of its adoption and implementation differ significantly. In the first instance, the observation that the approach has been used to assess hazard vulnerabilities of more healthcare institutions based in Asia compared to other parts of the world is consistent with the fact that Asia has experienced more disasters in the past decade than any other part of the world(4, 282). It is therefore possible that the increase in the rate of disasters has awoken renewed interests in issues relating to hospital safety and hazard preparedness more than before in the region (283). The hazard vulnerability assessment conducted in this thesis indicated that there is a significantly higher levels of probable and actual hazards in selected hospitals across Riyadh region. Therefore, the earlier reported increase in the rate of disasters in Asia may also be true for Riyadh region. Consistent with these observations, previous studies reported have indicated increasing incidence of disasters in KSA generally even though data on Riyadh regions is generally lacking. However, data on actual hazards reported in thesis represent a significant contribution to knowledge in this regard. In support of data obtained in this study, a study which looked at the level of hazard vulnerability of hospitals in Jeddah reached a similar conclusion (275). Specifically, Bajow and Alkhali (275)reported that hospitals in the city are becoming more aware and familiar with hospital preparedness while also highlighting increasing number of hazards in these hospitals. Similarly, high levels of hazard vulnerabilities in hospitals across different cities in KSA were reported in studies conducted by Alsalem and Alghanim (2021) and Al-Shareef et al (2017) (256, 284).

These similarities notwithstanding, hazards that hospitals in previous studies were exposed to differ significantly across cities in KSA. In fact, a careful observation revealed that these hazards are often associated with the most common disaster events in the city where hospitals are located.

This is also consistent with the findings of many articles selected and reviewed in the systematic review conducted in this thesis which showed that hazard vulnerability assessment exercises were focused on the most common disaster in the region where hospitals assessed were located. While this approach is good in that it could tailor the implementation of safety measures towards the most likely disaster that the hospital may experience, it has significant limitations as the hospital may not be well prepared for hazards leading to other forms of disasters. In the HVA conducted for selected hospitals in this thesis, it was clearly observed that hospitals in Riyadh region are prone many hazards that may not be directly associated with the most common disaster event in the area. As an illustration of this observation, AlQahtany and Abubakar (285) reported that due to the fact that the Riyadh region is surrounded by mountains, flood is recognised as the most common disaster event (285). However, the most probably hazard identified for hospitals in the region in this thesis was internal fire (even though hazards rated as first in selected hospitals differ). Also, actual hazard ranked as number in majority of the hospitals assessed was mass casualty event. These observations further provide a justification for the adoption of the all-hazard approach in hazard vulnerability assessment and in the development of structure for effective preparedness and response to disasters. If the focus is one disaster event, the hospital will not be well prepared to respond to other types of disaster events.

In addition, these observations have also exposed the complex interplay between natural and man-made disasters that a town or region is exposed to. Observations from across studies reviewed in the systematic review conducted indicated that majority of the assessment were focused on the level of preparedness of hospitals for natural disasters (64, 199, 200, 202-204, 206, 207, 209-212, 215-217). However, the observation from studies conducted in this thesis is that the likelihood of occurrence (probable hazard) and the actual occurrence of man-made disasters in Riyadh region is higher compared to natural disasters that the area is exposed to. Moreover, it was observed that many of the functional and non-structural capacities observed in majority of hospitals selected for this study relate largely to man-made (technological) disasters.

The importance of using a tool that is capable of collecting accurate information and that can be easily used by emergency managers cannot be overemphasized in an assessment such as the HVA (221). This highlights the importance of having a universal tool for hazard vulnerability assessment. However, such as a tool is not available at the moment. Systematic review conducted in this thesis revealed that the HSI and the WHO checklist were more widely used compared to other data collection tools. On the one hand, this indicates that efforts made by WHO and other organisations (such as PAHO) in addressing the problem of lack of a universal tool for HVA is becoming increasingly recognised. This recognition notwithstanding, inherent limitations in available tools detract from their wide utility and necessitated the development of various other tools as observed in articles reviewed in this thesis. One of such limitations is the generic approach to hospital safety that the HSI adopts, and such an approach has been criticised for lack of specificity that makes it relevant to situations where specific assessments peculiar to either a location or a disaster event is needed (286). However, an alternative view of the tool would see the generic nature of the tool as an advantage. This is because if the tool is too specific, it may lack characteristic that makes it adaptable to all types of hospitals irrespective of their individual peculiarities.

In this thesis, KP-HVA was used for hazard vulnerability assessment of selected hospitals and its selection was predicated on many factors. In the first instance, the KP-HVA has been widely used to assess hazard vulnerability of various types of organisation (and not limited to hospitals) (287, 288). This on the one hand gives the tool the generic nature highlighted as a key characteristic of a universal HVA tool. Moreover, the choice of the KP-HVA tool was also informed by the fact that the assessment tool addressed some of the limitations that have been highlighted for other tools used in articles reviewed in the systematics review partly motivated the use of the tool in this thesis. For example, it is more comprehensive in nature and provides the opportunity for users to capture other hazards that are not listed in the tool(289). This is one the ways that the result obtained through systematic review conducted influenced the conduct of other aspect of the research reported in this thesis. However, despite its wide use within the healthcare sector, the KP-HVA is by no means a recognised universal HVA tool. The fact that it was originally developed for hazard vulnerability assessment of only healthcare institutions alludes to this fact.

Findings of the systematic review conducted in this study indicated the all-hazard approach has been adopted for hazard vulnerability assessment of multiple hospitals globally. However, there is great variation in the coverage of components of the all-hazard approach assesses across all studies reviewed in this thesis. As earlier highlighted, non-structural components were more readily assessed across all the studies reviewed. This was followed by the functional component while the structural component was the least assessed. Consistent with this observation, a careful look at the items listed in the KP-HVA tool used to assess hazard vulnerabilities of selected hospitals also revealed that they are largely in the non-structural and functional domains of the all-hazard approach. The general lack of the required skills and competence for the assessment of structural components has been implicated as a reason for the omission of the structural components in most HVAs (290, 291). Consistently, the same factor partly informed the omission of the structural component from the hazard vulnerability assessment conducted in this thesis, and this remains one of the limitations of this study. Therefore, it is essential to address this gap in skill among emergency services directors as well as other staff cadres who are involved in emergency preparedness and response planning. Strategies including the use of short courses (Continuous Professional Development, CPD), the inclusion of relevant contents in the curriculum of recognized degree programme (such as nursing) and deliberate training of staff members with engineering skills in hospital hazard vulnerability assessment may address this problem.

In addition to the lack of structural components, the systematic review conducted in this thesis indicated significant disparities in the level of comprehensiveness of elements of the functional and non-structural components assessed during HVAs. It appears that assessors simply select elements of the functional and non-structural domains that have skills in assessing or those that they deem to be relevant to their organisation. However, this significantly negates the comprehensive nature of the all-hazard approach, and further highlights the importance of training and capacity building as earlier identified in this section. In addition, this problem also highlights the importance of collaborative efforts and effective leadership in hazard vulnerability assessment. Waugh and Streib particularly indicated that broad collaboration and effective leadership of the assessment process will facilitate the accuracy and comprehensiveness of vulnerability assessment. In addition, the report highlighted that this will also ensure effective management of emergency and disaster response (292). The HVA conducted in this study (to some extent) implemented collaborative efforts in HVA by requesting that the completion of the KP-HVA form sent to selected hospitals were completed by the Disaster Response Team as opposed sole completion by the Emergency Services Director.

Several other factors may contribute to differences in the level of hazard of healthcare organisations. Evidence from the systematic review conducted indicated that location could play a key role, as some locations may be more prone to disasters than the other. However, the clear understanding of how these location-specific factors inform the level of preparedness of healthcare organisations is not poorly understood. In addition, the hospital's level of emergency preparedness could be influenced by the level of care provided and whether or not it is a public organization (this will largely determine source of funding) (293). Though data obtained for HVA in this study are not stratified based on hospital location, funding type and level of service, the observation from the data collected using APAQ indicated that these factors do not significantly affect the level of emergency preparedness and response of hospitals assessed. However, this finding must be interpreted with caution. This is because the entire region has been reported to be experiencing an increase in the number of disaster and previous studies have also indicated that hospitals in the region are becoming increasingly aware of the importance of effective plans and strategies for disaster response and management (294). This awareness may have swept across all healthcare organisations in the regions, irrespective of their location, level of care and funding source. Moreover, it is possible that there is a policy or legislation which mandate hospitals in the region to implement certain safety measures. Research of the impact of policies in this regard as well as the adequacy of existing legislations will contribute to the understanding of status of disaster response and management in Riyadh region. This is a subject that could be pursued by future studies.

In addition to challenges relating to gaps in skills for HVA, other challenges facing the adoption of the all-hazard approach were identified across studies conducted in this thesis. These include biases that may be associated with self-assessment/self-reported data, the lack of effective management of the HVA process, poor leadership of the assessment process, inadequate financial resources and the lack of basic facilities and equipment for proper HVA. With respect to self-assessment biases, the employment of external agencies in the conduct of hazard vulnerability assessments has been recommended (295). However, this may be associated with its own challenges because external agents may not fully understand the operational processes of the organisation like people who work within the organisation. In addition to studies reviewed as part of the systematic review conducted in this thesis, many other studies have also identified poor management and leadership as one of the key problems facing effective disaster preparedness and response in KSA(149). These observations altogether suggest the implementation of urgent interventions to build capacity for effective emergency preparedness and response in emerging and current disaster managers in the country. Increased funding of the health system by government will address challenges associated with poor funding. However, the lack of political will or the commitment of governments has always been a challenge in this regard (296).

The extent to which challenges identified through systematic review contribute to the types of probable and actual hazards identified for healthcare organisations in Riyadh region is not yet fully understood. This is because the review conducted did not cover only healthcare facilities in Riyadh region and some of the challenges identified in hospitals afar field may not be applicable to institutions in Riyadh. This notwithstanding, challenges identified have the potential to affect effective HVA as well as the level of emergency preparedness and response wherever they are present. This understanding partly informed the collecting of information relating to challenges that Emergency Services Directors in selected face in this thesis. Consistently, challenges identified by these managers, to a large extent, were similar to those identified through the systematic review, with issues relating to poor management and scarcity of resources highlighted across both studies. In addition, issues relating to the lack of experience and human resources shortage highlighted by managers are also consistent with the earlier identified gap in skills for effective hazard vulnerability assessment. Similarly, highlighted challenges such as poor communication, poor engagement with external agencies, improper coordination of services, poor patient tracing, lack of post-disaster follow-up reports, lack of proper guidelines and assignment of responsibilities are problems that effective leadership could address(297) . These further highlights why efforts to build leadership competence and capacity of Emergency Services Directors in KSA is critical.

Findings reported in this thesis indicate that common methods for emergency plan assessment, include regular drills, regular review of emergency plans, and use of audit resources. A previous observational cross-sectional survey study by Shalhoub et al (245) in Riyadh, Saudi Arabia but only including private hospitals found that all the hospitals included in the sample reported to do drills for the hospital disaster preparedness, even though only two showed accompanying evidence. The findings of this thesis included both private and public hospitals, gave more representative data, and used interviews to gain a greater depth of understanding on the methods for emergency plan assessment and found similarly. Also, though the sample size of this thesis is small, findings included challenges associated with the adoption of the common methods for emergency plan assessment to gain a better understanding of disaster and emergency preparedness. This implies that these findings can be used for the development of interventions that can effectively address challenges identified.

The importance of communication and health information has been recognised in this thesis. Communication is important since emergency messages often include alerts and warnings, directions on evacuation, curfews, along with other protective actions, and information on the status of response and other issues that affect response and recovery. A previous descriptive quantitative study by Sultan et al(298). using a validated questionnaire in Najran region, KSA but using an Emergency Preparedness Information Questionnaire (EPIQ) on Ministry of Health’s (MOH) hospitals found that effective communication is essential during an emergency for better collaboration among health care providers and emergency response stakeholders. The findings of this thesis include expert opinion from Emergency Services Directors unlike Sultan et al (298) which focused on nursing and physicians' staff who work in emergency departments. Even though the findings of the thesis and those of Sultan et al (298) are similar, this thesis provides a greater depth of understanding on the factors and challenges associated with effective emergency response capability from the perspective of emergency experts. Together, these findings imply that hospital settings in Riyadh, SA and elsewhere must invest in training on communication protocols during disasters to boost their level of preparedness and response during emergencies.

Challenges relating to shortage of human resources such as doctors, nurses, and technicians, and lack of experience and knowledge among emergency response stakeholders is consistent with previous report by Alakeely et al (299). The exploratory study including workers from primary health care facilities found staff shortage as a key issue affecting service delivery during emergencies. However, the reason for the staff shortage in the study was COVID-19 diagnosis which led to the subsequent isolation of those affected from the rest of the staff. While Alakeely et al (299) solely focused on the challenges to service delivery at the PHC level, the current thesis covered the challenges at the secondary and tertiary level, providing a wider base of evidence. Another previous cross-sectional survey study by Alzahrani et al (157) in Mecca, Saudi Arabia but only using public hospitals found that emergency nurses had a significant knowledge deficit on appropriate disaster management. The findings of the thesis, however, drew evidence from emergency service directors, unlike Alzahrani et al (157) who used a sample of registered nurses in hospital emergency departments. The findings, nonetheless, imply that a larger national survey of all stakeholders involved in emergency preparedness and response is needed to gain a wider understanding of their knowledge and training needs for disaster response.

Regarding the strategies that can facilitate effective disaster response, most managers proposed the creation of platforms that can recruit and train volunteers who can eventually become useful during disaster response. These findings are consistent with a previous cross-sectional study by Mansour et al (300) investigating the knowledge, attitudes, and willingness of medical students at Unaizah College of Medicine, Qassim University, Saudi Arabia to volunteer in a disaster. Mansour et al (300) suggest the need for educational programs on preparedness among volunteers to improve their emergency response levels. The findings by Mansour et al (300) are not representative since the researchers use a sample chosen from only one university and does not consider other sources of volunteers. The findings of this thesis are, therefore, superior since they present a deeper understanding of the strategies that can enable better disaster response from an expert perspective.

7.4 Research Strengths and Limitations

This was the first research in Riyadh, Saudi Arabia, to look at the all-hazards approach to disaster preparedness and the response capacity at the healthcare facilities. As a result, this thesis stands out as a substantial research endeavour to address challenges impacting Riyadh's healthcare industry. The narrow focus on the question, comprehensive search for evidence, and rigorous appraisal of evidence in the systematic review all contribute to the strengths of the thesis. The outcome of the systematic review produces an indication of the adoption of the use of the all-hazards approach in disaster preparedness globally, with increasing level of awareness and adoption of the approach across Asia.

However, one of the key limitations of the systematic review conducted in this thesis is the fact that it identifies that only few articles that reported how all hazard approach has been applied in KSA. This could be due to the fact that the adoption of the approach is not yet widespread in the region or that there is a general lack of research on all hazard approach in the region. The systematic review may also suffer from publication bias since only peer-reviewed studies were included, and did not include grey literature, and potentially relevant reports on the use of the all-hazard approach may not have been included in published research. Four databases which are the most suitable repositories for this type of research were queried to identify article for review and it is possible that some other articles may be archived/indexed in other databases that are not included in our study. Therefore, a future study with expanded database coverage may be necessary. A few more studies emerged as the study progressed and some new evidences are currently being published. These further lend credence to the need for another systematic review in the future.

The quantitative component of the study presented a comprehensive analysis of functional and non-structural factors affecting emergency preparedness in healthcare settings in Riyadh, KSA. By identifying these two domains, the quantitative study opens up new areas of focus when examining the factors influencing emergency preparedness in healthcare settings. Nonetheless, the study is limited in its small sample size which could have yielded less precise and unrepresentative results. The small sample size could also have reduced the power of the study and increased the margin of error. Since the study only focused on emergency departments, the results of the quantitative component are also limited to this setup. Another limitation may emerge with the measurement instrument. The researcher did not conduct validation work to ascertain whether the scores for functional and non-structural elements were repeatable. Replicating this study in other hospitals within the region or in other regions of KSA will address this in the future.

Total sampling was used in selecting all the secondary and tertiary hospitals in Riyadh region in the qualitative component of the thesis. For both quantitative and qualitative part of this study, only very few participants (mainly people working within the emergency department within selected hospitals) participated in the study. This small sample size may compromise the precision of data collected and opinions are limited to the experience of people working in the emergency department only. Future studies using more diversified sample population (with larger sample size and people from other departments within the hospitals) will address this issue.

The KP-HVA tool used in the assessment of hazard vulnerabilities of selected hospitals is a standard tool. However, the computation of results generated by the tool is complicated as there are some hidden (and not properly understood) formulae within the tool itself. This means that it is possible that there are some intricate errors which the researcher may not be aware of. Moreover, APAQ was newly designed and used for the first time in this study. This indicates that further validations of the tool may be necessary and future studies using the tool may produce better results following the addressing of some of the challenges observed in this study. For instance, scoring of responses and ratings were based on the strategy used in a previous study (64). Another study which uses this tool, and a different scoring technique may unlock some hidden benefits and effectiveness of this tool in assessing hazard preparedness of healthcare organisations.

Challenges with the quality of data collected is a recognised limitation of quantitative studies. In this thesis, data used in the HVA quantitative study were mostly self-reported by members of the emergency services team. Therefore, the accuracy of data depends largely on the level of knowledge and sincerity of members of these teams. A noticeable impact of this was in the identification of potential and actual hazards. The fact that the same individual (or individuals) was asked to report on both hazards means that it is possible for them to confuse these hazards. The quantitative component may also suffer from a potential bias in response as it is possible that respondents may have overestimated the level of preparedness of their hospitals. This study used the reported approach, despite highlighted limitations, as it seems to be the best approach for data collection in the context of KSA where knowledge of all-hazard approach is limited, and the adoption of the approach is not yet widespread.

Another limitation relates to the use of the all-hazard assessment tool in tertiary hospitals. During the data collection visits, the researcher interacted with a tertiary hospital specialist in psychiatry. The hospital did not have any role in responding to the disasters that could occur in the area. The researcher made similar observations after visiting a geriatric home, a healthcare institution without an emergency department. Staff in the home were also not aware of their role in responding to potential disasters. The all-hazard assessment tool may not effectively examine tertiary hospitals since it is designed to focus on the full spectrum of emergencies or disasters. As such, effort must be put into designing an all-hazard assessment tool that suites tertiary hospitals or referral hospitals that have no emergency department.

Qualitative interviews were designed purposefully to include emergency directors with five and more years of experience in managing disasters at the hospitals. This is a strength of this study as the experience is deemed useful to this study. All interviewed managers have access to information about the designing and implementing emergency plans in their institutions. The qualitative research technique used in this thesis was also a plus since it allowed for in-depth insights into the essential factors impacting emergency planning and response in Riyadh hospitals.

However, only six participants provided met this requirement, which means there was no need for selection as all the six participants were interviewed. While this may be advantageous when considered from the point that the sample size is manageable, the sample size is small and may not be representative of the population. The sample size for qualitative research does tend to be small and the purpose is to get depth of understanding from the individuals concerned. Moreover, as soon as saturation of themes is reached, there is often no need for additional participants as this will add no meaningful information to the data being collected. Despite the small sample size used in this study, the research managed to get as much information as possible from managers interviewed who have similar experiences of emergency response planning and implementation. Despite this, and the fact that an interview guide question was used also it is possible that certain key information which may be beneficial to this study were omitted. Therefore, future studies which cover a wider range of topics in emergency planning and response may be needed. In addition, it is possible that the researcher's preconceptions may have impacted the results of the qualitative component of the thesis. Therefore, reflexivity was used throughout the study to continuously reflect on biases that the researcher’s involvement may bring to the study. Moreover, the fact that the researcher worked in the Riyadh region and is known to some of the respondents presupposes that it is possible that the respondents may not have answered some questions accurately as they may misconstrue the research process as a government investigation of their job performance. However, it was clearly explained to participants that data collected if purely for research and not any government investigation. Also, face-to-face interviews with hospital executives have limitations since they may not reflect the reality across the whole Kingdom of Saudi Arabia. Their perspectives and opinions are thought to be restricted to their own hospitals, which may differ in their approach and response to emergency situations.

7.5 Changes since the Covid-19 Pandemic

Data used to assess the level of all-hazard emergency preparedness of hospitals in Riyadh was collected before the coronavirus pandemic, between June and November 2019. This is important in the current thesis since the KSA government supported the health sector with millions of dollars during and post-Covid-19 to improve their state of preparedness. It is, therefore, crucial to examine the state of preparedness of hospitals in Riyadh region after the pandemic. Pre-Covid-19 pandemic, there were more work to be done in terms of health system preparedness and fast response, inter-sectoral collaboration, and emergency management plans and actions. Positive indicators of progress include the Makkah province train network, which connects and facilitates transportation between the Holy sites and Jeddah airport and seaport (301), a flying ambulance, improvements in drainage systems and power cables, and a gradual increase in Saudi workforce on emergency management.

Disaster preparedness has so far changed after the Covid-19 pandemic. Since the onset of the pandemic, hospitals have become more concerned about their preparedness for mass casualty events (256, 302). Hospitals have now been challenged to include epidemic crises in their emergency plans. However, it is still unclear how well hospitals are ready to handle surges in patients in the event of disease outbreaks. After the pandemic, hospitals have resolved to train and increase awareness among the personnel on how to approach crisis situations. For instance, Covid-19 saw hospitals plan and make efforts for personal protection equipment(256, 302). Future disasters will be well handled if the PPEs are readily available at the hospitals. Researchers have also developed more tools for assessing hospital preparedness. The developments aim at components such as planning, decision making and communication during disasters. The tools also assess hospitals on the component of monitoring and improvement of their emergency plans. Hospitals can also be assessed based on their preparedness to implement infection control. The welfare of staff is also an issue that has been given attention. Preparedness of hospitals must be assessed from the perspective of mental health of their staff as this is a public health issue that affects many professionals.

The outbreak of COVID-19 saw hospitals run out of major supplies and equipment. For instance, bed space was inadequate in most of the hospitals that experienced surges in patients. As part of disaster preparedness efforts, hospitals have been required to plan for additional beds in the event of a similar crisis (302, 303). Effective planning of bed space will in future prevent cases where patients are turned away or some sleeping on floors due to hospitals being overran by the surges in patients. Hospitals in Riyadh region could use the case of the coronavirus pandemic as a guide to developing their emergency preparedness. Moreover, the outbreak of Covid-19 may have shifted the type of hazard that hospitals are now vulnerable to. Adverse effects of Covid-19 strongly suggest the need for hospitals to prioritise how to respond effectively to epidemics while also preparing to respond effectively to other disasters.

7.6 Recommendations

Based on the findings of various studies reported in this thesis, the following are recommended:

1. Future studies which focus on further validation of the utility of the preparedness assessment tool (APAQ) developed in this thesis is recommended. Specifically, the adaptability of the tool in assessing hazard preparedness of hospitals in other regions of KSA, in context outside KSA as well as in assessing hazard preparedness of non-healthcare organisations are recommended.

2. An arbitrary scoring method (adopted from a previous study) was used in this thesis, studies investigating other scoring methods are also recommended.
3. Due to several changes that the outbreak of Covid-19 caused, particularly with respect to hospital safety and disaster response, it will be good to repeat this study post-pandemic to examine the impact of Covid-19 and associated changes in the level of preparedness of hospitals.
4. Furthermore, it has been highlighted that collaboration between healthcare organisations may improve their emergency preparedness and their ability to respond effectively. However, it is not yet fully understood how collaboration could be established between healthcare and other relevant organisations in the country. Therefore, a study which investigates models for collaboration between hospitals in KSA and associated challenges is recommended.
5. This has study has identified challenges associated with data collection tools for all hazard approach. Therefore, a study which compared the effectiveness of available tool, with the aim of identifying a universal tool for accurate and effective hazard vulnerability assessment is recommended.
6. It was evident from reviews conducted in this study that information on hazards and disasters across the Riyadh region are generally

lacking. Therefore, a study which documents disasters events across the region is recommended.

7. Several challenges/barriers to the adoption of all hazard approach have been identified. Therefore, studies which develop and implement interventions to address these challenges are recommended. An example of such studies is one which build the capacity in the development of emergency plans as well as capacity of emergency services directors in the management of emergency preparedness and response.
8. The use of regular drills was discovered as a common method for emergency plan assessment in hospital settings in Riyadh region, KSA. Based on this, it is recommended that Emergency Service Directors should develop protocols for continuous emergency drilling exercises for old and new personnel in their hospitals. During the drills, specialised drilling experts knowledgeable of the all-hazard approach should be engaged.
9. Challenges to human resources, especially staff shortages and lack of expertise in emergency situations were noted in the thesis. It is recommended that managers engage in continuous recruitment of qualified staff to improve preparedness. For staff shortages, managers should collaborate with institutions that can provide volunteers, such as medical schools, to guarantee an adequate number of human resources during emergency response. Also, directors should create a communication plan to guide their hospitals

on the messaging protocols during an emergency to minimise confusion.

10. As a multi-disciplinary team, emergency department committees have the role of developing processes, policies, and procedures, and securing relevant resources to ensure prompt and effective emergency response. To address challenges associated with this responsibility, this thesis recommends continuous upgrading the experiences of emergency staff in all hospitals to keep them in check with modern trends of rendering emergencies. Besides, the committee should establish a framework that guarantees regular review of emergency plans, at least annually, to ensure the laid-out protocols remain valid. Apart from annual provisions, it is recommended that the emergency department committee reviews the emergency plan as soon as emergencies happen in the interim period. Such reviews would improve the level of preparedness of hospital settings in KSA and globally.
11. The need for external facing approaches such as those required for effective collaboration with other hospitals as well as other relevant external agencies such as the Saudi Red Crescent Authority has been identified in this thesis. Therefore, the establishment of a coalition of Emergency Services Directors by the Ministry of Health is recommended. The coalition should engage in regular meetings and brainstorming sessions could be facilitated by the ministry to

provide opportunities for managers to be aware of activities at other organisations and form partnerships.

12. In addition, the use of volunteers has been advocated in this thesis. However, it may be difficult for hospitals to have all it takes to recruit the right type and adequate number of volunteers. Therefore, collaborations with organisations that are involved in the recruitment of volunteers will represent a pragmatic approach in this regard.

7.7 Conclusions and remarks

The thesis showed that most of the hospitals in Riyadh, Saudi Arabia had moderate resources and capabilities to manage disasters. However, the effectiveness of disaster preparedness was inadequate. Based on the findings, the thesis recommends improving the disaster preparedness of these hospitals. Key areas of urgent focus include staff training on emergency preparedness using feasible exercises, such as drills, training on emergency leadership and suitable communication protocols, acquisition of better safety equipment, creating appropriate logistics and accessibility plans before a disaster strikes, and incorporation of a holistic approach to disaster management.

REFERENCES

1. WHO. Environmental health in emergencies: WHO; 2018 [Available from: http://www.who.int/environmental_health_emergencies/natural_events/en/.
2. Paton D. Disaster preparedness: a social-cognitive perspective. Disaster Prevention and Management: An International Journal. 2003;12(3):210-6.
3. Dar O, Buckley EJ, Rokadiya S, Huda Q, Abrahams J. Integrating Health Into Disaster Risk Reduction Strategies: Key Considerations for Success. American Journal of Public Health. 2014;104(10):1811-6.
4. CRED. Disasters in Numbers 2022. 2023.
5. Shi P, Yang X, Xu W, Wang Ja. Mapping global mortality and affected population risks for multiple natural hazards. International Journal of Disaster Risk Science. 2016;7:54-62.
6. Ahmad J, Ahmad MM, Su Z, Rana IA, Rehman A, Sadia H. A systematic analysis of worldwide disasters, epidemics and pandemics associated mortality of 210 countries for 15 years (2001–2015). International Journal of Disaster Risk Reduction. 2022;76:103001.
7. Ladds M, Keating A, Handmer J, Magee L. How much do disasters cost? A comparison of disaster cost estimates in Australia. International Journal of Disaster Risk Reduction. 2017;21:419-29.
8. Crawford L, Langston C, Bajracharya B, editors. Building capability for disaster resilience. Annual Conference of the Association of Researchers in Construction Management; 2012: Association of Researchers in Construction Management.
9. Hunt S. Building adaptive capacities for disaster resilience: what role for government? Australian Journal of Emergency Management, The. 2016;31(1):31-6.
10. Gil‐Rivas V, Kilmer RP. Building community capacity and fostering disaster resilience. Journal of clinical psychology. 2016;72(12):1318-32.
11. Alcantara-Ayala I. Geomorphology, natural hazards, vulnerability and prevention of natural disasters in developing countries. Geomorphology. 2002;47(2-4):107-24.
12. Thomalla F, Downing T, Spanger‐Siegfried E, Han G, Rockström J. Reducing hazard vulnerability: towards a common approach between disaster risk reduction and climate adaptation. Disasters. 2006;30(1):39-48.
13. Blaikie P, Cannon T, Davis I, Wisner B. At risk: natural hazards, people's vulnerability, and disasters. London: Routledge; 2004.
14. Cannon T. Vulnerability analysis and the explanation of 'natural'disasters. Disasters, development and environment. 1994;1:13-30.
15. Shirley WL, Boruff BJ, Cutter SL. Social vulnerability to environmental hazards. Hazards Vulnerability and Environmental Justice: Routledge; 2012. p. 143-60.
16. Cutter SL, Barnes L, Berry M, Burton C, Evans E, Tate E, et al. A place-based model for understanding community resilience to natural disasters. Global environmental change. 2008;18(4):598-606.
17. Abosuliman SS, Kumar A, Alam F. Disaster preparedness and management in Saudi Arabia: An empirical investigation. International Journal of Social, Behavioral, Educational, Economic and Management Engineering. 2013;7:1979-83.
18. Chen S, Luo Z, Pan X. Natural disasters in China: 1900–2011. Natural hazards. 2013;69(3):1597-605.
19. Malalgoda C, Amaratunga D, Haigh R. Challenges in creating a disaster resilient built environment. Procedia Economics and Finance. 2014;18:736-44.
20. Ravankhah M, Chmutina K, Schmidt M, Bosher L. Integration of cultural heritage into disaster risk management: challenges and opportunities for increased disaster resilience. Going Beyond: Perceptions of Sustainability in Heritage Studies No 2. 2017:307-21.
21. Fekete A, Hufschmidt G, Kruse S. Benefits and challenges of resilience and vulnerability for disaster risk management. International journal of disaster risk science. 2014;5:3-20.

22. Julià PB, Ferreira TM. From single-to multi-hazard vulnerability and risk in Historic Urban Areas: a literature review. Natural hazards. 2021;108(1):93-128.
23. Awal M. Vulnerability to disaster: Pressure and release model for climate change hazards in Bangladesh. International Journal of Environmental Monitoring and Protection. 2015;2(2):15-21.
24. CRED. General Classification. EM-DAT | The international disasters database. 2009.
25. Leaning J, Guha-Sapir D. Natural disasters, armed conflict, and public health. New England journal of medicine. 2013;369(19):1836-42.
26. Lukić T, Gavrilov MB, Marković SB, Komac B, Zorn M, Mlađan D, et al. Classification of natural disasters between the legislation and application: experience of the Republic of Serbia. Acta geographica Slovenica. 2013;53(1):149-64.
27. Blockley D, editor. Man Made Disasters. Risk Management: Palgrave Macmillan UK; 1999.
28. Coleman L. Frequency of man - made disasters in the 20th century. Journal of Contingencies and Crisis Management. 2006;14(1):3-11.
29. Ramesh AC, Kumar S. Triage, monitoring, and treatment of mass casualty events involving chemical, biological, radiological, or nuclear agents. Journal of Pharmacy and Bioallied Sciences. 2010;2(3):239.
30. Weichselgartner J. Disaster mitigation: the concept of vulnerability revisited. Disaster Prevention and Management: An International Journal. 2001;10(2):85-95.
31. O'Brien G, O'keefe P, Rose J, Wisner B. Climate change and disaster management. Disasters. 2006;30(1):64-80.
32. Reisner M. A dangerous place: California's unsettling fate: Penguin Group USA; 2004.
33. Masika R. Gender, development, and climate change: Oxfam; 2002.
34. Scawthorn C, Ballantyne D. Emergency Water Supply and Disaster Vulnerability. Water for Urban Areas United Nations University Press, Tokyo. 2000:200-25.
35. WHO. Disasters and emergencies. 2018.
36. ESCAP U. Disasters in Asia and the Pacific: 2015 year in review. United Nations report Economic and social commission for Asia and the Pacific. 2015.
37. CRED. Annual Disaster Statistical Review 2015 – The numbers and trends. Centre for Research on the Epidemiology of Disasters (CRED). 2015.
38. (EM-DAT) IDD. Center forResearch on the Epidemiology of Disasters (CRED).Natural disaster 2018.
39. CRED. Natural Disasters 2018
40. Alraga S. An Investigation into Disaster Health Management in Saudi Arabia. 2017;03.
41. Zahran S, Peek L, Snodgrass JG, Weiler S, Hempel L. Economics of disaster risk, social vulnerability, and mental health resilience. Risk analysis : an official publication of the Society for Risk Analysis. 2011;31(7):1107.
42. Afifi WA, Felix ED, Afifi TD. The impact of uncertainty and communal coping on mental health following natural disasters. Anxiety, Stress, & Coping. 2012;25(3):329-47.
43. Rose A, Benavides J, E. Chang S, Szczesniak P, Lim D. The Regional Economic Impact of an Earthquake: Direct and Indirect Effects of Electricity Lifeline Disruptions2002. 437-58 p.
44. Shoaf KIR, Steven J. Public health impact of disasters. Australian Journal of Emergency Management. 2000;15(3):58-63.
45. Du W, Fitzgerald G, Clark M, Hou X-Y. Health Impacts of Floods2010. 265-72 p.
46. Streeter CL. Disasters and development: disaster preparedness and mitigation as an essential component of development planning. Social Development Issues. 1991;13(3):100-10.
47. Allen KM. Community-based disaster preparedness and climate adaptation: local capacity-building in the Philippines. Disasters. 2006;30(1):81-101.
48. Kaji AH, Koenig KL, Lewis RJ. Current hospital disaster preparedness. Jama. 2007;298(18):2188-90.

49. Baack S, Alfred D. Nurses' preparedness and perceived competence in managing disasters. J Nurs Scholarsh. 2013;45(3):281-7.
50. Testa MA, Pettigrew ML, Savoia E. Measurement, geospatial, and mechanistic models of public health hazard vulnerability and jurisdictional risk. Journal of public health management and practice. 2014;20:S61-S8.
51. Füssel H-M, Klein RJ. Climate change vulnerability assessments: an evolution of conceptual thinking. Climatic change. 2006;75(3):301-29.
52. Du Y, Ding Y, Li Z, Cao G. The role of hazard vulnerability assessments in disaster preparedness and prevention in China. Military Medical Research. 2015;2(1):27.
53. Peduzzi P, Dao H, Herold C, Mouton F. Assessing global exposure and vulnerability towards natural hazards: the Disaster Risk Index. Natural Hazards and Earth System Sciences. 2009;9(4):1149-59.
54. Simpson DM, Human RJ. Large-scale vulnerability assessments for natural hazards. Natural Hazards. 2008;47(2):143-55.
55. Rojek A, Little M. Evacuating hospitals in A ustralia: What lessons can we learn from the world literature? Emergency Medicine Australasia. 2013;25(6):496-502.
56. Organization WH. Global assessment of national health sector emergency preparedness and response. Geneva: World Health Organization. 2008:11-39.
57. WHO. WHAT IS ALL-HAZARD APPROACH 2018 [Available from: http://www.euro.who.int/en/health-topics/emergencies/disaster-preparedness-and-response/policy.
58. Schultz CH, Koenig KL, Whiteside M, Murray R. Development of national standardized all-hazard disaster core competencies for acute care physicians, nurses, and EMS professionals. Ann Emerg Med. 2012;59(3):196-208.e1.
59. Adini B, Goldberg A, Laor D, Cohen R, Zadok R, Bar-Dayan Y. Assessing levels of hospital emergency preparedness. Prehospital and disaster medicine. 2006;21(6):451.
60. Wetter DC, Daniell WE, Treser CD. Hospital preparedness for victims of chemical or biological terrorism. American Journal of Public Health. 2001;91(5):710-6.
61. Braun BI, Wineman NV, Finn NL, Barbera JA, Schmaltz SP, Loeb JM. Integrating hospitals into community emergency preparedness planning. Annals of Internal Medicine. 2006;144(11):799-811.
62. Barbera JA, Yeatts DJ, Macintyre AG. Challenge of hospital emergency preparedness: analysis and recommendations. Disaster Medicine & Public Health Preparedness. 2009;3(2 Suppl):S74-82.
63. Hatami H, Neisi A, Kooti M. Functional, Structural and Non-Structural Preparedness of Ahvaz Health Centers Against Disasters in 2014 – 2015. 2017;9(1):e66561.
64. Ahmadi B, Foroushani AR, Tanha N, Abad AMB, Asadi H. Study of functional vulnerability status of Tehran Hospitals in dealing with natural disasters. Electronic physician. 2016;8(11):3198.
65. WHO. Safe hospitals in emergencies and disasters: structural, non-structural and functional indicators. Manila: WHO Regional Office for the Western Pacific; 2010.
66. Chang JC, Gluckman W, Weinstein ES. Health care facility hazard and vulnerability analysis. Disaster Medicine: Elsevier; 2006. p. 117-23.
67. Salter J. Risk management in a disaster management context. Journal of Contingencies and Crisis Management. 1997;5(1):60-5.
68. Innocenti D, Albrito P. Reducing the risks posed by natural hazards and climate change: the need for a participatory dialogue between the scientific community and policy makers. Environmental Science & Policy. 2011;14(7):730-3.
69. Ghazali DA, Guericolas M, Thys F, Sarasin F, Arcos González P, Casalino E. Climate change impacts on disaster and emergency medicine focusing on mitigation disruptive effects: an international perspective. International journal of environmental research and public health. 2018;15(7):1379.
70. PAHO. Health Sector Multi-Hazard Response Framework.; 2019.
71. 2017. What is the “all hazards approach” to emergency preparedness?

72. Bodas M, Kirsch TD, Peleg K. Top hazards approach – Rethinking the appropriateness of the All-Hazards approach in disaster risk management. International Journal of Disaster Risk Reduction. 2020;47:101559.
73. Organization WH. Global Assessment of National Health Sector Emergency Preparedness and Response: Specifiation Guidelines: World Health Organization; 2008.
74. WHO. Global assessment of national health sector emergency preparedness and response. 2008.
75. Everbridge. 2023. [20/07/2023]. Available from: https://www.everbridge.com/blog/what-is-the-all-hazards-approach/.
76. OECD. Towards an All-Hazards Approach to Emergency Preparedness and Response: Lessons Learnt from Non-Nuclear Events. 2018.
77. PAHO. Health Sector Multi-Hazard Response Framework. Pan American Health Organization / World Health Organization. 2019.
78. Gregory PA. Reassessing the Effectiveness of All-Hazards Planning in Emergency Management. Inquiries Journal/Student Pulse [Internet]. 2015; 7(06). Available from: http://www.inquiriesjournal.com/a?id=1050.
79. Adini B, Goldberg A, Cohen R, Laor D, Bar-Dayan Y. Evidence-based support for the all-hazards approach to emergency preparedness. Israel journal of health policy research. 2012;1(1):40.
80. Aitsi-Selmi A, Murray V, Heymann D, McCloskey B, Azhar EI, Petersen E, et al. Reducing risks to health and wellbeing at mass gatherings: the role of the Sendai Framework for Disaster Risk Reduction. Int J Infect Dis. 2016;47:101-4.
81. IFRC. Introduction to Disaster preparedness. PreventionWebnet. 2000.
82. Khan H, Vasilescu LG, Khan A. Disaster management cycle-a theoretical approach. Journal of Management and Marketing. 2008;6(1):43-50.
83. Coetzee C, Van Niekerk D. Tracking the evolution of the disaster management cycle: A general system theory approach. Jàmbá: Journal of Disaster Risk Studies. 2012;4(1):1-9.
84. Joyce KE, Wright KC, Samsonov SV, Ambrosia VG. Remote sensing and the disaster management cycle. Advances in geoscience and remote sensing: InTech; 2009.
85. Faisal I, Kabir M, Nishat A. Non-structural flood mitigation measures for Dhaka City. Urban Water. 1999;1(2):145-53.
86. Few R. Flooding, vulnerability and coping strategies: local responses to a global threat. Progress in Development Studies. 2003;3(1):43-58.
87. Berke P, Smith G, Lyles W. Planning for resiliency: Evaluation of state hazard mitigation plans under the disaster mitigation act. Natural Hazards Review. 2012;13(2):139-49.
88. Keeney GB. Disaster preparedness: what do we do now? Journal of midwifery & women's health. 2004;49(S1):2-6.
89. Miceli R, Sotgiu I, Settanni M. Disaster preparedness and perception of flood risk: A study in an alpine valley in Italy. Journal of environmental psychology. 2008;28(2):164-73.
90. Fothergill A, Peek LA. Poverty and disasters in the United States: A review of recent sociological findings. Natural hazards. 2004;32(1):89-110.
91. Brandeau ML, McCoy JH, Hupert N, Holty JE, Bravata DM. Recommendations for modeling disaster responses in public health and medicine: a position paper of the society for medical decision making. Med Decis Making. 2009;29(4):438-60.
92. Leitmann J. Cities and calamities: learning from post-disaster response in Indonesia. J Urban Health. 2007;84(3 Suppl):i144-53.
93. Ingram JC, Franco G, Rumbaitis-del Rio C, Khazai B. Post-disaster recovery dilemmas: challenges in balancing short-term and long-term needs for vulnerability reduction. Environmental Science & Policy. 2006;9(7-8):607-13.
94. Aldrich DP. Building resilience: Social capital in post-disaster recovery: University of Chicago Press; 2012.
95. Olshansky R, Chang S. Planning for disaster recovery: Emerging research needs and challenges. Progress in Planning. 2009;72(4):200-9.

96. Mannakkara S, Wilkinson S. Re-conceptualising “Building Back Better” to improve post-disaster recovery. International Journal of Managing Projects in Business. 2014;7(3):327-41.
97. UNDRR. Disaster risk reduction. 2020.
98. UNISDR U, editor Sendai framework for disaster risk reduction 2015–2030. Proceedings of the 3rd United Nations World Conference on DRR, Sendai, Japan; 2015.
99. Aitsi-Selmi A, Egawa S, Sasaki H, Wannous C, Murray V. The Sendai framework for disaster risk reduction: Renewing the global commitment to people’s resilience, health, and well-being. International Journal of Disaster Risk Science. 2015;6(2):164-76.
100. Pearson L, Pelling M. The UN Sendai framework for disaster risk reduction 2015–2030: Negotiation process and prospects for science and practice. Journal of Extreme Events. 2015;2(01):1571001.
101. Goniewicz K, Burkle Jr FM. Challenges in implementing Sendai framework for disaster risk reduction in Poland. International journal of environmental research and public health. 2019;16(14):2574.
102. Green HK, Lysaght O, Saulnier DD, Blanchard K, Humphrey A, Fakhruddin B, et al. Challenges with disaster mortality data and measuring progress towards the implementation of the Sendai framework. International Journal of Disaster Risk Science. 2019;10:449-61.
103. Goryushina E, editor Challenges of the Sendai Framework for Disaster Risk Reduction Adaption in Russia. IOP Conference Series: Earth and Environmental Science; 2021: IOP Publishing.
104. Wilkins A, Pennaz A, Dix M, Smith A, Vawter J, Karlson D, et al. Challenges and opportunities for Sendai framework disaster loss reporting in the United States. Progress in Disaster Science. 2021;10:100167.
105. Nations U. Main findings and recommendations of the midterm review of the implementation of the Sendai Framework for Disaster Risk Reduction 2015–2030. 2023.
106. Chisty MA, Muhtasim M, Biva FJ, Dola SEA, Khan NA. Sendai Framework for Disaster Risk Reduction (SFDRR) and disaster management policies in Bangladesh: How far we have come to make communities resilient? International Journal of Disaster Risk Reduction. 2022;76:103039.
107. Zaidi RZ, Fordham M. The missing half of the Sendai framework: Gender and women in the implementation of global disaster risk reduction policy. Progress in Disaster Science. 2021;10:100170.
108. Ayeb‐Karlsson S, Kniveton D, Cannon T, Van Der Geest K, Ahmed I, Derrington EM, et al. I will not go, I cannot go: cultural and social limitations of disaster preparedness in Asia, Africa, and Oceania. Disasters. 2019;43(4):752-70.
109. Haines P. Disaster Preparedness and Response in the Pacific: Strengths, Challenges, Limitations and Successes. A Pacific Disaster Prevention Review. 2020:62-5.
110. Ramet V. Linking relief, rehabilitation and development: Towards more effective aid. Brussels, BE: Directorate-General for External Policies of the European Union. 2012.
111. Collinson S, Buchanan-Smith M, Elhawary S. Good humanitarian donorship principles in practice: Assessing humanitarian assistance to internally displaced persons in Sudan and Sri Lanka. Humanitarian Policy Group London: Overseas Development Institute. 2009.
112. Christoplos ID, Wu T. Linking Relief, Rehabilitation and Development (LRRD) & Social Protection. 2012.
113. Rama M. Linking Relief, Rehabilitation and Development (LRRD): Examples and Lessons learned for the WASH sector.
114. Dijkzeul D, Addis A. Humanitarian–Development Integration? Comparing ‘Linking Relief, Rehabilitation and Development’,‘Early Recovery’,‘Resilience’and the ‘Triple Nexus’. Forced Displacement and Migration: Approaches and Programmes of International Cooperation. 2022:55-75.
115. Mena R, Hilhorst D. The development–humanitarian nexus: Linking development and disaster risk reduction with relief in Yemen as a case of high‐intensity conflict. Disasters. 2021.

116. Cochrane L, Wilson A. Nuancing the double and triple nexus: analyzing the potential for unintended, negative consequences. Development Studies Research. 2023;10(1):2181729.
117. Sauer LM, McCarthy ML, Knebel A, Brewster P. Major influences on hospital emergency management and disaster preparedness. Disaster medicine and public health preparedness. 2009;3(S1):S68-S73.
118. Phalkey R. Phalkey R, Runge –Ranzinger, S, Marx, M (2010) "Systems impacts of natural disasters- A systematic literature review" Health for Millions 36, 2 & 3: 10-252010. 10-25 p.
119. Carmona RH. The science of surge: an all‐hazard approach is critical to improving public health preparedness. Academic Emergency Medicine. 2006;13(11):1097-.
120. Ardalan A, Kandi M, Talebian MT, Khankeh H, Masoumi G, Mohammadi R, et al. Hospitals safety from disasters in IR iran: the results from assessment of 224 hospitals. PLoS currents. 2014;6.
121. WHO. Comprehensive safe hospital framework. World Health Organization Web sitehttps://viewckcestcn/AllFiles/ZKBG/Pages/152/comprehensive-safe-hospital-frameworkpdf. 2015.
122. Olowu D. The Hyogo Framework for Action and its implications for disaster management and reduction in Africa. JAMBA: Journal of Disaster Risk Studies. 2010;3(1):303-20.
123. Vega FC, Flores PC. (A253) Safe Hospital Program and Safe Medical Unit in Mexico. Prehospital and Disaster Medicine. 2011;26(S1):s85.
124. Montejano-Castillo M, Moreno-Villanueva M. Hospitals safe from disasters: A glimpse into the Mexican coastal zones. Safety and Security Studies. 2018:149.
125. Organization WH. Safe Hospitals Initiatives: Comprehensive Safe Hospital Framework. Geneva. 2015.
126. Shaw CD, Jelfs E, Franklin P. Implementing recommendations for safer hospitals in Europe: SANITAS project. Eurohealth. 2012;18(2):26-8.
127. Bazyar J, Pourvakhshoori N, Safarpour H, Farrokhi M, Khankeh HR, Daliri S, et al. Hospital Disaster Preparedness in Iran: A Systematic Review and Meta-Analysis. Iran J Public Health. 2020;49(5):837-50.
128. Munasinghe NL, Matsui K. Examining disaster preparedness at Matara District General Hospital in Sri Lanka. International Journal of Disaster Risk Reduction. 2019;40:101154.
129. Dowlati M, Seyedin H, Moslehi S. Hospital preparedness measures for biological hazards: a systematic review and meta-synthesis. Disaster Medicine and Public Health Preparedness. 2021;15(6):790-803.
130. Arabia GAfSiS. Demography Survey. 2016.
131. Alamri YA. Emergency management in Saudi Arabia: Past, present and future. Un Of Christchurch report, New Zealand. 2010;21.
132. Interior Mo. Traffic statistics: statistical publication of 2008. 2008.
133. Ansari S, Akhdar F, Mandoorah M, Moutaery K. Causes and effects of road traffic accidents in Saudi Arabia. Public Health. 2000;114(1):37-9.
134. Dhaffar KO, Sindy AF, Gazzaz ZJ, Shabaz J. Evaluation of an emergency service attempted by the Saudi Red Crescent Society. Saudi medical journal. 2005;26(2):357-9.
135. Alaska YA, Aldawas AD, Aljerian NA, Memish ZA, Suner S. The impact of crowd control measures on the occurrence of stampedes during mass gatherings: the Hajj experience. Travel medicine and infectious disease. 2017;15:67-70.
136. Al-Saggaf Y, Simmons P. Social media in Saudi Arabia: Exploring its use during two natural disasters. Technological Forecasting and Social Change. 2015;95:3-15.
137. Al Saud M. Assessment of flood hazard of Jeddah area 2009, Saudi Arabia. Journal of Water Resource and Protection. 2010;2(9):839-47.
138. Fekete A. Safety and security target levels: Opportunities and challenges for risk management and risk communication. International Journal of Disaster Risk Reduction. 2012;2:67-76.

139. Salamati P, Rahimi-Movaghar V. Hajj stampede in Mina, 2015: need for intervention. Arch Trauma Res. 2016;5(2):e36308.
140. Maben J, Al-Thowini K, West E, Rafferty A-M. Uneven development: Comparing the indigenous health care workforce in Saudi Arabia, Bahrain and Oman. International journal of nursing studies. 2010;47(3):392-6.
141. planning Moea. The Saudi economy in figures 1434/1435H (2013) Riyadh: Ministry of Economy & Planning. 2013.
142. Savage DA. Towards a complex model of disaster behaviour. Disasters. 2019;43(4):771-98.
143. Alyami A, Dulong CL, Younis MZ, Mansoor S. Disaster preparedness in the kingdom of Saudi Arabia: exploring and evaluating the policy, legislative organisational arrangements particularly during the hajj period. European Journal of Environment and Public Health. 2020;5(1):em0053.
144. Tambo E, Fouad AM, Khater EI. Strengthening community emergency preparedness and response in threats and epidemics disasters prevention and management in Saudi Arabia. International Journal of Emergency Management. 2017;13(3):288-303.
145. Al Yousuf M, Akerele T, Al Mazrou Y. Organization of the Saudi health system. 2002.
146. Almalki M, FitzGerald G, Clark M. Health care system in Saudi Arabia: an overview. 2011.
147. AlKhenizan A, Shaw C. Assessment of the accreditation standards of the Central Board for Accreditation of Healthcare Institutions in Saudi Arabia against the principles of the International Society for Quality in Health Care (ISQua). Annals of Saudi medicine. 2010;30(5):386.
148. Al Harthi M, Al Thobaity A, Almalki M, Al Ahmari W. Improving disaster readiness and the response of nurses in Saudi Arabia. Risk management and healthcare policy. 2021:4537-44.
149. Alrehaili N. An investigation into emergency planning requirements and challenges of disaster management in the Kingdom of Saudi Arabia. International Journal of Disaster Management. 2021;4(3):1-10.
150. Ayyub BM, McGill WL, Kaminskiy M. Critical asset and portfolio risk analysis: An all‐hazards framework. Risk Analysis: An International Journal. 2007;27(4):789-801.
151. Malina MA, Nørreklit HS, Selto FH. Lessons learned: advantages and disadvantages of mixed method research. Qualitative Research in Accounting & Management. 2011;8(1):59-71.
152. Molina-Azorin JF, Tarí JJ, Lopez-Gamero MD, Pereira-Moliner J, Pertusa-Ortega E. The implementation and advantages of mixed methods in competitive strategy and management systems. 2018.
153. Al Thobaity A, Alamri S, Plummer V, Williams B. Exploring the necessary disaster plan components in Saudi Arabian hospitals. International Journal of Disaster Risk Reduction. 2019;41:101316.
154. Al Mousa Y, Callaghan P, Michail M, Caswell G. Saudi service users' perceptions and experiences of the quality of their mental health care provision in the Kingdom of Saudi Arabia (KSA): A qualitative inquiry. International journal of mental health nursing. 2021;30(1):300-16.
155. Al-Dossary R, Alamri M, Albaqawi H, Al Hosis K, Aljeldah M, Aljohan M, et al. Awareness, Attitudes, Prevention, and Perceptions of COVID-19 Outbreak among Nurses in Saudi Arabia. International Journal of Environmental Research and Public Health. 2020;17(21):8269.
156. Tayyib N, Alsolami F, Lindsay G, Alshhmemri M, Asfour H, Ramaiah P, et al. Undergraduate Nursing Students' Satisfaction with blended e-learning following the Covid-19 pandemic. 2020.
157. Alzahrani F, Kyratsis Y. Emergency nurse disaster preparedness during mass gatherings: a cross-sectional survey of emergency nurses' perceptions in hospitals in Mecca, Saudi Arabia. BMJ open. 2017;7(4):e013563.

158. Brewer CA, Hutton A, Hammad KS, Geale SK. A feasibility study on disaster preparedness in regional and rural emergency departments in New South Wales: Nurses self-assessment of knowledge, skills and preparation for disaster management. Australasian Emergency Care. 2020;23(1):29-36.
159. Farcas A, Ko J, Chan J, Malik S, Nono L, Chiampas G. Use of incident command system for disaster preparedness: a model for an emergency department COVID-19 response. Disaster Medicine and Public Health Preparedness. 2021;15(3):e31-e6.
160. Cherry RA, Trainer M. The current crisis in emergency care and the impact on disaster preparedness. BMC Emerg Med. 2008;8:7.
161. Dimitrov BG. Topological (in) Hegel: Topological Notions of Qualitative Quantity and Multiplicity in Hegel's Fourfold of Infinities: Borislav Dimitrov; 2018.
162. Foth T, Holmes D, Hülsken-Giesler M, Kreutzer S, Remmers H. Critical approaches in nursing theory and nursing research: Implications for nursing practice: V&R unipress GmbH; 2017.
163. Johansson I, Lynøe N. Medicine & philosophy: A twenty-first century introduction: Walter de Gruyter; 2013.
164. Denicolo P, Long T, Bradley-Cole K. Constructivist approaches and research methods: A practical guide to exploring personal meanings: Sage; 2016.
165. Given LM. The Sage encyclopedia of qualitative research methods: Sage publications; 2008.
166. Dodgson JE. Reflexivity in qualitative research. Journal of Human Lactation. 2019;35(2):220-2.
167. Amin MEK, Nørgaard LS, Cavaco AM, Witry MJ, Hillman L, Cernasev A, et al. Establishing trustworthiness and authenticity in qualitative pharmacy research. Research in Social and Administrative Pharmacy. 2020;16(10):1472-82.
168. Haynes K. Reflexivity in qualitative research. Qualitative organizational research: Core methods and current challenges. 2012:72-89.
169. Hewitt E. Building bridges: the use of reflective oral diaries as a qualitative research tool. International Journal of Research & Method in Education. 2017;40(4):345-59.
170. Tufford L, Newman P. Bracketing in qualitative research. Qualitative social work. 2012;11(1):80-96.
171. Chan ZC, Fung Y-l, Chien W-t. Bracketing in phenomenology: Only undertaken in the data collection and analysis process. The qualitative report. 2013;18(30):1-9.
172. Dörfler V, Stierand M. Bracketing: a phenomenological theory applied through transpersonal reflexivity. Journal of Organizational Change Management. 2020.
173. Weatherford J, Maitra D. How Online Students Approach Bracketing: A Survey Research Study. Educational Research: Theory and Practice. 2019;30(2):91-102.
174. Maxwell JA, Mittapalli K. Realism as a stance for mixed methods research. SAGE handbook of mixed methods in social & behavioral research. 2010;2:145-68.
175. Rahman MS. The advantages and disadvantages of using qualitative and quantitative approaches and methods in language "testing and assessment" research: A literature review. 2020.
176. Ivankova N, Wingo N. Applying mixed methods in action research: Methodological potentials and advantages. American Behavioral Scientist. 2018;62(7):978-97.
177. Al-Ababneh MM. Linking ontology, epistemology and research methodology. Science & Philosophy. 2020;8(1):75-91.
178. Queirós A, Faria D, Almeida F. Strengths and limitations of qualitative and quantitative research methods. European journal of education studies. 2017.
179. Biesta G. 'This is My Truth, Tell Me Yours'. Deconstructive pragmatism as a philosophy for education. Educational Philosophy and Theory. 2010;42(7):710-27.
180. Alahmadi M, Mansour S, Martin D, Atkinson PM. An improved index for urban population distribution mapping based on nighttime lights (DMSP-OLS) data: An experiment in Riyadh Province, Saudi Arabia. Remote Sensing. 2021;13(6):1171.
181. Alazmy W, Samarkandi O, Williams B. The history of emergency medical services response to mass casualty incidents in disasters, Saudi Arabia. Journal of Emergency Medicine, Trauma & Acute Care. 2020;2020(1):3.

182. Campbell S, Greenwood M, Prior S, Shearer T, Walkem K, Young S, et al. Purposive sampling: complex or simple? Research case examples. Journal of research in Nursing. 2020;25(8):652-61.
183. Permanente K. Kaiser Permanente. Medical center hazard and vulnerability analysis. Kaiser Foundation Health Plan, Inc. [http://www.calhospitalprepare.org/hazard-vulnerability-analysis] Accessed 31 Jan 2015. 2011.
184. Arnold JL. Risk and risk assessment in health emergency management. Prehospital and disaster medicine. 2005;20(3):143-54.
185. Campbell P, Trockman SJ, Walker AR. On linkages: Strengthening hazard vulnerability analysis: Results of recent research in Maine. Public Health Reports. 2011;126(2):290-3.
186. Arbon P. Developing a model and tool to measure community disaster resilience. Australian Journal of Emergency Management, The. 2014;29(4):12.
187. WHO. Field manual for capacity assessment of health facilities in responding to emergencies: World Health Organization; 2006.
188. CDC. Hospital All-Hazards Self-Assessment. 2013.
189. ACEP. Hospital Disaster Preparedness Self-Assessment Tool. 2011.
190. Chen S, Luo Z, Pan X. Natural disasters in China: 1900–2011. Nat Hazards. 2013;69.
191. Pidgeon N, O'Leary M. Man-made disasters: why technology and organizations (sometimes) fail. Safety Science. 2000;34(1-3):15-30.
192. Munn Z, Porritt K, Lockwood C, Aromataris E, Pearson A. Establishing confidence in the output of qualitative research synthesis: the ConQual approach. BMC Medical Research Methodology. 2014;14(1).
193. Xiao Y, Watson M. Guidance on conducting a systematic literature review. Journal of planning education and research. 2019;39(1):93-112.
194. Mulrow CD. Systematic reviews: rationale for systematic reviews. Bmj. 1994;309(6954):597-9.
195. Peters MD, Godfrey CM, Khalil H, McInerney P, Parker D, Soares CB. Guidance for conducting systematic scoping reviews. Int J Evid Based Healthc. 2015;13(3):141-6.
196. Lockwood C, Munn Z, Porritt K. Qualitative research synthesis: methodological guidance for systematic reviewers utilizing meta-aggregation. International journal of evidence-based healthcare. 2015;13(3):179-87.
197. Stern C, Munn Z, Porritt K, Lockwood C, Peters MDJ, Bellman S, et al. An International Educational Training Course for Conducting Systematic Reviews in Health Care: The Joanna Briggs Institute's Comprehensive Systematic Review Training Program. Worldviews Evid Based Nurs. 2018.
198. Moher D, Liberati A, Tetzlaff J, Altman DG, Group* P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Annals of internal medicine. 2009;151(4):264-9.
199. Lang D, Verbicaro M, Singh Y, Prasad J, Diaz DW, Gutiérrez M, editors. Structural and Nonstructural Seismic Vulnerability Assessment for Schools and Hospitals Based on Questionnaire Surveys: Case Studies in Central America and India. Proceedings of the 9th US National and 10th Canadian Conference on Earthquake Engineering; 2010.
200. Miniati R, Iasio C. Methodology for rapid seismic risk assessment of health structures: Case study of the hospital system in Florence, Italy. International journal of disaster risk reduction. 2012;2:16-24.
201. Norman ID, Aikins M, Binka FN, Nyarko KM. Hospital all-risk emergency preparedness in Ghana. Ghana Med J. 2012;46(1):34-42.
202. Djalali A, Ardalan A, Ohlen G, Ingrassia PL, Della Corte F, Castren M, et al. Nonstructural safety of hospitals for disasters: A comparison between two capital cities. Disaster medicine and public health preparedness. 2014;8(2):179-84.
203. Jahangiri K, Izadkhah YO, Lari A. Hospital safety index (HSI) analysis in confronting disasters: A case study from Iran. International Journal of Health System and Disaster Management. 2014;2(1):44.
204. Perrone D, Aiello MA, Pecce M, Rossi F, editors. Rapid visual screening for seismic evaluation of RC hospital buildings. Structures; 2015: Elsevier.

205. Golabek-Goldman M. Adequacy of US Hospital Security Preparedness for Mass Casualty Incidents: Critical Lessons From the Israeli Experience. Journal of Public Health Management & Practice. 2016;22(1):68-80.
206. Asefzadeh S, Varyani AS, Gholami S. Disaster risk assessment in educational hospitals of Qazvin based on WHO pattern in 2015. Electronic physician. 2016;8(1):1770.
207. Ardalan A, Kandi Keleh M, Saberinia A, Khorasani-Zavareh D, Khankeh H, Miadfar J, et al. 2015 estimation of hospitals safety from disasters in IR Iran: the results from the assessment of 421 hospitals. PloS one. 2016;11(9):e0161542.
208. Tabatabaei SAN, Abbasi S. Risk assessment in social security hospitals of Isfahan Province in case of disasters based on the hospital safety index. International Journal of Health System and Disaster Management. 2016;4(3):82.
209. Moghadam MN, Moradi SM, Amiresmaili M. Examining non-structural retrofitting status of teaching hospitals in Kerman against disasters. Electronic Physician. 2017;9(5):4434.
210. Monfared YK, Jamaly Z, Keykale MS, Asgary J, Khoshghadam M, Farzam S, et al. How is training hospitals of Qazvin preparedness against disaster in 2015? Annals of Tropical Medicine and Public Health. 2017;10(5).
211. Haryanto Y, Sudibyo GH, Effendi FCA. Preliminary seismic hazard assessment of the oral and dental hospital of Jenderal Soedirman University Indonesia. Procedia engineering. 2017;171:1025-34.
212. Gargaro D, Rainieri C, Fabbrocino G. Structural and seismic monitoring of the “Cardarelli” Hospital in Campobasso. Procedia engineering. 2017;199:936-41.
213. Santa-Cruz S, Palomino J, Liguori N, Vona M, Tamayo R, editors. Seismic risk assessment of hospitals in Lima City using GIS tools. Computational Science and Its Applications–ICCSA 2017: 17th International Conference, Trieste, Italy, July 3-6, 2017, Proceedings, Part III 17; 2017: Springer.
214. Nenković-Riznić M, Brankov BD, Peirović SM, Pucar M. Safe healthcare facilities-Their place and role in resilient cities. Thermal Science. 2018;22.
215. Morán-Rodríguez S, Novelo-Casanova DA. A methodology to estimate seismic vulnerability of health facilities. Case study: Mexico City, Mexico. Natural hazards. 2018;90:1349-75.
216. Cruz-Vega F, Elizondo-Argueta S, Sánchez-Echeverría JC, Loría-Castellanos J. Hospitals of the Mexican Institute of Social Security in the Face of September 2017 earthquakes. Analysis from the perspective of the safe hospital program. Gac Med Mex. 2018;154:575-81.
217. Lapčević Z, Mandić-Rajčević S, Lepić M, Jovanović M. Evaluating a primary healthcare centre's preparedness for disasters using the hospital safety index: lessons learned from the 2014 floods in Obrenovac, Serbia. International journal of disaster risk reduction. 2019;34:436-42.
218. Aslani AM, Habibi E. Evaluation of the risk of fire by the FRAME method and survey of the effect of crisis management team, on the level of fire risk at a university hospital during year 2017. Health Scope. 2019;7(4).
219. Guha-Sapir D, Hoyois P. Trends and Patterns in Disasters and Their Impact in the Asia-Pacific Countries of the Asian Development Bank. 2014.
220. Ostrom LT, Wilhelmsen CA. Risk assessment: tools, techniques, and their applications: John Wiley & Sons; 2019.
221. Panko J, Hitchcock K, Fung M, Spencer P, Kingsbury T, Mason A. A comparative evaluation of five hazard screening tools. Integrated Environmental Assessment and Management. 2017;13(1):139-54.
222. Organization WH. Hospital safety index: Guide for evaluators: World Health Organization; 2015.
223. Lam JC, Heitzler M, Hackl J, Adey BT, Hurni L. Modelling the functional capacity losses of networks exposed to hazards. Sustainable and Resilient Infrastructure. 2020;5(1-2):30-48.
224. Fuchs S, Kuhlicke C, Meyer V. Editorial for the special issue: vulnerability to natural hazards—the challenge of integration. Natural Hazards. 2011;58:609-19.

225. Du F, Okazaki K. Building improvement responses to multi-hazard risk in the historic Dali Dong Village, Guizhou, China. International Journal of Disaster Risk Reduction. 2016;19:64-74.
226. Mao X, Loke AY, Hu X. Developing a tool for measuring the disaster resilience of healthcare rescuers: a modified Delphi study. Scandinavian journal of trauma, resuscitation and emergency medicine. 2020;28:1-12.
227. Parand A, Dopson S, Renz A, Vincent C. The role of hospital managers in quality and patient safety: a systematic review. BMJ open. 2014;4(9):e005055.
228. Veenema TG, Losinski SL, Hilmi LM. Increasing Emergency Preparedness. Am. 2016;116(1):49-53.
229. Al-Dahash H, Kulatunga U, Thayaparan M. Weaknesses during the disaster response management resulting from war operations and terrorism in Iraq. International journal of disaster risk reduction. 2019;34:295-304.
230. Adini B, Goldberg A, Laor D, Cohen R, Zadok R, Bar-Dayan Y. Assessing Levels of Hospital Emergency Preparedness. Prehospital and Disaster Medicine. 2012;21(6):451-7.
231. Kearns RD, Myers B, Cairns CB, Rich PB, Hultman CS, Charles AG, et al. Hospital bioterrorism planning and burn surge. Biosecur Bioterror. 2014;12(1):20-8.
232. Evans CA, Baumberger-Henry M, Martin SJ. Fire! Facilitating long-term care emergency preparedness. Nursing Management. 2018;49(12):47-50.
233. Lam RPK, Balsari S, Hung KKC, Hsiao K-H, Leung LP, Leaning J. How Do Doctors and Nurses in Emergency Departments in Hong Kong View Their Disaster Preparedness? A Cross-Sectional Territory-Wide Online Survey. Disaster medicine and public health preparedness. 2018;12(3):329-36.
234. Daugherty EL, Carlson AL, Perl TM. Planning for the inevitable: preparing for epidemic and pandemic respiratory illness in the shadow of H1N1 influenza. Clin Infect Dis. 2010;50(8):1145-54.
235. Der-Martirosian C, Radcliff TA, Gable AR, Riopelle D, Hagigi FA, Brewster P, et al. Assessing Hospital Disaster Readiness Over Time at the US Department of Veterans Affairs. Prehospital & Disaster Medicine. 2017;32(1):46-57.
236. Yoon PW, Ising AI, Gunn JE. Using Syndromic Surveillance for All-Hazards Public Health Surveillance: Successes, Challenges, and the Future. Public Health Rep. 2017;132(1_suppl):3s-6s.
237. Steven Ross J. Power plays Blackout response plans require regular attention. Modern healthcare (1976). 2019;49(31):25.
238. Sauer LM, Romig M, Andonian J, Flinn JB, Hynes N, Maloney R, et al. Application of the Incident Command System to the Hospital Biocontainment Unit Setting. Health Secur. 2019;17(1):27-34.
239. Joint Commission Resources I. Emergency management in health care: An all-hazards approach: Joint Commission Resources; 2012.
240. Fuchs S, Birkmann J, Glade T. Vulnerability assessment in natural hazard and risk analysis: current approaches and future challenges. Natural Hazards. 2012;64(3):1969-75.
241. Merriman P, Browitt C. Natural disasters: protecting vulnerable communities: proceedings of the conference held in London, 13-15 October 1993: Thomas Telford; 1993.
242. McLaughlin SB. Hazard vulnerability analysis: American Society for Healthcare Engineering of the American Hospital …; 2001.
243. Campbell P, Trockman SJ, Walker AR. Strengthening Hazard Vulnerability Analysis: Results Of Recent Research In Maine. Public Health Reports. 2011;126(2):290-3.
244. Fares S, Femino M, Sayah A, Weiner DL, Yim ES, Douthwright S. Health care system hazard vulnerability analysis: an assessment of all public hospitals in Abu Dhabi. Disasters. 2014;38.
245. Shalhoub AAB, Khan AA, Alaska YA. Evaluation of disaster preparedness for mass casualty incidents in private hospitals in Central Saudi Arabia. Saudi medical journal. 2017;38(3):302.

246. Al-Shareef AS, Alsulimani LK, Bojan HM, Masri TM, Grimes JO, Molloy MS, et al. Evaluation of Hospitals' Disaster Preparedness Plans in the Holy City of Makkah (Mecca): A Cross-Sectional Observation Study. Prehospital & Disaster Medicine. 2017;32(1):33-45.
247. Miller RK, Field CB, Mach KJ. Factors influencing adoption and rejection of fire hazard severity zone maps in California. International Journal of Disaster Risk Reduction. 2020:101686.
248. Kwatra S, Fox J, Allen C, Wilson J. Methods and systems for managing hazard risk based on location and incident data. Google Patents; 2020.
249. Schwab AK, Sandler D, Brower DJ. Hazard mitigation and preparedness: An introductory text for emergency management and planning professionals: CRC Press; 2016.
250. WHO. Making health facilities safe in emergencies and disasters. 2020.
251. Mañez M, Carmona M, Haro D, Hanger S. Risk perception. 2016.
252. Yang J. Environmental management in mega construction projects: Springer; 2017.
253. Zio E, Piccinelli R, Sansavini G, editors. An all-hazard approach for the vulnerability analysis of critical infrastructures. ESREL 2011; 2011.
254. Djalali A, Castren M, Khankeh H, Gryth D, Radestad M, Öhlen G, et al. Hospital Disaster Preparedness as Measured by Functional Capacity: a Comparison between Iran and Sweden. Prehospital and Disaster Medicine. 2013;28(5):454-61.
255. Alruwaili A, Islam MS, Usher K. Hospitals disaster preparedness and management in the Eastern Province of the Kingdom of Saudi Arabia: a cross-sectional study. Disaster medicine and public health preparedness. 2021:1-8.
256. Alsalem MM, Alghanim SA. An assessment of Saudi hospitals' disaster preparedness. European Journal of Environment and Public Health. 2021;5(2):em0071.
257. Jabnoun N, Chaker M. Comparing the quality of private and public hospitals. Managing Service Quality: An International Journal. 2003.
258. Irfan S, Ijaz A. Comparison of service quality between private and public hospitals: Empirical evidences from Pakistan. Journal of Quality and Technology Management. 2011;7(1):1-22.
259. Shmueli A, Savage E. Private and public patients in public hospitals in Australia. Health Policy. 2014;115(2-3):189-95.
260. Alazmy W, Samarkandi O, Williams B. The history of emergency medical services response to mass casualty incidents in disasters, Saudi Arabia. Journal of Emergency Medicine, Trauma and Acute Care. 2020;2020(1).
261. Shammah AA. Preparedness Assessment for Disaster Management Among Dhahran Al Janoub General Hospital Staff During Hazm Storm Support 1436/2015. International Journal of Community & Family Medicine. 2018;2018.
262. Gale NK, Heath G, Cameron E, Rashid S, Redwood S. Using the framework method for the analysis of qualitative data in multi-disciplinary health research. BMC medical research methodology. 2013;13(1):1-8.
263. Furber C. Framework analysis: a method for analysing qualitative data. African Journal of Midwifery and Women's health. 2010;4(2):97-100.
264. Ritchie J, Lewis J, Nicholls CM, Ormston R. Qualitative research practice: A guide for social science students and researchers: sage; 2013.
265. Murtagh J, Dixey R, Rudolf M. A qualitative investigation into the levers and barriers to weight loss in children: opinions of obese children. Archives of disease in childhood. 2006;91(11):920-3.
266. Sheard L, Marsh C, O'Hara J, Armitage G, Wright J, Lawton R. The Patient Feedback Response Framework – Understanding why UK hospital staff find it difficult to make improvements based on patient feedback: A qualitative study. Social Science & Medicine. 2017;178:19-27.
267. Srivastava A, Thomson S. Framework Analysis: A Qualitative Methodology for Applied Policy Research. JOAAG. 2008;4.
268. Kiernan MD, Hill M. Framework analysis: a whole paradigm approach. Qualitative Research Journal. 2018;18(3):248-61.

269. Patton MQ. Enhancing the quality and credibility of qualitative analysis. Health Serv Res. 1999;34(5 Pt 2):1189-208.
270. Morse JM. Qualitative Health Research: Challenges for the 21st Century. Qual Health Res. 2002;12(1):116-29.
271. Denzin NK, Lincoln YS. The Sage handbook of qualitative research: sage; 2011.
272. Kaji AH, Lewis RJ. Hospital disaster preparedness in Los Angeles County. Acad Emerg Med. 2006;13(11):1198-203.
273. Skryabina E, Reedy G, Amlot R, Jaye P, Riley P. What is the value of health emergency preparedness exercises? A scoping review study. International journal of disaster risk reduction. 2017;21:274-83.
274. Higgins W, Wainright III C, Lu N, Carrico R. Assessing hospital preparedness using an instrument based on the Mass Casualty Disaster Plan Checklist: results of a statewide survey. American journal of infection control. 2004;32(6):327-32.
275. Bajow NA, Alkhalil SM. Evaluation and analysis of hospital disaster preparedness in Jeddah. Health. 2014;6(19):2668.
276. Li X, Huang J, Zhang H. An analysis of hospital preparedness capacity for public health emergency in four regions of China: Beijing, Shandong, Guangxi, and Hainan. BMC Public Health. 2008;8:319.
277. Hennink M, Kaiser BN. Sample sizes for saturation in qualitative research: A systematic review of empirical tests. Social Science & Medicine. 2021:114523.
278. Morse JM. The significance of saturation. Sage publications Sage CA: Thousand Oaks, CA; 1995. p. 147-9.
279. Sandelowski M. Sample size in qualitative research. Research in nursing & health. 1995;18(2):179-83.
280. Heidaranlu E, Ebadi A, Khankeh HR, Ardalan A. Hospital disaster preparedness tools: a systematic review. PLoS currents. 2015;7.
281. Alshehri A. The Hospital's Role Within a Regional Disaster Response: A Comparison Study of an Urban Hospital Versus a Rural Hospital: Rochester Institute of Technology; 2012.
282. Abe Y, Zodrow I, Johnson DA, Silerio L. Risk informed and resilient development: Engaging the private sector in the era of the Sendai Framework. Progress in Disaster Science. 2019;2:100020.
283. Wuthisuthimethawee P, Tin D. Disaster Response in Asia. Ciottone's Disaster Medicine: Elsevier; 2024. p. 98-101.
284. Al-Shareef AS, Alsulimani LK, Bojan HM, Masri TM, Grimes JO, Molloy MS, et al. Evaluation of hospitals’ disaster preparedness plans in the Holy City of Makkah (Mecca): a cross-sectional observation study. Prehospital and disaster medicine. 2017;32(1):33-45.
285. AlQahtany AM, Abubakar IR. Public perception and attitudes to disaster risks in a coastal metropolis of Saudi Arabia. International journal of disaster risk reduction. 2020;44:101422.
286. Sunindijo RY, Lestari F, Wijaya O. Hospital safety index: assessing the readiness and resiliency of hospitals in Indonesia. Facilities. 2020;38(1/2):39-51.
287. Cole R. Analysis of County Hazard Vulnerability Assessments for Flood Risk in Illinois: University of Illinois at Chicago; 2014.
288. Fifolt M, Burrowes J, McPherson T, McCormick LC. Strengthening emergency preparedness in higher education through hazard vulnerability analysis. College and University. 2016;91(4):61.
289. Chang JC. Hazard Vulnerability Analysis. Ciottone's Disaster Medicine: Elsevier; 2024. p. 147-56.
290. Dester W, Blockley D. Hazard engineering. Structural safety. 1994;16(1-2):3-12.
291. Kaundinya I, Nisancioglu S, Kammerer H, Oliva R. All-hazard guide for transport infrastructure. Transportation research procedia. 2016;14:1325-34.
292. Waugh Jr WL, Streib G. Collaboration and leadership for effective emergency management. Public administration review. 2006;66:131-40.
293. De Lorenzo RA. Financing hospital disaster preparedness. Prehosp Disaster Med. 2007;22(5):436-9.

294. Ledraa TA, Al-Ghamdi AM. Planning and management issues and challenges of flash flooding disasters in Saudi Arabia: The case of Riyadh City. J Archit Plan. 2020;32:155-71.
295. Karmokar S, Mohin MM, Islam MK, Alam MR, Rahman MM. Quantitative vulnerability assessment: an approach to reduce biases in disaster vulnerability assessment. Current World Environment. 2019;14(3):383.
296. Al-Wathinani AM, Alghadeer SM, AlRuthia YS, Mobrad A, Alhallaf MA, Alghamdi AA, et al. The characteristics and distribution of emergency medical services in Saudi Arabia. Annals of Saudi medicine. 2023;43(2):63-9.
297. Al Aseeri MRM. Perceived challenges of working environment among emergency department nurses in Saudi Arabia. J Biol Agric Healthc. 2020;10:25-31.
298. Sultan MAS, Løwe Sørensen J, Carlström E, Mortelmans L, Khorram-Manesh A. Emergency Healthcare Providers' Perceptions of Preparedness and Willingness to Work during Disasters and Public Health Emergencies. Healthcare. 2020;8(4):442.
299. Alakeely M, Almutari A, Masud N, Altulaihi B. Preparedness of Primary Health Care Leaders During COVID-19 Outbreak, Riyadh, Saudi Arabia: A Qualitative Study. Risk Management and Healthcare Policy. 2021;14:4339.
300. Mansour A, Alharbi S, Almutiri E, Almutiri M, Almutairi A, Alharbi A. Knowledge, attitudes, and willingness of medical students to volunteer in a disaster at Unaizah College of Medicine, Qassim University, Saudi Arabia. Int J Med Dev Ctries. 2020;4(8):1198-207.
301. Group OB. Saudi Arabia moving ahead with local and regional rail integration. Oxford Business Group

2022.
302. Balay-odao EM, Alquwez N, Inocian EP, Alotaibi RS. Hospital Preparedness, Resilience, and Psychological Burden Among Clinical Nurses in Addressing the COVID-19 Crisis in Riyadh, Saudi Arabia. Frontiers in Public Health. 2021;8.
303. Qureshi MN, AlRajhi A. Challenge of COVID-19 crisis managed by emergency department of a big tertiary centre in Saudi Arabia. International Journal of Pediatrics and Adolescent Medicine. 2020;7(3):147-52.

CHAPTER EIGHT: APPENDICES

Appendix A: Ethical approvals

Appendix 2.1 Ethical approvals from UoN

University of Nottingham
UK | CHINA | MALAYSIA

Faculty of Medicine & Health Sciences
Research Ethics Committee
Faculty Hub
Room E41, Medical School
Queen's Medical Centre Campus
Nottingham University Hospitals
Nottingham, NG7 2UH
Email: FMHS-ResearchEthics@nottingham.ac.uk

31 March 2019

Ms Roaa Hajjam
PhD in Epidemiology & Public Health
Senior Public health specialist
Division of Epidemiology and Public Health
School of Medicine, University of Nottingham
Room B126, New Clinical Sciences Building
City Hospital campus, Hucknall Road
Nottingham
NG5 1PB

Dear Ms Hajjam

Ethics Reference No: 291-1903 – **please always quote** **KSA Central IRB -MoH ref no: 2019-0024E dated 25/3/2019** **Princess Nourah Bint Abdulrahman University IRB Log no: 19-0072 27/3/2019**	
Study Title: All-hazard emergency preparedness: An assessment of the Hazard vulnerability and response capacity of secondary and tertiary Hospitals in Riyadh Region, Saudi Arabia.	
Chief Investigator/Supervisor: Dr Ravati Phalkey, Assistant Professor in Public Health, Division of Public Health & Epidemiology, School of Medicine	
Lead Investigators/student: Ms Roaa Hajjam, PhD Epidemiology & Public Health	
Other Key Investigators: Dr Frank Coffey, Consultant in Emergency Medicine, Nottingham University Hospitals NHS Trust, Magdalena Opazo Breton, Research Fellow, Statistics, Epidemiology & Public Health, School of Medicine	
Proposed Start Date: 01/04/2019	**Proposed End Date:** 01/03/2020

Thank you for submitting the above application and the following documents were received:

- FMHS REC Application form and supporting documents version 1.0: 05.03.2019
- 6x Letters of approval from KSA Ministry of Health and public and private specialised health care facilities dated 25.03.2019 and 26.5.2019.

These have been reviewed and are satisfactory and the study has been given a favourable opinion.

A favourable opinion has been given on the understanding that:

1. All appropriate ethical and regulatory permissions are respected and followed in accordance with all local laws of the country in which the study is being conducted and those required by the host organisation/s involved.
2. The protocol agreed is followed and the Committee is informed of any changes using a notice of amendment form (please request a form).
3. The Chair is informed of any serious or unexpected event.
4. An End of Project Progress Report is completed and returned when the study has finished (Please request a form).

Yours sincerely

Professor Ravi Mahajan
Chair, Faculty of Medicine & Health Sciences Research Ethics Committee

Appendix 2.2 Ethical approvals from Saudi Arabia for field visit and data collection

Kingdom of Saudi Arabia Ministry of Health King Fahad Medical City (162)	المملكة العربية السعودية وزارة الصحة مدينة الملك فهد الطبية (١٦٢)

وزارة الصحة
مدينة الملك فهد الطبية
King Fahad Medical City

IRB Registration Number with KACST, KSA: H-01-R-012
IRB Registration Number with OHRP/NIH, USA: IRB00010471
Approval Number Federal Wide Assurance NIH, USA: FWA00018774

May 9, 2019
IRB Log Number: 19-261E
Department: External - University of Nottingham
Category of Approval: EXEMPT

Dear Roaa Hajjam and Dr. Revati Phalkey,

I am pleased to inform you that your submission dated May 8, 2019 for the study titled '**All-hazard emergency preparedness: An assessment of the hazard vulnerability and response capacity of secondary and tertiary hospitals in Riyadh Region, Saudi Arabia**' was reviewed and was approved according to Good Clinical Practice guidelines. Please note that this approval is from the research ethics perspective only. You will still need to get permission from the head of department or unit in KFMC or an external institution to commence data collection.

We wish you well as you proceed with the study and request you to keep the IRB informed of the progress on a regular basis, using the IRB log number shown above.

Please be advised that regulations require that you submit a progress report on your research every 6 months. You are also required to submit any manuscript resulting from this research for approval by IRB before submission to journals for publication.

As a researcher you are required to have current and valid certification on protection human research subjects that can be obtained by taking a short online course at the US NIH site or the Saudi NCBE site followed by a multiple choice test. Please submit your current and valid certificate for our records. Failure to submit this certificate shall a reason for suspension of your research project.

If you have any further questions feel free to contact me.

Sincerely yours,

Institutional Review Board
Approved
Date: 09 MAY 2019

Prof. Omar H. Kasule
Chairman, Institutional Review Board (IRB)
King Fahad Medical City, Riyadh, KSA
Tel: + 966 1 288 9999 Ext. 26913
E-mail: okasule@kfmc.med.sa

مستشفى الملك خالد التخصصي للعيون
King Khaled Eye Specialist Hospital

MEMORANDUM
25 June 2019

To: Roaa Hajjam, MD, Principal Investigator
Location: University of Nottingham
School of medicine
Division of Epidemiology and Public health

From: Hassan Al-Dhibi, MD, IRB Chair
Location: Research Department

25.6.2019

Subject: **RP 1939-P ALL-HAZARD EMERGENCY PREPAREDNESS: AN ASSESSMENT OF THE HAZARD VULNERABILITY AND RESPONSE CAPACITY OF SECONDARY AND TERTIARY HOSPITALS IN RIYADH REGION, SAUDI ARABIA**

Reference: RD/26001/7099-19

This is to advise you that the above-mentioned prospective project was reviewed by the IRB Chair through the expedited review pathway and it was his decision to grant **approval**.

Please note that the approval is ***valid for 1 year*** and will expire ***24th of June 2020***. Once a progress report has been submitted, the approval will be renewed.

If you wish to make any changes to the approved submission you will need to submit an amendment for IRB review before any implementation.

Please contact Mr. Abdulrahman Al-Hommadi, Clinical Research Manager, to assist you with starting your project.

cc: Mr.Revati Phalkey, Co-Investigator
Mohammed AlAmry, MD, Co-Investigator
Abdulrahman AlHommadi, Clinical Research Manager
RP 1939-P File Copy

د. سليمان الحبيب
DR SULAIMAN AL HABIB

NCBE (H-01-R-082)

Al Habib Research Center

IRB Approval Form

Study Number: RC19.06.44
Study Title: All-hazard emergency preparedness: An assessment of the Hazard vulnerability and response capacity of secondary and tertiary Hospitals in Riyadh Region, Saudi Arabia

IRB Approval Date: 19 June 2019

IRB Review Type:	□ Exempt Review	■ Expedited Review	□ Full-Board
Type of the Study:	□Retrospective	■ Prospective	□Observational
Consent Form:	■Require	□ Do Not Require	

Dear Mrs. Roaa Hajjam,

This is to clarify that IRB committee has reviewed and **APPROVED** the study titled above.

The approval of the research study is valid **for one year** from the above approval date.

On behalf of the committee, best of luck as you move forward with your research.

Terms of approval:

- Approval is only valid while you hold a position at HMG.
- No changes may be made in the procedures nor any study materials until such modifications have been submitted to the IRB for review and have been given approval.
- The principal investigator is responsible for the storage and retention of original data relating to a project for a period of three years.
- After completion of the study, a final report must be send to the IRB.
- Any amendments to the approved protocol or any element of the submitted documents should **NOT** be undertaken without prior re-submission to, and approval of the IRB for prior approval.
- The PI and Investigators are expected to submit a final report at the end of the study.
- The PI and Investigators must provide to IRB a conclusion abstract and the manuscript before publication.

Dr. Abbas Al Mutair
Head of the IRB

Dr. Awad Al Omari
Associate VP – Academic Affairs

Kingdom of Saudi Arabia

Ministry of National Guard - Health Affairs

المملكة العربية السعودية

وزارة الحرس الوطني - الشؤون الصحية

King Abdullah International Medical Research Center (KAIMRC)

(84) 94456 1515 94466 irb@ngha.med.sa

IRB NCBE Registration No.: **H-01-R-005**

IRB Office

Memo Ref.No. IRBC/1421/19 E-CTS Ref. No. RYD-19-419812-96712

Study Number: **RC19/207/R**

Study Title: **All-hazard emergency preparedness: An assessment of the Hazard vulnerability and response capacity of secondary and tertiary Hospitals in Riyadh Region, Saudi Arabia**

Study Sponsor: **Non Grant**

IRB Approval Date: **22 August 2019**

IRB Review Type: ■ **Expedited Review** ☐ **Full Board**

Study site(s): **Central Region**

Dear **Dr. Sami Yousif**

Head of Disaster Management/Consultant – Emergency Medicine, KAMC

Ministry of National Guard – Health Affairs

Sub-investigators: Roaa Mohammed Hajjam, and Revati Phalkey

After reviewing your submitted research proposal/protocol and related documents, the IRB has APPROVED the submission.

The approval includes the following related documents:

Document/Title	Version	Date
Research Proposal	01	22 August 2019
Data Collection Form	01	22 August 2019
Informed Consent Form	01	22 August 2019

The approval of the research study is valid for **one year** from the above approval to expiration date.

Terms of Approval:

- **Annual Reports:** An Annual report must be submitted for approval to avoid termination/suspension of your research.
- **Financial report:** If your study is funded project, details financial report should be submitted with the scientific report.
- **Final Report:** After completion of the study, a final report must be forwarded to the IRB.
- **Retention of original data:** The PI is responsible for the storage and retention of original data pertaining to the project for a minimum of five years.
- **Reporting of adverse events or unanticipated problems:** The PI is responsible to report any serious or unexpected adverse events or unanticipated problems, which could involve a risk to participants or others.
- **Biological samples:** No biological samples to be shipped out of the Kingdom of Saudi Arabia without prior IRB approval.
- **Participant incentives:** No financial compensation or gifts to be given to participants without prior IRB approval.
- **Storage of biological samples:** All biological samples collected for the purpose of this research must be stored in the KAIMRC related repository.

2 8 AUG 2019

Dr. Abdallah Adlan

Chairman, Institutional Review Board (IRB)

Head, Biomedical Ethics Section - KAIMRC

Ministry of National Guard - Health Affairs

AA/GA/FAS

P.O. Box 22490, Riyadh 11426

Tel. 8011111

Telex : 403450 NGRMED SJ

KFH - MATERIALS 14574 (.05/96) (ORACLE 29795)

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ص.ب ٢٢٤٩٠ الرياض ١١٤٢٦

تلفون ٨٠١١١١١

تلكس ٤٠٣٤٥٠

Kingdom of Saudi Arabia
King Saud University (034)
P.O. Box 7805 Riyadh 11472
Tel: +966 11 467 00 11
Fax: +966 11 467 19 92
http://medicalcity.ksu.edu.sa

المملكة العربية السعودية
جامعة الملك سعود (٣٤)
ص.ب ٧٨٠٥ الرياض ١١٤٧٢
هاتف +٩٦٦١١٤٦٧٠٠١١
فاكس +٩٦٦١١٤٦٧١٩٩٢

جامعة الملك سعود
King Saud University
المدينة الطبية الجامعية

14.04.2019 (09.08.1440)
Ref. No. 19/0481/RB

To:	**Ms. Roaa Mohammed Hajjam** Department of Epidemiology and public health King Saud University College of Medicine King Saud University Medical City Principal Investigator
Cc:	Dr. Revati Phalkey Co-Investigator
Subject:	**<u>Approval of Research Project No. E-19-3820</u>**
Study Title:	"All-hazard emergency preparedness: An assessment of the Hazard vulnerability and response capacity of secondary and tertiary Hospitals in Riyadh Region, Saudi Arabia"
Type of Review:	Expedite
Date of Approval:	14 April 2019
Date of Expiry:	14 April 2020

Dear Ms. Roaa Mohammed Hajjam,

I am pleased to inform you that your above-mentioned research project submitted to the IRB was reviewed and approved on 14 April 2019 (09 Shabaan 1440). You are now granted permission to conduct this study given that your study does not disclose participant's identity and poses no risk to the patients.

As principal investigator, you are required to abide by the rules and regulations of the Kingdom of Saudi Arabia and the research policies and procedures of the KSU IRB. If you make any changes to the protocol during the period of this approval, you must submit a revised protocol to the IRB for approval prior to implementing the changes. Please quote the project number shown above in any future correspondence or follow-ups related to this study.

This approval is for a period of one (1) year commencing from the date of this letter. If you wish to have your protocol approved for continuation, please submit a completed request for reapproval of an approved protocol form (KSU-IRB 017E) at least 30 days before the expiry date. Failure to receive approval for continuation before the expiration date will result in automatic suspension of the approval of this protocol on the expiration date. Information collected following suspension is unapproved research and can never be reported or published as research data.

We wish you success in your research and request you to keep the IRB informed about the progress and final outcome of the study in a regular basis. If you have any question, please feel free to contact me.

Thank you!

Sincerely yours,

Dr. Abdulrahman Alsultan
Chairman of IRB
Health Sciences Colleges Research on Human Subjects
King Saud University College of Medicine
P. O. B ox 7805 Riyadh 11472 K.S.A.
Email: aalsultan1@ksu.edu.sa

بسم الله الرحمن الرحيم

KINGDOM OF SAUDI ARABIA
MINISTRY OF INTERIOR
General Administration For Medical Services
SECURITY FORCES HOSPITAL PROGRAM

المملكة العربية السعودية
وزارة الداخلية
الإدارة العامة للخدمات الطبية
برنامج مستشفى قوى الأمن

Research Number in Security Forces Hospital Program: 19-320-18
IRB Registration Number with KACST, KSA: H-01-R-069
Date: 8 May 2019

Ms. Roaa Mohammed Hajjam
Epidemiology and Public Health Department
Medicine College, Nottingham University in UK

Co-investigators:
Revati Phalkey

Dear Ms. Hajjam,

The research committee in Security Forces Hospital is constituted and functions in accordance with the National Committee of Bio Ethics (NCBE) in Saudi Arabia, Accreditation number (H-01-R-069). The Committee has reviewed the research proposal for compliance with national requirements and the approval of this research is conditional upon your continuing compliance with this document.

I am pleased to confirm a favorable ethical opinion for the above research on the basis described in the documents submitted with your proposal titled "*All-hazard Emergency Preparedness: An Assessment of the Hazard Vulnerability and Response Capacity of Secondary and Tertiary Hospitals in Riyadh Region, Saudi Arabia*", without funding guaranteed.

As evidence of continuing compliance with each research approved by the committee, the primary researcher is responsible to send documents to the research committee in Security Forces Hospital about his ongoing research every six months and on the time of publication.

For more information please do not hesitate to contact me.

Best regards,

Dr. Marzooq Abdullah Albadi
Chairman, Institutional Review Board (IRB)
Chairman, Research Committee
Security Forces Hospital Program, Riyadh, KSA
Tel: 00966118024425

Academic Affairs/ Rania

Kingdom of Saudi Arabia
Ministry of Education
Princess Nourah Bint Abdulrahman University
(048)

المملكة العربية السعودية
وزارة التعليم
جامعة الأميرة نورة بنت عبدالرحمن
(٠٤٨)

Institutional Review Board

مجلس المراجعة المؤسسي

IRB Registration Number with KACST, KSA: H-01-R-059

February 27, 2019
IRB Log Number: 19-0072
Project Title: All-hazard emergency preparedness: An assessment of the hazard vulnerability and response capacity of secondary and tertiary hospitals in Riyadh Region, Saudi Arabia
Category of Approval: EXEMPT

Dear Roaa Hajjam and Revati Phalkey,

Thank you for submitting your proposal to the PNU Institutional Review Board. Your proposal was evaluated considering the national regulations that govern the protection of human subjects. The IRB has determined that your proposed project poses no more than minimal risk to the participants. Therefore, your proposal has been deemed ***EXEMPT*** from IRB review. Please note that this approval is from the research ethics perspective only. You will still need to get permission from the head of the department in PNU or an external institution to commence data collection.

Please note that the research must be conducted according to the proposal submitted to the PNU IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For ***any*** proposed changes in your research protocol, please submit a Request for Modification form to the PNU IRB. Please be aware that changes to the research protocol may prevent the research from qualifying for exempt review and require submission of a new IRB application or other materials to the PNU IRB. In addition, if an unexpected situation or adverse event happens during your investigation, please notify the PNU IRB as soon as possible. If notified, we will ask for a complete explanation of the event and your response.

Please be advised that regulations require that you submit a progress report on your research every 6 months. Please refer to the protocol number denoted above in all communication or correspondence related to your application and this approval. You are also required to submit any manuscript resulting from this research for approval by IRB before submission to journals for publication.

We wish you well as you proceed with the study. Should you have additional questions or require clarification of the contents of this letter, please contact me.

Sincerely Yours,

Ebtisam AlMadi

جامعة الأميرة نورة بنت عبدالرحمن
مجلس المراجعة المؤسسي
Institutional Review
Board (IRB)
27 FEB 2019

Dr. Ebtisam AlMadi
Chairman, Institutional Review Board (IRB)
Princess Nourah bin Abdulrahman University, Riyadh, KSA
Tel: + 966 11 824 0861
E-mail: irb@pnu.edu.sa

الرقم:	التاريخ : / / 143هـ

Appendix 2.3 Participants Consent Form

University of Nottingham
UK | CHINA | MALAYSIA

Faculty of Medicine & Health Sciences
School of Medicine
126 Room B Floor, Clinical science Building
Division of Epidemiology and Public Health
City Hospital Campus
Hucknall Road
Nottingham
NG5 1PB

Participants Consent Form
Final version 1.0: 07.10.2018

Title of Study:

All-hazard emergency preparedness: An assessment of the Hazard vulnerability and response capacity of secondary and tertiary Hospitals in Riyadh Region, Saudi Arabia

REC ref: 291-1903

Name of Researchers:
Roaa Hajjam, PhD Candidate Lead investigator
Supervisor: Dr.Revati Phalkey, Assistance professor
Supervisor: Dr. Frank Coffey, Associate professor
Name of Participant: **Please initial box**

1. I confirm that I have read and understand the information sheet for the above study which is attached and have had the opportunity to ask questions. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without any negative consequences. ☐
3. I understand that relevant sections of my data collected in the study may be looked at by the research group and by other responsible individuals for monitoring and audit purposes. I give permission for these individuals to have access to these records and to collect, store, analyse and publish information obtained from my participation in this study. I understand that my personal details will be kept confidential. ☐
4. I understand that the "interview/Focus Group/seminar session etc" (*delete/revise as appropriate) will be audio recorded using a digital device and that anonymous direct quotes from the interview may be used in the study reports. ☐
5. I understand that information about me recorded during the study will be made anonymous before it is stored. It will be uploaded into a secure database on a computer kept in a secure place. Data will be kept for 7 years after the study has ended and then destroyed. ☐
6. **Optional:** I agree that my anonymous research data will be stored and used to support other research in the future, and shared with other researchers including those working outside the University. ☐
7. I understand that what I say during the "interview/Focus Group/seminar session etc" (*delete/revise as appropriate) will be kept confidential unless I reveal something of concern that may put myself or someone else at any risk. It will then be necessary to report this to the appropriate persons. ☐
8. I agree to take part in the above study. ☐

____________________ ____________ __________________

2 copies: 1 for participant, 1 for the project notes.

University of Nottingham
UK | CHINA | MALAYSIA

Faculty of Medicine & Health Sciences
School of Medicine
126 Room B Floor, Clinical science Building
Division of Epidemiology and Public Health
City Hospital Campus
Hucknall Road
Nottingham
NG5 1PB

Name of Participant Date Signature

____________________ ____________ __________________
Name of Person taking consent Date Signature

Participants Information Sheets

University of Nottingham
UK | CHINA | MALAYSIA

Faculty of Medicine & Health Sciences
School of Medicine
126 Room B Floor, Clinical science Building
Division of Epidemiology and Public Health
City Hospital Campus
Hucknall Road
Nottingham
NG5 1PB

Dr.Revati Phalkey
Assistant Professor in Public Health
Address: Division of Epidemiology and Public Health
School of Medicine, The University of Nottingham
Room C111, New Clinical Sciences Building
City Hospital campus, Hucknall Road
Nottingham
NG5 1PB
Division of Epidemiology and Public Health
T: +44 (0) 115 82 31390
M: +44 (0) 7952930406
Email: revati.phalkey@nottingham.ac.uk

Roaa.M. Hajjam [PhD Candidate]
T: +44 (0) 115 8231364
M: +44 (0) 7384643605 |+966(0)591515337
Email: Roaahajjam@gmail.com | msxrh11@exmail.nottingham.ac.uk

All-hazard emergency preparedness: An assessment of the Hazard vulnerability and response capacity of secondary and tertiary Hospitals in Riyadh Region, Saudi Arabia

PARTICIPANT INFORMATION SHEET

Research Ethics Reference: [291-1903] Version 1.0   Date: 05/03/2019.

We would like to invite you to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. One of our team will go through the information sheet with you and answer any questions you have. Please take time to read this carefully and discuss it with others if you wish. Ask us anything that is not clear.

What is the purpose of the research?

The overall purpose of this study is to investigate all-hazard disaster preparedness and response capacity of hospitals across Riyadh region of the Kingdom of Saudi Arabia. Specifically, the study hopes to achieve the following:

1. analyse the Hazard vulnerability of secondary and tertiary health care facilities for multiple hazards in the Riyadh region, KSA.
2. Estimate the functional vulnerability, preparedness, and response capacity of secondary and tertiary health care facilities for multiple hazards.
3. Develop a comprehensive all-hazard assessment tool specific for secondary and tertiary health care facilities in KSA based on the International best emergency management practice.

Why have I been invited to take part?

You have been invited to take part in this research because of your role as the Manager of Emergency Services at the healthcare facility. Moreover, your institution has met the inclusion criteria set for this study, which include that eligible healthcare facilities must:

1. Be providing secondary or tertiary have a capacity of 100 beds or more with a functioning Emergency Care Department.
2. Operate under the control of the Ministry of Health, Universities, the Military or private firms.

We will be recruiting all the Directors of Emergency Services from all the eligible hospitals in all the 20 provinces which make up Riyadh region for this study.

Do I have to take part?

No. It is up to you to decide if you want to take part in this research. We will describe the study and go through this information sheet with you to answer any questions you may have. If you agree to participate, we will ask you to sign a consent form and will give you a copy to keep. However, you would still be free to withdraw from the study at any time, without giving a reason and without any negative consequences, by advising the researchers of this decision. This would not affect your legal rights.

What will happen to me if I take part?

A researcher will contact you to go over the information sheet, explain the study process, and go through the various phases of the project with you. If you agree to take part in the study, you will be asked to complete a structured questionnaire, make vital documents such as the emergency plan and Standard Operating Procedures.
If needed the total number of visits will not exceed three visits. Upon arrival for the first visit, we will talk you through the study process and give you a chance to ask any questions.

The study will involve three components, namely:

- Component 1 which contains the KP-HVA with some detailed questions about the general characteristics of the hospitals. Will be distributed electronically throughout the General Directorate of Ministry of health before administering the component two of the study.
- Component 2 will be the main Questionnaire that includes all the critical items of all-hazard preparedness factors of analysis.
- Component 3 is a Qualitative interview for the emergency department directors with 5+ years of experience in emergency management.

For component one, the healthcare facility who wish to participate in this study should fill the small online survey with KP-HVA excel form. The General Directorate of the ministry of health will send you the link attached with a copy of KP-HVA form to participate in the initial phase of the study; this phase should not exceed one month from the time of receiving to return the form.

For component 2, the researcher will visit the health facility to administer face to face survey completing the survey questionnaire will take between 60 to 90 minutes. If you are selected for the qualitative interview, you will require an additional 30 minutes to participate in the qualitative interview. you will be asked to do the interview only if you have working experience more than 5+ years in the field of emergency medicine and management.

If you are still happy to take part, then you will then be asked to sign a consent form.

Are there any risks in taking part?

There are no risks for participating in this study. You will not be exposed to any danger or harm, what is ever.

Are there any benefits in taking part?

There will be no direct benefit to you from taking part in this research, but your contribution may help in knowledge contribution to the emergency management field.

Will my time/travel costs be reimbursed?

Participants will not receive an inconvenience allowance from participating in the study. You will not need to travel to participate in this study. Therefore, no travel expenses will be offered for any visits incurred as a result of participation.

What happens to the data provided?

Data collected through this study will be entered into an Excel file in a password-protected computer at the University of Nottingham. Personal data (such as your age, gender, name, etc.) or any personal identifiers will be collected in this study.

The research data will be stored confidentially using the platform available at the University of Nottingham. To ensure privacy, you will be assigned a volunteer study identification number (for example, H=01 for participant number (1), and it will be used instead of your name.

Personal/sensitive data will be stored confidentially using password protected computers. The [researcher and the research team, supervisor, collaborator, the transcriber will have access to research data collected in this study.

If applicable: We would like your permission to use fully anonymised direct quotes in research publications.

All research data and records will be stored for a minimum of 3 years after publication or public release of the work of the research. We would like your permission to use anonymised data in future studies and to share our research data (e.g. in online databases) with other researchers in other Universities and organisations both inside and outside the European Union. Sharing research data is important to allow peer scrutiny, re-use (and therefore avoiding duplication of research) and to understand the bigger picture in particular areas of research. All personal information that could identify you will be removed or changed before the information is shared with other researchers or results are made public.

Data sharing in this way is usually anonymised (so that you could not be identified)

What will happen if I do not want to carry on with the study?

Even after you have signed the consent form, you are free to withdraw from the study at any time without giving any reason and without your legal rights being affected. Any personal data will be destroyed. However, data provided before withdrawal from the study will still be used for analysis in this study.

Who will know that I am taking part in this research?

All information collected about you during this research would be kept strictly confidential. Any imaging and electronic data will be anonymised with a code as detailed above. All such data are kept on password-protected databases sitting on a restricted access computer system and any paper information (such as your consent form, contact details and any research questionnaires) would be stored safely in lockable cabinets in a swipe-card secured building and would only be accessed by the research team.

Under UK Data Protection laws, the University is the Data Controller (legally responsible for the data security), and the Chief Investigator of this study (named above) is the Data Custodian (manages access to the data). This means we are responsible for looking after your information and using it properly. Your rights to access, change or move your information are limited as we need to manage your information in specific ways to comply with certain laws and for the research to be reliable and accurate. To safeguard your rights, we will use the minimum personally – identifiable information possible.

You can find out more about how we use your information and to read our privacy notice at: https://www.nottingham.ac.uk/utilities/privacy.aspx/

Designated individuals of the University of Nottingham may be given access to data for monitoring and/or audit of the study to ensure we are complying with guidelines.

With your consent, we will keep your personal information on a secure database in order to contact you for future studies.

What will happen to the results of the research?

The research will be written up as a thesis. On successful submission of the thesis, it will be deposited both in print and online in the University archives, to facilitate its use in future research. The thesis will be published open access. The research will be written up as dissertation for the degree of Doctor of philosophy in Epidemiology and Public health.

Who has reviewed this study?

All research involving people is looked at by an independent group of people, called a Research Ethics Committee, to protect your interests. This study has been reviewed and given favourable opinion by the Faculty of Medicine and Health Sciences Research Ethics Committee (Reference number: FMHS).

Who is organising and funding the research?

This study is funded by the PhD research scholarship awarded by the government of the Kingdom of Saudi Arabia to the researcher. Moreover, the University of Nottingham will also partially sponsor this study.

What if something goes wrong?

If you have a concern about any aspect of this project, please speak to the researcher [Roaa Hajjam] or the Principal Investigator [Dr Revati Phalkey], who will do their best to answer your query. The researcher should acknowledge your concern within ten working days and give you an indication of how he/she intends to deal with it. If you remain unhappy and wish to complain formally, you can do this by contacting the FMHS Research Ethics Committee Administrator, c/o The University of Nottingham, Faculty PVC Office, B Floor, Medical School, Queen's Medical

Centre Campus, Nottingham University Hospitals, Nottingham, NG7 2UH.

E-mail: FMHS-ResearchEthics@nottingham.ac.uk

Contact Details

If you would like to discuss the research with someone beforehand (or if you have questions afterwards), please contact:

Roaa. M. Hajjam

First Year PhD student, Division of Epidemiology and Public Health

T : +44 (0) 115 8231364, M : +44 (0) 7384643605 |+966(0)591515337

Email : Msxrh11@exmail.nottingham.ac.uk

Dr Revati Phalkey

Assistant Professor in Public Health, Division of Epidemiology and Public Health

T : +44 (0) 115 82 31390, M : +44 (0) 7952930406

Email : mszrkp@exmail.nottingham.ac.uk

Study Coordinating Centre:

The University of Nottingham

Mrs Louise Sabir

FMHS Research Ethics Committee Administrator

c/o Faculty PVC Office

B Floor, School of Medicine Administration,

Queen’s Medical Centre Campus

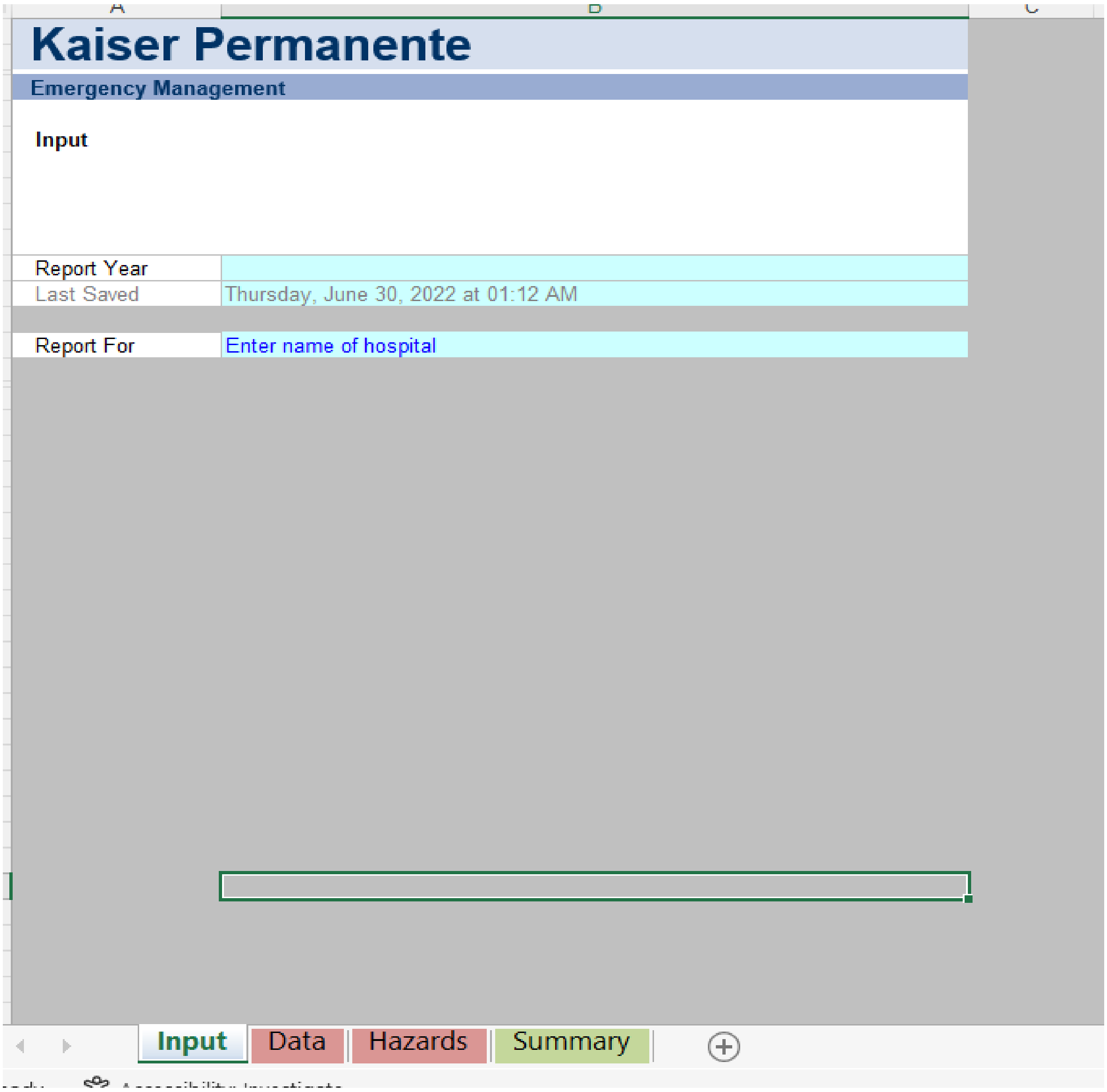
Nottingham University Hospitals

NG7 2UH

Email: FMHS-ResearchEthics@nottingham.ac.uk

Appendix B Data collection tools

Appendix 4.1 Hazard Vulnerability Analysis Tool 2017 Ver


Kaiser Permanente

Emergency Management

Input

Report Year	
Last Saved	Thursday, June 30, 2022 at 01:12 AM
Report For	Enter name of hospital

Input | Data | Hazards | Summary

Kaiser Permanente

Emergency Management

Data - Enter name of hospital

Date	Alert Category	Alert Type	Internal/ Externa	Responder	Location	Address	Notification Method	Point of Contac	Command Cente Activat	Patient Care Impac	Business/ Operati l Impa	Structu Impac	Resou Reque	Recovery Plan Activat	AAR	Top 5 H	End Da	Event Summary
	Natural	Water Contamination	Internal				In Person		Yes	Not Sure				Yes	Yes	Yes		

Kaiser Permanente

Emergency Management

Hazards - Enter name of hospital
Hazard and Vulnerability Assessment Tool
Naturally Occurring Events

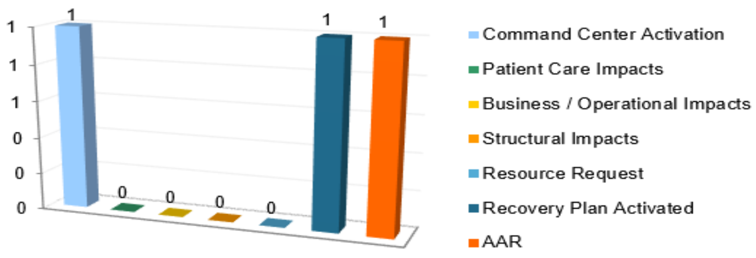
Event	PROBABILITY	ALERTS	ACTIVATIONS	SEVERITY = (MAGNITUDE - MITGATION) HUMAN IMPACT	PROPERTY IMPACT	BUSINESS IMPACT	PREPARED-NESS	INTERNAL RESPONSE	EXTERNAL RESPONSE	RISK
	Likelihood this will occur			Possibility of dealth or injury	Physical losses and damages	Interuption of services	Preplanning	Time, effectiveness, resources	Community/Mutual Aid staff and supplies	* Relative threat
SCORE	0 = N/A 1 = Low 2 = Moderate 3 = High	Number of Alerts	Number of Activations	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = High 2 = Moderate 3 = Low	0 = N/A 1 = High 2 = Moderate 3 = Low	0 = N/A 1 =High 2 = Moderate 3 = Low	0 - 100%
Active Shooter	3	6	0	3	3	3	2	1	1	59%
Acts of Intent	3	3	0	2	2	2	1	2	3	50%
Bomb Threat	3	1	0	2	2	2	1	2	2	41%
Building Move	3	1	0	2	2	2	2	2	2	44%
Chemical Exposure, External	3	2	0	1	1	1	1	1	1	24%
Civil Unrest	3	3	0	1	1	1	1	2	3	38%
Communication / TelephonyFailure	3	0	0	3	3	3	2	1	1	43%
Dam Failure	3	1	0	2	2	2	1	2	3	44%
Drought	3	2	0	2	2	2	1	2	2	44%
Earthquake	3	3	0	2	2	2	2	2	2	50%
Epidemic	3	4	0	1	1	1	1	1	1	26%
Evacuation	3	5	0	1	1	1	1	2	3	40%

Kaiser Permanente

Emergency Management

Summary For - Enter name of hospital

ALERT TYPE	OCCURRENCE
Command Center Activation	1
Patient Care Impacts	0
Business / Operational Impacts	0
Structural Impacts	0
Resource Request	0
Recovery Plan Activated	1
AAR	1
Total Alert	**1**



0

TOP 10 HVA	RANK	OCCURRENCE
Active Shooter	1	0
Acts of Intent	2	0
Earthquake	3	0
Building Move	4	0
Dam Failure	5	0
Drought	6	0
Communication / TelephonyFailure	7	0
Bomb Threat	8	0
Evacuation	9	0
Civil Unrest	10	0

0

TOP 10 ACTUAL ALERTS	OCCURRENCE	HVA RANK
Water Contamination	1	14

Appendix 4.2 Kaiser-HVA-Tool-and-Instruction

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Medical Center Hazard and Vulnerability Analysis

This document is a sample Hazard Vulnerability Analysis tool. It is not a substitute for a comprehensive emergency preparedness program. Individuals or organizations using this tool are solely responsible for any hazard assessment and compliance with applicable laws and regulations.

INSTRUCTIONS:

Evaluate potential for event and response among the following categories using the hazard specific scale. Assume each event incident occurs at the worst possible time (e.g. during peak patient loads).

Please note specific score criteria on each work sheet to ensure accurate recording.

Issues to consider for **probability** include, but are not limited to:

1 Known risk
2 Historical data
3 Manufacturer/vendor statistics

Issues to consider for **response** include, but are not limited to:

1 Time to marshal an on-scene response
2 Scope of response capability
3 Historical evaluation of response success

Issues to consider for **human impact** include, but are not limited to:

1 Potential for staff death or injury
2 Potential for patient death or injury

Issues to consider for **property impact** include, but are not limited to:

1 Cost to replace
2 Cost to set up temporary replacement
3 Cost to repair
4 Time to recover

Issues to consider for **business impact** include, but are not limited to:

1 Business interruption
2 Employees unable to report to work
3 Customers unable to reach facility
4 Company in violation of contractual agreements
5 Imposition of fines and penalties or legal costs
6 Interruption of critical supplies
7 Interruption of product distribution
8 Reputation and public image
9 Financial impact/burden

KAISER PERMANENTE

Medical Center Hazard and Vulnerability Analysis

Issues to consider for **preparedness** include, but are not limited to:

1 Status of current plans
2 Frequency of drills
3 Training status
4 Insurance
5 Availability of alternate sources for critical supplies/services

Issues to consider for **internal resources** include, but are not limited to:

1 Types of supplies on hand/will they meet need?
2 Volume of supplies on hand/will they meet need?
3 Staff availability
4 Coordination with MOB's
5 Availability of back-up systems
6 Internal resources ability to withstand disasters/survivability

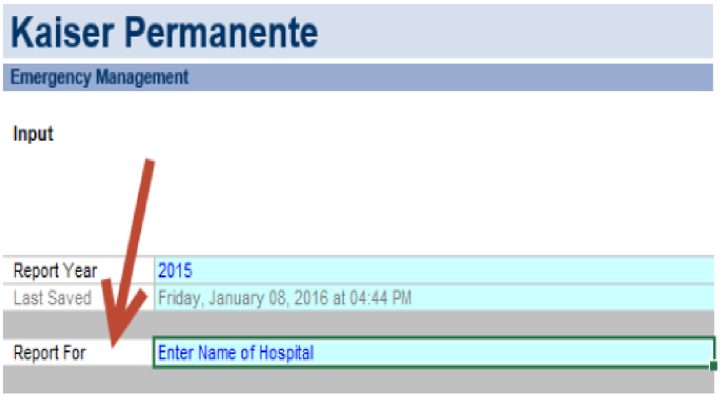
Issues to consider for **external resources** include, but are not limited to:

1 Types of agreements with community agencies/drills?
2 Coordination with local and state agencies
3 Coordination with proximal health care facilities
4 Coordination with treatment specific facilities
5 Community resources

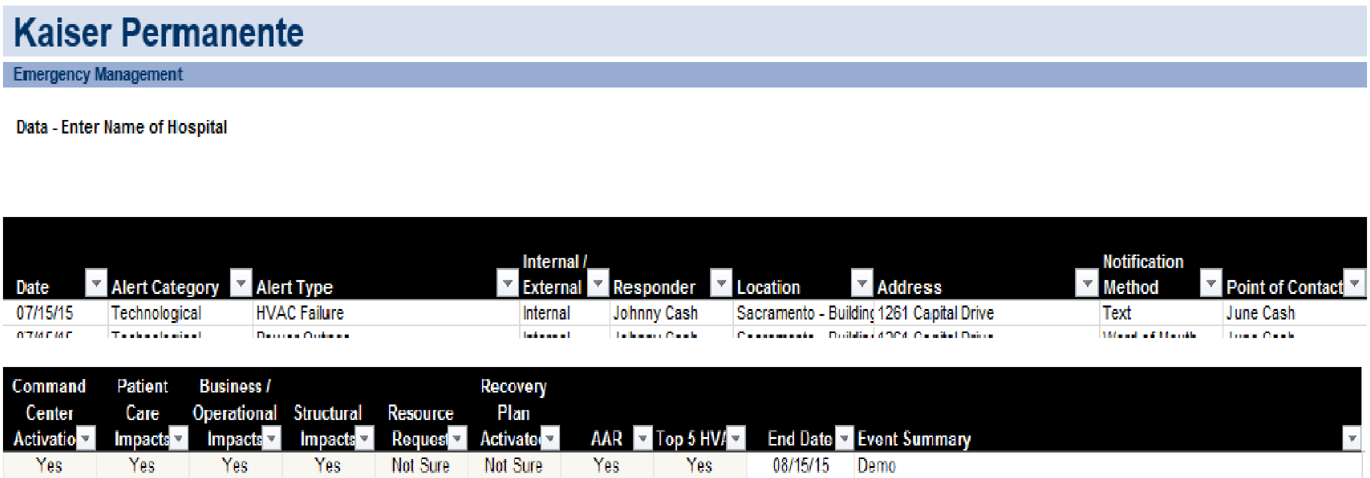
Complete all worksheets including Natural, Technological, Human and Hazmat.
The summary section will automatically provide your specific and overall relative threat.

Incident Log HVA Instructions

Input Tab – Under Report For, enter the name of the hospital or organization this tool will be used for and it will carry over to all other tabs



Data Tab – Use this tab to input data on all events you would like captured in your log (i.e., disaster, emergencies, and disruptions)


Kaiser Permanente

Emergency Management

Data - Enter Name of Hospital

Date	Alert Category	Alert Type	Internal / External	Responder	Location	Address	Notification Method	Point of Contact
07/15/15	Technological	HVAC Failure	Internal	Johnny Cash	Sacramento - Building	1261 Capital Drive	Text	June Cash

Command Center Activatio	Patient Care Impacts	Business / Operational Impacts	Structural Impacts	Resource Reques	Recovery Plan Activate	AAR	Top 5 HVA	End Date	Event Summary
Yes	Yes	Yes	Yes	Not Sure	Not Sure	Yes	Yes	08/15/15	Demo

KAISER PERMANENTE.

HVA Tab – Consistent with the traditional HVA, use the drop down options to populate information for Probability, Magnitude, and Mitigation. Alerts and Activations will automatically populate as a result of data inputted from the corresponding Incident Log. Subsequently, a score will be generated under Risk in the form of a percentage. The higher the score, the higher the priority.

*Note, risk score will only appear once the Probability, Magnitude, and Mitigation ratings have been completed.

Kaiser Permanente

Emergency Management

Harzards - Enter Name of Hospital
Harzard Vulnerability Assessment Tool
Emergenct Occurring Events

Event	PROBABILITY	ALERTS	ACTIVATIONS	SEVERITY = (MAGNITUDE - MITGATION)						RISK
				HUMAN IMPACT	PROPERTY IMPACT	BUSINESS IMPACT	PREPARED-NESS	INTERNAL RESPONSE	EXTERNAL RESPONSE	
	Likelihood this will occur			Possibility of death or injury	Physical losses and damages	Interuption of services	Preplanning	Time, effectiveness, resources	Community/Mutual Aid staff and supplies	* Relative threat
SCORE	0 = N/A 1 = Low 2 = Moderate 3 = High	Number of Alerts	Number of Activations	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = High 2 = Moderate 3 = Low	0 = N/A 1 = High 2 = Moderate 3 = Low	0 = N/A 1 =High 2 = Moderate 3 = Low	0 - 100%
Active Shooter	2	1	0	3	1	3	2	2	2	36%
Acts of Intent	1	0	0	3	3	3	2	2	2	17%
Bomb Threat	2	0	0	3	3	3	2	2	2	33%
Building Move	2	0	0	1	2	1	2	2	2	22%
Chemical Exposure, External	1	0	0	2	2	1	2	2	2	12%
Civil Unrest	2	0	0	2	2	2	2	2	2	27%
Communication / TelephonyFailure	3	0	0	1	1	2	2	2	2	33%
Dam Failure	0	0	0	2	3	2	3	3	3	0%
Drought	2	0	0	1	1	1	2	2	2	20%
Earthquake	3	10	6	3	3	3	1	1	1	60%
Epidemic	3	0	0	3	1	2	2	2	2	40%
Evacuation	2	12	8	1	1	2	2	2	2	49%
Explosion	2	2	2	2	3	2	2	2	2	48%
External Flood	3	0	0	1	2	2	2	2	2	37%
Fire	3	4	2	2	3	3	2	2	2	64%
Flood	3	12	8	2	2	3	2	2	2	66%

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Summary Tab – As a result of information captured in the Data and HVA tabs, the summary report tab will provide a snapshot of the total alerts, Top 10 HVA Threats, and a list of the Top 10 Actual Occurrences.

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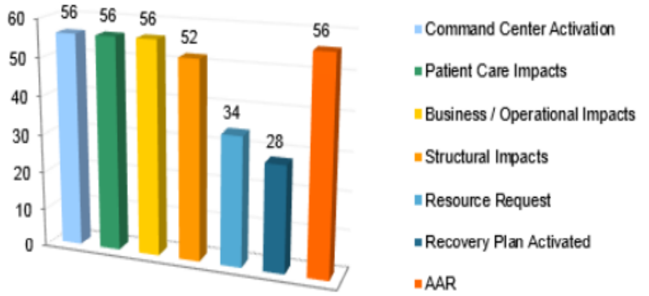
Emergency Management

Summary For - Enter Name of Hospital

ALERT TYPE	OCCURRENCE
Command Center Activation	56
Patient Care Impacts	56
Business / Operational Impacts	56
Structural Impacts	52
Resource Request	34
Recovery Plan Activated	28
AAR	56
Total Alert	**82**



2015

TOP 10 HVA	RANK	OCCURRENCE
Flood	1	12
Fire	2	4
Patient Surge	3	13
Power Outage	4	14
Earthquake	5	10
HVAC Failure	6	6
Evacuation	7	12
Explosion	8	2
IT System Outage	9	6
Water Contamination	10	0

2015

TOP 10 ACTUAL ALERTS	OCCURRENCE	HVA RANK
Power Outage	14	4
Patient Surge	13	3
Evacuation	12	7
Flood	12	1
Earthquake	10	5
IT System Outage	6	9
HVAC Failure	6	6
Fire	4	2
Explosion	2	8
Supply Chain Shortage / Failure	2	11

**Information shown on these instructions do not reflect actual data from any Kaiser Permanente Hospitals*

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Questionnaire

Appendix 5.1 All-hazard Preparedness Assessment Questionnaire (APAQ)

All-hazard emergency preparedness: An assessment of the Hazard vulnerability and response capacity of secondary and tertiary Hospitals in Riyadh Region, Saudi Arabia

Hospital code or Name (optional):

Visit date:

Time:

Signature:

I. Assessment of Functional Vulnerability

A. Site and Accessibility

1. Is the health facility located in the town/city proper?

Yes

No

_____ Non-applicable

If you answered no, please proceed to questions 1a-1b; otherwise go to the box after question 21b.

a.1 How far is the facility from the main town/city? 0-5 Km

b.1. Is the facility separated from the main town/city by a bridge?

Yes

No

_____ Don't Know

NA

2. Is the health facility located along the main street/highway?

Yes

No

If you answered no, please proceed to question number a2; otherwise go to question 3.

a.2. How far is the facility from the main street/highway? 0-5 Km

3. How many roads lead to the health facility?

1

2

3

>3, specify:

4. What are the conditions of the roads that lead to the health facility?

(Please fill in the table below.)

Road	No. of lanes	Road Condition		
		Well paved, no potholes	Paved but with potholes	Unpaved
1				
2				
3				
4				
5				

B. Areas in the Health Facility

5. What are the major areas of your institution? (Please check all applicable answers.)

_____ Administration

_____ Ambulatory Care Units (Outpatient)

_____ General Services

_____ Emergency Services

_____ In-patient Care Units

_____ Laboratory

_____ Pharmacy

_____ Radiology

_____ Operating Rooms

Others, specify:

6. Where are the points of entry to the health facility? (Please check all applicable answers.)

ER area.

_____ Administration area

_____ OPD area

Others, specify:

7. What comprise the General Services area? (Please check all applicable answers.)

Boilers

_____ Kitchen area

_____ Laundry area

_____ Communication

_____ Machinery area

_____ Storeroom

Others, specify:

8. Is the General Services area located in a separate building?

Yes

No

_____ Don't Know

9. What specific areas of the health facility can be converted into spaces for patients during disaster situations? (Please check all applicable answers.)

_____ Waiting areas/lobby

_____ Physician's offices

_____ Parking lots

_____ Physiotherapy room

_____ Park/ free area

_____ Outpatient consultation

_____ Diagnostic and treatment room

Others, specify:

10. What provisions are located in these areas? (Please check all applicable answers.)

_____ Adequate lighting

_____ Electrical outlets

_____ Water supply

_____ Bathroom

_____ Telephone outlets.

None

C. Equipment and Supplies

11. Are the following equipment/supplies available in your institution? (Please fill in the table below.)

Equipment/Supply	No. of units available	Functional		Properly labelled	
				YES	NO
a. Stethoscope, adult					
b. Stethoscope, paediatric					
c. Sphygmomanometer					
d. Thermometer					
e. Tongue depressors					
f. Light source (flashlight)					
g. Tape measure					
h. Vision testing chart (Snellen)					
i. Reflex hammer					
j. Head mirror					
k. Mirror, laryngeal set					
l. Otoscope set					
m. Pelvimeter (Collyer, external)					
n. Speculum, nasal					
o. Scale, spring/infant					
p. Scale, adult					

Equipment/Supply	No. of units available	Functional		Properly labelled	
				YES	NO
q. Ambu-bags (infant, child, adult with masks)					
r. Laryngoscope					
s. Suction Machine					
t. Oropharyngeal airway					
u. Endotracheal tubes with cuffs					
v. Intubating forceps					
w. Endotracheal tube connectors					
x. Examination table					

12. Are there stocks of the necessary supplies and equipment in the health facility?

Yes

No

_____ Don't Know

13. Is inventory of resources done by the institution?

Yes

No

_____ Don't Know

If you answered yes, please proceed to questions 13a-13b; otherwise go to question 14.

13a How often is the inventory conducted?

_____ Every month

_____ Quarterly

_____ Annually

Others, specify:

13b. what benefits have been realized from this practice? (Please check all applicable answers.)

______Identification of resources needed for effective emergency management.

_____ Identification of resources currently available within the community

________ Identification of variation (shortfall/surplus)

14. Is there a detailed list showing the destination (intended use) of these supplies?

Yes

No

_____ Don’t Know

15. How many months of supplies (medical and surgical items, essential medicines, and other supplies) are stocked for use by the health facility?

1 month

_____ 2 months

_____ 3 months

>3 months, specify:

16. Is there an arrangement with vendors regarding procurement of supplies and equipment during a disaster?

Yes

No

_____ Don’t Know

_____ Not applicable

17. Pharmacy monitors daily medication usage on a changing baseline.

Yes

No

_____ Don’t Know

18. Does the health facility have a system in place for emergency procurement of supplies?

Yes

No

_____ Don’t Know

_____ Not applicable

If you answered yes, please proceed to question 18a; otherwise go to question 19.

18a. How long does the procurement of supplies take under emergency conditions?

1 week

2 weeks

3 weeks

Others, specify:

19. Is there an arrangement for sharing resources with other health facilities and / or potential emergency suppliers of resources?

Yes

No

_____ Don't Know

_____ Not applicable

20. Is rotation of items with expiry dates done?

Yes

No

_____ Don't Know

_____ Not applicable

21. Who coordinates resource allocation? (Please check all applicable answers.)

_____ Staff of emergency controller

_____ Administrative staff

_____ Volunteers

Others, specify:

22. Does your health facility have an emergency kit?

Yes

No

_____ Don't Know

_____ Not applicable

If you answered yes, please proceed to question 22a; otherwise proceed to question 23.

22a. Are the contents of your emergency kit consistent with the WHO's prescribed New Emergency Health Kit2017?

Yes

No

_____ Don't Know

_____ Not applicable

23. Does your health facility have the capacity to store blood products?

Yes

No

_____ Don't Know

If you answered no, please proceed to question 23a; otherwise, proceed to question 24.

23a. where do you get blood and other blood products? (Please check all applicable answers.)

_____ Commercial blood banks

_____ Other health facilities

_____ Blood donors

Others, please specify:

24. Does your Blood bank services have surge capacity plans in place and are trained for surge activity?

Yes

No

_____ Don't Know

25. Do you have MOU is in place with regional blood center for emergent delivery of blood products.

Yes

No

_____ Don't Know

D. Utilities

26. How is water supplied to the health facility? (Please check all applicable answers.)

_____ From a water company

_____ Deep Well

Others, specify:

27. Does the health facility have suitable means of storing water?

Yes

No

_____ Don't Know

28. Is there an alternative source/s for water in case the main supply gets cut off?

Yes

No

_____ Don't Know

If you answered yes, please proceed to questions 28a-28c; otherwise proceed to question 29.

28a. What is the alternative source of water? _____

28b. How is the water from the alternative source treated? (Please check all applicable answers.)

____ Filtration

____ Chlorination

____ Sedimentation

____ Boiling

____ Water tablets

____ Not treated

28c. How long would the health facility continue to function using the alternative source of water? (In days)

29. How is electricity supplied?

Voltage: 110 V 220 V

Amperage: Cyclage:

30. Where are the control panels and electric power distribution lines located?

31. Is there an alternative source of electrical supply (Emergency power generator)?

Yes

No

_____ Don’t Know

NA

If you answered yes, please proceed to questions 31a-31c; otherwise proceed to question 32.

31a. What is the capacity of the emergency power generator? (In watt (kw)

31b. What fuel is utilized by the emergency power generator?

31c. What proportion (in %) of the facility’s energy requirement can it supply? _

32. Does the health facility have emergency lights (for use between periods of power interruption and restoration of electrical supply with generator set)?

Yes

No

_____ Don’t Know

NA

If you answered yes, please proceed to questions 32a-32b; otherwise proceed to question 33.

32a. How are the emergency lights activated?

Manual

_____ Automatic

32b. Where are they located?

_____ Nurses’ stations

_____ Emergency room

Wards

_____ Operating room

_____ Individual patients’ rooms

_____ Laboratory

_____ Hallways

Lobby

_____ Stairwells

Others, specify:

33. How are medical gases supplied?

_____ Main pipeline

_____ Individual tanks

Others, specify:

34. Are there safety measures to ascertain prevention of gas spills/leaks?

Yes

No

_____ Don’t Know

35. Does your Facility have medical gasses to last 3-4 days without re-supply?

Yes

No

_____ Don’t Know

36. Facility has adequate food on hand for staff for a 3–4-day period?

Yes

No

_____ Don’t Know

36a.Facility has adequate food on hand for patients for a 3–4-day period?

Yes

No

_____ Don’t Know

36.b. Facility has a plan for food service surge?

Yes

No

____ Don’t Know

37. Facility can isolate and shut down Heating, Ventilation, and Air Conditioning (HVAC) system zones in an emergency?

Yes

No

_____ Don’t Know

37a. Facilities and Engineering staff have knowledge of HVAC zones and shutdown procedures.

Yes

No

_____ Don’t Know

E. Warning System and Safety Equipment

38. Facility can send and receive emergency warning and notification information?

Yes

No

_____ Don’t Know

39. Facility has a safety program that identifies, controls, and mitigates facility hazards.

Yes

No

_____ Don’t Know

40. Facility has a fire prevention and response plan.

Yes

No

_____ Don’t Know

41. Is there a system of signs instituted in response to a disaster situation?

Yes

No

_____ Don’t Know

If you answered yes, please proceed to question 41a; otherwise go to question 42.

41a. What signs are included? (Please check all applicable answers.)

_____ Escape route indicators.

_____ Fire-fighting equipment indicators.

_____ Building layout diagram

42. Does the institution have fire detection equipment (e.g., smoke alarms)?

Yes

No

_____ Don't Know

NA

If you answered yes, please proceed to question 42a; otherwise go to question 43.

42a. Is the fire detection equipment strategically located?

Yes

No

_____ Don't Know

_____ Not applicable

43. Does the institution have fire extinguishers?

Yes

No

_____ Don't Know

If you answered yes, please proceed to questions 43a-43c; otherwise go to question44.

43a. How many fire extinguishers does the institution have? (Number of extinguishers in emergency department)

43b. Are fire extinguishers strategically located?

Yes

No

_____ Don't Know

43c. How often are the fire extinguishers replenished/serviced?

_____ Once a year

_____ Once in two years

_____ As needed.

Never

Others, specify:

F. Security

44. Does the health facility have a security unit?

Yes

No

If you answered yes, please proceed to questions 44a-44b; otherwise go to question 45.

44a. Who provides the personnel for the security unit?

_____ Health Facility

_____ Private security agency

44b. What areas in the health facility are given top priority in terms of security especially during disasters? (Please check all that apply.)

_____ Entrance / Exit points

_____ Main thoroughfares

_____ Storage area for controlled substances

_____ Storage area for high-value medical equipment

Others, specify:

45. Are there specific people assigned to security and crowd-control?

Yes

No

_____ Don’t Know

_____ Not applicable

If you answered yes, please proceed to question45.a; otherwise go to question 46.

45a. what are these people tasked to do?

_____ Close off other points of entry that are not vital to the emergency operations of the health facility.

_____ Control the flow of people entering the health facility.

_____ Direct people to appropriate areas inside the health facility

_____ Act as marshals in case evacuation is necessary.

Others, specify:

46. Does the Facility have a security force with full-time security responsibilities?

Yes

No

_____ Don’t Know

_____ Not applicable

47. Does All entrances and exits are controlled, monitored, and can be locked?

Yes

No

_____ Don’t Know

_____ Not applicable

48. A plan is in place to allow prompt facility access for staff and other authorized personnel.

Yes

No

_____ Don’t Know

_____ Not applicable

G. Transportation and Communication

49. What forms of internal communication are being used by the institution?

(Please check all the applicable answers.)

_____ Regular telephone

_____Cellular telephone

Pager

_____ Public address system

_____ Short-wave radio (800 MHz)

_____ Intercoms

Runners

Others, specify:

50. What forms of external communication are being used by the institution? (Please check all applicable answers.)

_____ Telephone with landline.

_____ Cellular telephone

Pager

_____ Facsimile machine (Fax)

_____ Short-wave radio (800 MHz)

Runners

_____ Trunk line

Others, specify:

50a. If the health facility is using telephones (whether landline or cellular), what are the alternative forms of communication in case the phone system breaks down? (Please check all applicable answers.)

_____ Short-wave radio (800 MHz)

Runners

____ Cell on Wheels COWS

____ Amateur radio system (Ham/RACES)

Others, specify:

51. Does your health facility have a back-up communications system is in place if the primary system fails?

Yes

No

_____ Don’t Know

_____ Not applicable

52. What means of patient transport are used by the institution? (Please check all applicable answers.)

_____ Buses, minibuses, and vans

_____ Ambulance

_____ Trucks

_____ Private vehicles

_____ Boats (if applicable)

_____ Aircraft (both fixed-wing and helicopters)

_____ Motorcycles

Others, specify:

If your facility has at least one ambulance, please answer question 52a; otherwise, please proceed to question 53.

52a. What are the capabilities of your ambulance/s? (Please fill in the table below).

Ambulance capabilities	No. of ambulances in the facility	No. of Personnel assigned to the ambulance			
		Driver	Paramedic	Nurse	Doctor
Purely for transport, No special equipment					
With supplies for Basic Life Support					

Ambulance capabilities	No. of ambulances in the facility	No. of Personnel assigned to the ambulance			
		Driver	Paramedic	Nurse	Doctor
With supplies for both Basic Life Support and Advance Cardiac Life Support					
Others, specify:					

H. Public Information

53. Is there a public information Centre in the institution?

Yes

No

_____ Don't Know

_____ Not applicable

If you answered yes, please proceed to questions 53a-53e; otherwise go to question 54.

53a. Who coordinates the public information Centre? (Please check all applicable answers.)

_____ Social worker

_____ Administrative staff

_____ Volunteer

Others, specify:

53.b. Which personnel are tasked to staff the public information Centre?

(Please check all applicable answers.)

_____ Social workers

_____ Administrative staff members

_____ Volunteers

Others, specify:

53. c What services are provided at the information Centre? (Please check all applicable answers.)

_____ Information about patients admitted and discharged.

_____ Finding addresses and whereabouts of family members of patients admitted to the health facility.

_____ Assisting in the identification of victims

_____ Assisting family members to locate relatives.

Others, specify:

53.d. Will the Public Information Centre continue to provide the above-mentioned services during disaster situations?

Yes

No

_____ Don't Know

_____ Not applicable

53e. Does the Public Information Centre have the capacity to coordinate with the following external entities in the event of a disaster? (Please check all that apply.)

_____ National emergency preparedness agency

_____ Saudi Red Crescent authority and other emergency management agencies.

_____ Other specialized health facilities in the vicinity

_____ Civil Défense

_____ Police department

_____ Local utility companies

_____Transport companies (for external means of transporting patients)

_____ Local funeral homes (for temporary morgue facilities)

_____ Medical supply vendors

54. Does your health Facility have a designated public information officer (PIO)?

Yes

No

_____ Don't Know

_____ Not applicable

54.a. Are PIO and leadership trained in risk communication skills?

Yes

No

_____ Don’t Know

_____ Not applicable

55. Are there means to create public awareness of the disaster preparedness plan of the institution?

Yes

No

_____ Don’t Know

_____ Not applicable

If you answered yes, please proceed to question 55a; otherwise go to question 56.

55. What communication tools are used to create public awareness of the Disaster Preparedness Plan?’ what are these measures? (Please check all the applicable answers.)

Posters

_____ Hanging signs

_____ Sign boards.

_____ Public meetings

_____ Labels on necessary equipment

_____ Labels on exit doors

_____ General evacuation route

Others, specify:

56. How is the public informed of a disaster situation in your catchment area? (Please check all applicable answers.)

_____ Mass media

_____ Audible and visual signs

_____ Community network

_____ Loudspeakers

_____ Door-to-door announcements

Others, specify:

57. What methods are used to disseminate emergency plans to the public?

(Please check all applicable answers.)

_____ Local press

Radio

_____ Television

_____ Public meetings

_____ Visits to schools, offices, etc.

_____ Brochures

Others, specify:

II. Emergency preparedness and response Capacity Assessment

A. Emergency Planning Group/committee

58. Is there an existing emergency planning group in your institution?

Yes

No

_____ Don’t Know

_____ Not applicable

59. Is the Committee a multidisciplinary team?

Yes

No

_____ Don’t Know

_____ Not applicable

If you answered yes, please proceed to questions 59a-59e; otherwise go to question 60.

59a. When was this group formed?

59b. Who are the members of this planning group? (Please check all applicable answers.)

_____ Health facility chief executive officer

_____ Chief of medical personnel

_____ Head of administration

_____ Director of nursing services

_____ Public Information Centre head

_____ Security services supervisor

_____ Maintenance chief

_____ Staff representative

_____ A health department representative

_____ Engineer

_____ Architect

_____ Other organizations with which the health facility may interact in emergency management.

Others, specify:

59c. Are all members of sufficient seniority to commit the organization to planning group decisions?

Yes

No

_____ Don't Know

_____ Not applicable

59d. Are they capable of contributing to the planning group's work?

Yes

No

_____ Don’t Know

_____ Not applicable

59e. What activities are done by the emergency planning group?

(Please check all applicable answers.)

_____ Hazard/potential problem analysis

_____ Structural vulnerability assessment

_____ Non-structural vulnerability assessment

_____ Functional vulnerability assessment

_____ Determine operating capacity during disaster situations.

_____ Plan for mobilization of resources.

_____ Define roles and responsibilities of each member/group.

_____ Ensure training and education of personnel as required.

_____ Provide for a monitoring and evaluation system for the emergency preparedness program.

_____ Provide pre-disaster photographic documentation of facility buildings and equipment for insurance purposes.

Others, specify:

60. What type/s of disaster does the health facility prepare for?

_____ External disasters only

_____ Internal disasters only

_____ Both internal and external disasters

61. Does the health facility have an emergency preparedness plan?

Yes

No

_____ Don't Know

_____ Not applicable

If you answered yes, please proceed to questions 61a-61e; otherwise go to question 62.

61a. Is the health facility emergency plan documented in writing?

Yes

No

_____ Don't Know

_____ Not applicable

61b. How often do you evaluate your disaster preparedness plan?

_____ Semi-annually

_____ Annually

_____ Biannually

Others, specify:

61c. How do you evaluate your disaster preparedness plan?

_____ By discussion

_____ By performing drills

_____ By performing simulation exercises

Others, specify:

61.d How is the disaster preparedness plan distributed?

_____Hard copy

_____Electronic copy

_____The plan is not distributed.

_____Other [short answer]

61.e. When was the plan last updated?

61f. What is your evaluation of your most recent emergency plan?

_____ Effective

_____ Needs changes/improvement.

62. Is there an existing/updated organizational chart for disaster situations?

Yes

No

_____ Don't Know

_____ Not applicable

If you answered yes, please proceed to question 62a; otherwise proceed to question63.

62a. Does the organizational chart follow the structure recommended by the Hospital Emergency Incident Command System (HEICS)?

Yes

No

_____ Don’t Know

_____ Not applicable

63. Has the An Incident Command System (ICS) or Hospital Incident Command System (HICS) in place.

Yes

No

_____ Don’t Know

_____ Not applicable

64. Does the ICS exercised at least twice annually.

Yes

No

_____ Don’t Know

_____ Not applicable

64.a Last exercised on (year)

65. Is the ICS coordinated by a Unified Command Structure coordinated when appropriate with law enforcement, fire, EMS?

Yes

No

_____ Don’t Know

_____ Not applicable

Task/duties of ICS	Yes	No	Don’t know
All staff know Incident Commander.			
There is a clear A procedure to designate an Incident Commander.			
Staff assigned to ICS leadership roles are oriented to their responsibilities.			
Staff assigned to key roles wear identifying gear during an event.			
All staff know where to report when the ICS is activated.			
Staff understands the flexibility of their positions in the ICS if leadership is unavailable.			
ICS or HICS is NIMS compliant?			
Is After action, reports are completed after all exercises?			

66. How are the members of the emergency planning group made aware of these management roles? (Please check all applicable answers.)

_____ Distribution of copies

_____ Regular meetings

Others, specify:

67. How are the members encouraged to actively be involved in preparedness, response, or recovery? (Please check all applicable answers.)

_____ Meetings

_____ Drills/ exercises

Others, specify:

B. Subcommittees

68. Is the emergency preparedness committee divided into subcommittees or subgroups?

Yes

No

_____ Don't Know

_____ Not applicable

If you answered yes, please proceed to questions 68a-68d; otherwise go to question 69.

68a. What are these subcommittees/subgroups? (Please check all applicable answers.)

Health

Rescue

_____ Transportation

_____ Communication

_____ Mutual assistance and welfare

_____ Engineering

Others, specify:

68b. Are the roles and responsibilities of these subcommittees/ subgroups clearly defined by the planning committee?

Yes

No

_____ Don’t Know

_____ Not applicable

68c. How are these responsibilities assigned to them?

_____ According to existing function

_____ According to assessed capability of a group.

_____ By random selection

_____ By volunteerism

Others, specify:

68d. what subcommittee/subgroup is directly involved among the following: (Please identify.)

TASKS/DUTIES	Name of Subcommittee or Subgroup
1 servicing and testing of emergency equipment regularly in accordance with relevant standards and manufacturers' recommendations	
2 providing advice to management regarding new equipment or existing safety equipment	
3 implementing a yearly plan of hospital hazard audits to determine that good housekeeping is being maintained and to identify remedial action	
4 planning & coordinating emergency planning group meetings	
5 disseminating emergency plans	
6 reviewing emergency planning at least once a year	
7 exercising emergency plans at least once a year	
8 providing all new, temporary, and casual personnel, with a summary of emergency plans at the time of appointment	

C. Human Resources

69. How many doctors does your health facility have? (Please fill in the table below.)

Areas of Specialty	No. of consultants	No. of Residents	No. of Interns
Family Medicine			
Internal Medicine			

Obstetrics and Gynaecology			
Paediatrics			
Surgery			
Anaesthesiology			
ENT			
Ophthalmology			
Orthopaedics			
Others, please specify:			

70. How many staff members does the health facility have per ward/area?

(Please fill in the table below.)

Ward/ Area	Bed capacity of ward/area	No. of Staff Nurses/Shift	No. of Nursing Aides/Shift	No. of Orderlies/Shift
Family Medicine				
Internal Medicine				
Obstetrics and Gynaecology				
Paediatrics				
Surgery				

Ward/ Area	Bed capacity of ward/area	No. of Staff Nurses/Shift	No. of Nursing Aides/Shift	No. of Orderlies/Shift
Anaesthesiology				
ENT				
Ophthalmology				
Orthopaedics				
Others, please specify:				

71. How many laboratory/radiology technicians does your health facility have?

71.a Laboratory:

Laboratory Area	No. of Technicians/Shift	No. of Shifts	Total No

71.b Radiology

Radiology Area	No. of Technicians/Shift	No. of Shifts	Total No.

72. Facility can notify the staff of emergency status and [recall to duty]?

Yes

No

_____ Don't Know

_____ Not applicable

72. a. Facility has a plan to notify on-duty and off-duty staff of emergency status?

Yes

No

_____ Don't Know

_____ Not applicable

D. Response protocols

73. How are alarms raised during disaster situation? (Please check all applicable answers.)

Alarm

Bell

_____ Megaphone

Verbal

Siren

Others, specify:

74. Who may activate the alarm? (Please check all applicable answers.)

_____ Special committee

_____ Administrator

_____ Director of health facility

Others, specify:

75. Does the administration have an updated list of addresses and telephone numbers of all staff involved in the emergency preparedness plan?

Yes

No

_____ Don't Know

_____ Not applicable

If you answered yes, please proceed to question 75a; otherwise, proceed to question 76.

75a. Is the list of addresses and telephone numbers of hospital staff always located in an accessible area?

Yes

No

_____ Not applicable

76. Does the health facility have a diagram of the communication network?

Yes

No

_____ Don’t Know

_____ Not applicable

77. Is there a pre-assigned emergency operations center (EOC) in the institution?

Yes

No

_____ Don’t Know

_____ Not applicable

If you answered yes, please proceed to questions 77a-77b; otherwise go to question 78.

77a where is it located?

77b. who is/are assigned to run the operation centre?

_____ Administrative personnel

_____ Physician

Nurse

_____ All of the above

Others, specify:

78. In the EOC, telephone numbers are available for: [Check all apply]

_______The local public health department

_______Regional health department (MoH General Directorate of Ministry of health)

_______Civil defence

_______Ministry of interior

_______National health surveillance office

_______CDC Emergency Preparedness Office

_______Other health care facilities

78.a EOC is equipped with.

______Telephones

______Telephone trunk line

______Satellite phones

______Fax

______Generator

______Maps of hospital

______Maps of local area

______ handheld bull horns

79. Do you conduct Rapid Need Assessment (RNA) during emergencies?

Yes

No

_____ Don’t Know

_____ Not applicable

79. a If yes, how often do you update it? (In Minutes)

80. Does the health facility have an on-site disaster response team?

Yes

No

_____ Don’t Know

_____ Not applicable

If you answered yes, please proceed to questions 80a-80b; otherwise go to question 81.

80a. who are the members of the on-site disaster response team?

(Please check all applicable answers.)

_____ ER Physician-on-duty.

_____ Family Medicine Resident-on-duty

_____ Surgery Resident-on-duty

_____ ER Nurse-on-duty.

_____ Emergency Medical Technicians (EMTs)

_____ Volunteers

Others, specify:

80b. Which of the following are team members trained to do?

(Please check all applicable answers.)

_____ Analyse the magnitude of the disaster.

_____ Coordinate efforts of various hospitals/support groups

_____ Basic Life Support

_____ Advanced Cardiac Life Support

_____ Perform limited surgery when necessary.

(e.g. doing amputation to free trapped victims)

_____ Relieve pain and anxiety of the injured.

_____ Indicate the order of how casualties must be rescued according to medical condition (Initial triage)

81. Have provisions been made for activating a disaster medical team in response to disasters that occur within your facility?

Yes

No

_____ Don't Know

_____ Not applicable

82. Have provisions been made for activating a disaster medical team in response to disasters that occur within your community (or outside your facility)?

Yes

No

_____ Don't Know

_____ Not applicable

83. Do you have a pre-assigned area for reception of victims at the health facility?

Yes

No

_____ Don't Know

_____ Not applicable

If you answered yes, please proceed to question 83a; otherwise go to question 84.

83a. where is the pre-assigned area for reception located?

_____ Inside the emergency room

_____ Outside the emergency room but inside the health facility

_____ Outside the health facility

Others, specify:

84. Do you have a pre-assigned area for triage in the health facility?

Yes

No

_____ Don’t Know

_____ Not applicable

If you answered yes, please proceed to questions 84a-84c; otherwise go to question 85.

84a. Where is the pre-assigned area for triage located?

_____ Inside the emergency room

_____ Outside the emergency room but inside the health facility

_____ Outside the health facility

Others, specify:

84b. Who is/are tasked with staffing the triage area? (Please check all applicable answers.)

_____ General Practitioners

_____ Surgeons

_____ Internists

_____ Physicians trained in traumatology.

Nurses

_____ Volunteers

_____ Paramedical personnel

Others, specify:

84c. What functions are assigned to the triage team? (Please check all applicable answers.)

_____ Classification of patients according to priority of treatment

_____ Referral of patient/s to the appropriate place within the health facility

_____ Referral of patient/s to other treatment centres following stabilization

_____ Updating the Health Facility Emergency Committee of the situation

85. Do ED has designated an alternate triage area?

Yes

No

_____ Don’t Know

_____ Not applicable

85a. If yes, (Please check all applicable answers.

a.1 _____Area can be used at night

b.1 _____Area is weather-proof.

c.1 _____ Area is temperature controlled.

86. Do you have an established system for proper categorization and tagging of patients/casualties (e.g. color-coding)?

Yes

No

_____ Don’t Know

_____ Not applicable

87. Does your health Facility use a triage system that is consistent with local EMS the (e.g., Saudi red crescent Authority)?

Yes

No

_____ Don’t Know

_____ Not applicable

88. Level of patient volume that triggers activation of triage system is defined.

Yes

No

_____ Don’t Know

_____ Not applicable

E. Patient Decontamination

89. Has an area been identified for decontaminating patients at your facility, if necessary?

Yes

No

_____ Don’t Know

_____ Not applicable

89a.If you answered yes, please (Please check all applicable answers.)

_______The Facility is able to manage emergency decontamination of 4 patients without outside resources or equipment that must be constructed to be deployed.

_______A fully operational patient decontamination area is external and proximate to the ED.

______A trained decontamination team exists and is trained to OSHA levels with NIOSH approved equipment.

________Facility has access to a portable decontamination unit that is accessible and operational within minutes. How many______

______Decontamination team has executed full exercise of process in last year.

______Decontamination team is capable of decontaminating ambulatory and non-ambulatory patients.

F. Hazard and Vulnerability Analysis

90. Has the emergency preparedness group conducted hazard and vulnerability analysis?

Yes

No

_____ Don’t Know

_____ Not applicable

If you answered yes, please proceed to question 90a-90c; otherwise go to question 91.

90a. What techniques were involved? (Please check all applicable answers.)

_____ Identification of hazard

_____ Listing of possible effects

_____ Listing of potential problems

_____ Determining causes

_____ Develop preventive strategies.

_____ Develop response and recovery strategies and trigger events for this strategy.

90b. What benefits have been realized from this tool? (Please check all applicable answers.)

_____ Obtained a list of possible hazards.

_____ Identified the most likely and damaging hazards.

_____ Identified the effects of those hazards in the health facility infrastructure and community.

______ Obtained a firm basis for health facility emergency management planning.

90c. What types of hazards does the health facility prepare for? (Please check all the applicable answers.)

_____ Earthquake

Flood

Fire

Tsunami

_____ Hurricane

_____ Volcanic eruption

_____ War/Armed conflict

_____ Epidemic

_____ Infectious Disease Outbreak

_____ Chemical/Radiologic Emergency

_____ Industrial/Technological

Others, specify:

G. Training and Drills

91. Does your facility have ongoing disaster training and education programs?

Yes

No

_____ Don’t Know

_____ Not applicable

91a.If yes, training is mandatory for: [check all that apply]

______ Administrative staff

______Housekeeping and food service staff

______Laboratory and radiology staff

______Medical and nursing students

______Medical staff

______Nursing staff

______Residents

______Security staff

______other [short answer]

If you answered yes, please proceed to question 91a-91d; otherwise go to question 92.

91a. What strategies have been tried? (Please check all the applicable answers.)

_____ Workshops, seminars, conferences

_____ Self-directed learning

_____ Individual tuition

_____ Exercises (Discussion-based, Tabletop, live)

_____ Pamphlets, videos, media

_____ Informal/formal presentations

_____ Public displays, meetings

Others, specify:

91b. What stages are involved in training? (Please check all applicable answers.)

_____ Analyse training needs

_____ Design training.

_____ Develop instruction.

_____ Conduct instruction.

_____ Validate training.

91c. How often does the health care facility conduct training?

_____ Biannually

_____ Annually

_____ As necessary

Others, specify:

91d. How many attended the most recent training conducted by the institution?

(Actual number)

___________ % (proportion of those who attended among those who need to be trained)

92. Does your facility conduct joint training programs with other external organizations involved in disaster response?

Yes

No

_____ Don't Know

_____ Not applicable

92a.If yes, list these organizations. [short answer]

93. Is there a regular drill/exercise being conducted in preparation for any disaster occurrence?

Yes

No

_____ Don't Know

_____ Not applicable

If you answered yes, please proceed to question 93a-93c; otherwise go to question 94.

93a. How regular are these drills done?

_____ Quarterly

_____ Semi-annually

_____ Annually

Others, specify:

93b. Who heads the drills?

_____ Special committee

_____ Administrator

_____ Director of health facility

Others, specify:

93.c. what type(s) of exercise(s) do you conduct? [Check all that apply]

______ Drill

______ Tabletop Exercise

______ Functional Exercise

______ Full-Scale Exercise

______ Response to a hoax

______ Response to a real event

94. Healthcare Facility representative reports to governance of the hospital on community planning, exercises, and after-action reports?

Yes

No

_____ Don’t Know

_____ Not applicable

95. Is there financial support for the training and drills mentioned above Q93c?

Yes

No

_____ Don’t Know

_____ Not applicable

If you answered yes, please proceed to question 95a-95b; otherwise go to question96.

95a. What are the sources of financial support? (Please check all applicable answers.)

_____ Donation

_____ Insurance

_____ Allotment from the health facility’s budget

Others, specify:

95b. What proportion of your budget is allocated for (training and drills)?

__/Year

H. Evacuation

96. Does Facility have evacuation plan?

Yes

No

_____ Don’t Know

_____ Not applicable

97. I s there a system for the evacuation of the institution?

Yes

No

_____ Don't Know

_____ Not applicable

If you answered yes, please proceed to question 97a-97c; otherwise go to question 98.

97a. Which among the following stages of evacuation are being conducted in the facility? (Please check all applicable answers.)

_____ Warning

_____ Withdrawal

_____Return

97b. In general, what activities are done in connection with the evacuation? (Please check all the applicable answers.)

_____ Identifying options of vertical or horizontal evacuation within the health facility

_____ Identifying the type of signal or alarm that will signify an evacuation is required.

_____ Outlining the evacuation routes

_____ Identifying the assembly areas

_____ Establishing the means of accounting for evacuees

_____ Anticipating types of support or assistance likely to be required by patients.

_____ Establishing the type of "all clear" signal 7 that will be given.

_____Not applicable

97c.Will elevators be staffed during evacuation?

Yes

No

_____ Don't Know

_____ Not applicable

97d. Is there an evacuation warden assigned for each part of the health facility?

Yes

No

_____ Don't Know

_____ Not applicable

98. Are agreements in place with other facilities to relocate patients if your facility is unable to provide patient care?

Yes

No

_____ Don't Know

_____ Not applicable

99. Has your facility designated evacuation routes?

Yes

No

_____ Don't Know

_____ Not applicable

100. Does the plan designate transportation requirements for the movement of patients and staff?

Yes

No

_____ Don't Know

_____ Not applicable

101. Have transportation vendors been identified to assist with evacuation if necessary?

Yes

No

_____ Don't Know

_____ Not applicable

102. Does the plan include provisions for moving patient records and documents during an evacuation?

Yes

No

_____ Don't Know

_____ Not applicable

102.a If yes, who is responsible for overseeing the movement of patient records and documents?

103. Does the plan include timelines for moving patients?

Yes

No

_____ Don’t Know

_____ Not applicable

103a.If yes, describe these timelines. [Short answer]

104. Will patients to be moved be prioritized during an evacuation?

Yes

No

_____ Don’t Know

_____ Not applicable

104a. If yes, how will patients be prioritized? [Short answer]

105. Does the plan include provisions for discharging stable patients to their homes if possible?

Yes

No

_____ Don’t Know

_____ Not applicable

105a. If yes, describe these provisions. [Short answer]

106. Have alternate care sites been identified and equipped with material and staff?

Yes

No

_____ Don’t Know

_____ Not applicable

106a. If yes, list these alternate care sites and their addresses.

I. Health Facility Networking

107. Is your disaster plan coordinated with those of other health facilities in your area?

Yes

No

_____ Don’t Know

_____ Not applicable

If you answered yes, please proceed to question 107a-107b; otherwise go to question 108.

107a. Is your coordination part of a formal agreement?

Yes

No

_____ Don't Know

_____ Not applicable

107.b. Do you perform drills together?

Yes

No

_____ Don't Know

_____ Not applicable

108. Does the facility have current mutual aid Memorandum of Understanding (MOUs) in place? [Check ALL APPLY]

________ Law enforcement

________Fire

________Emergency medical services (EMS)

________Public Safety

________Military installations

________other local and regional health care facilities

________Burn centre

________Red Cross

Other, specify.

109. Memorandum of Understanding (MOUs) are in place for:

________Portable MRI

________Portable CT

________Portable Dialysis

________Generators

J. Community Involvement

110. Does the institution take into consideration the characteristics of its community in responding to emergency situations?

Yes

No

_____ Don’t Know

_____ Not applicable

If you answered yes, please proceed to question 110a; otherwise go to question111.

110.a. What characteristics of the community are taken into account? (Please check all applicable answers.)

_____ Demography

_____ Environment (plants, animals, waters, air, and soil)

_____ Infrastructure

Culture

Economy

_____ Disease pattern

Others, specify:

111. Does the local community have its own disaster preparedness plan?

Yes

No

_____ Don’t Know

_____ Not applicable

If you answered yes, please proceed to question 111a.

111.a. Is the health facility disaster preparedness plan coordinated with the community disaster preparedness plan?

Yes

No

_____ Don’t Know

_____ Not applicable

K. Disease surveillance

112. Do you have health surveillance networks?

Yes

No

Other, specify.

113. What do you monitor?

114. Do you monitor incident trend?

Yes

No

_____ Don't Know

_____ Not applicable

115. How frequent do you report this incident?

________Immediately

________ weekly

________ Monthly

________Quarterly

________Annually

116. Admission diagnoses and ED diagnoses are reviewed daily with focus on spikes in disorders:

Yes

No

_____ Don't Know

_____ Not applicable

If yes, which diseases (please check all applicable answer)

_____ Pulmonary

_____GI

_____ Dermatologic

Other

117. Does the Staff aware of and complies with disease reporting requirements to the public health department in the region and the ministry of health headquarters?

Yes

No

_____ Don’t Know

_____ Not applicable

118. Does your Facility participate in the health electronic surveillance network (HESN)?

Yes

No

_____ Don’t Know

_____ Not applicable

118a.If yes, List of Notifiable diseases?

L. FATALITIES MANAGEMENT

119. Adequate plans are in place for management of fatalities.

Yes

No

_____ Don’t Know

_____ Not applicable

If you answered yes, please proceed to question 119a-119d.

119a. Refrigerated storage facilities for fatalities are available or an MOU is in place to acquire storage.

Yes

No

_____ Don’t Know

_____ Not applicable

119. b. Morgue/mortuary services staff are trained for surge.

Yes

No

_____ Don’t Know

_____ Not applicable

119. c. In cases where remains are infectious, contaminated or evidence, the fatalities management plan addresses the cultural and religious needs of survivors.

Yes

No

_____ Don’t Know

_____ Not applicable

119. d. Extra storage areas have been designated within the facility.

Policies and procedures are in place to facilitate the disposition of contaminated (infectious and/or chemical) remains.

Yes

No

_____ Don't Know

_____ Not applicable

………………………………. The End……………………………...

Thank you for your participation.

Qualitative Interview Questions

Interviewee personal details

Name

…………………………………………………………

Title

………………………………………………………..

Gender ☐ F ☐M

Age

☐20-30

☐30-40

☐45<

Years of experience

☐3-5

☐5-10

☐>10

Email ………………………………………………...

Phone ………………………………………………...

1. What are the ways and methods that can be used to evaluate the required resources, facilities, skills, and level of communications to manage the hazards and crises in healthcare facilities?

2. What are the main factors that are effective in All-Hazard emergency management?

Indicate them based on importance 1 is the most important and 5 is the least important.

Factors	score				
Governance and leadership	1	2	3	4	5
Emergency management planning	1	2	3	4	5
Logistics and supplies	1	2	3	4	5
Communication, health information system	1	2	3	4	5
Human resources	1	2	3	4	5
Finance	1	2	3	4	5
Training and Drills	1	2	3	4	5
Coordination with other facilities	1	2	3	4	5

3. What methods are used to ensure the effectiveness of the external/ the internal Emergency plans?

4. What are the major challenges in evaluating the capabilities in your Facility during the response to natural or technological disasters?

5. What methods are used to ensure the effectiveness of the early warning system and facility Notification inside /outside the health care facility?

6. What are the suggestions for improvement and strengthening the health care facilities capability to deal with different disaster scenarios in the region?

7. To what extent is the private sectors and volunteers' abilities have been used to mitigate the impact of the emergencies?

8. What are your suggestions for better use of the mutual agreement among the health sectors?

………………………………The End of the Questions…………………

Appendix 6.1 Interview guide

Research title: All hazard emergency preparedness and response capacities of secondary and tertiary health care facilities in Riaydh region Saudi Arabia

Researcher Name: Roaa Hajjam

We would like to invite you to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. the researcher herself Roaa Hajjam will go through the information sheet with you and answer any questions you have. Please take time to read this carefully and discuss it with others if you wish. Ask us anything that is not clear.

The overall purpose of this study is to investigate all-hazard disaster preparedness and response capacity of hospitals across Riyadh region of the Kingdom of Saudi Arabia. Specifically, the study hopes to achieve the following objectives:

1. analyse the Hazard vulnerability of secondary and tertiary health care facilities for multiple hazards in the Riyadh region, KSA.
2. Estimate the functional vulnerability, preparedness, and response capacity of secondary and tertiary health care facilities for multiple hazards.
3. Develop a comprehensive all-hazard assessment tool specific for secondary and tertiary health care facilities in KSA based on the International best emergency management practice.

The study will involve three components, namely:

- Component 1 which contains the KP-HVA tools.
- Component 2 will be the main Questionnaire that includes all the critical items of all-hazard preparedness elements for analysis.
- Component 3 is a Qualitative interview for the emergency department directors with 5+ years of experience in emergency management.

For component one, the healthcare facility who wish to participate in this study should fill the KP-HVA tool excel form.

For component 2, the researcher will visit the health facility to administer face to face survey completing the survey questionnaire will take between 60 to 90 minutes. If you are selected for the qualitative interview, you will require an additional 30 minutes to participate in the qualitative interview. you will be asked to do the interview only, if you have working experience more than 5+ years in the field of emergency medicine and management

If you are still happy to take part, then you will then be asked to sign a consent form.

Appendix 6.2 The Qualitative Interview Charting the data into framework Matrix.

Participants Code	Theme 1: Methods for assessing the effectiveness of emergency response process			
	sub theme 1: Emergency response plan assessment method			
	Drills	plans Status (changes in the plans)	Need for Audit	External Audit
Hospital 01				
Hospital 03	"…we do some drills for the internal disaster this is frequently, and this probably for all the employee and department and sections…"	"…drills we do it monthly to ensure everyone is ready and understand how to respond during the disaster…"		
Hospital 027				
Hospital 032	"For now, the only thing that we used to measure is the drills, we do one the external drills and one			

Participants Code	Theme 1: Methods for assessing the effectiveness of emergency response process			
	sub theme 1: Emergency response plan assessment method			
	Drills	plans Status (changes in the plans)	Need for Audit	External Audit
	internal drill every year and of course if we have the real activation…”			
Hospital 034			“…we do sometimes round to check our equipment and the other one by testing them by doing drills…” H034	
Hospital 035		“…usually, each plan and policy have a valid date which is one to two years. After two years we need to update it. After two years, we usually set and try to review it. We see if there is anything is		“…we need help from others, when the CBAHI came, or the Canadian accreditation came they give us some feedback based on the feedback we try to update our external

Participants Code	Theme 1: Methods for assessing the effectiveness of emergency response process			
	sub theme 1: Emergency response plan assessment method			
	Drills	plans Status (changes in the plans)	Need for Audit	External Audit
		happening within the two years…” H035		and internal plans...” H035

Participant Code	Theme1: Methods for assessing the effectiveness of emergency response process
	sub theme2: Evaluation of emergency response facilities and equipment
	Equipment checks list (assessment of resources)
Hospital 01	
Hospital 03	“…about the resources we all the time check, we have a list, and we have people who will have to check daily the resources, the medical resources and medical supplies to ensure we have enough resources in case of disaster at any time…”
Hospital 027	“…The evaluation of resources usually based on our evaluation of the previous incidents that have happened in the past, plus the drills and the disaster plans. Then we list the current hazard and the needed resources. Also, sometimes we receive some advice from higher management level at the MoH about the necessary action to prepare for the disasters…”

Hospital 032	"…we do have a disaster committee…, the committee reports to the internal audit and disaster unit section is under the medical services directly…."
Hospital 034	"…usually, we do analysis after any event this is the main issue, plus we have a committee in our department, we have regular meetings every three to four months to evaluate the situation…"
Hospital 035	

Participant Code	Theme1: Methods for assessing the effectiveness of emergency response process			
	sub theme3: Assessment of warning system			
	Hospitals central communication system	external warning notification system	Disaster Code	Internal warning system
Hospital 01			"…from inside for sure! because the staff is aware of the codes and like	

			what you see here (Card of the codes) they can call we have standard and unified number only for disasters…” H01	
Hospital 03		“…but still, we have a lot of difficulties to understand what type of disaster particularly the explosion of building collapse. the message is usually not clear and not complete information about the type of disaster that’s why this make		

		the hospital less prepared and not fully aware with the cases that will be coming to us, especially with the explosion events or Building collapse (Mass casualty event). The data is not clear enough to activate the disaster plan in the hospital…" H03		
Hospital 03		"…to receive the warning from the other agencies, sometimes we receive it from the social media, or the civil defence or the Saudi Red Crescent authority ….		

		sometimes we receive it from the health affairs at the Ministry of Health…" H03		
Hospital 027	"... for the incidence inside the hospital, the notification will be by the hospital operator, he will announce the code over the hospital headphones, there is special code for each problem and the manager on duty will be notified, and he will take the needed action. The manager on duty will decide if he needs to inform the director of the	"…the early warning system notification from outside the hospital, there is a wireless communication linked with the general directorate at the health affairs (MoH). As well we do have a device that connects the Saudi red crescent with us throughout the wireless communication to inform us..." H027		

	hospital or scale it up with the other health sectors (MoH general directorate, SRCA) and civil defence (Firefighter) or not…" H027			
Hospital 032		"… there is check every month, the outside the facility notification we receive it until now it is based on the radio communication and telephonic communication, the telephonic communication we tested all the time it is in use all the time with the SRCA, Civil defence, and the		"...for this we have a dedicated department called utility and maintenance and fire department, the utility and maintenance check all the facility procedures and make sure that everything is good inside national guard facility, the fire department checks all fires doors, and fire hydrants alarms on monthly bases…" H032

		MoH, all of those with the goes to dispatch centre. this is what we use during the real event activation. and every day it been tested with the SRCA…" H032		
Hospital 034				
Hospital 035				

Participant Code	Theme2: Factors and challenges associated with effective emergency response capability of hospitals
	Sub-theme1: leadership and Coordination
	Need for a disaster centre
Hospital 01	"…we need to have a disaster centre.H01
Hospital 03	"…I believe we need to do coalition as hospital, now we have cluster one and cluster two that new strategy for the ministry of health, but we need to do this with the university and military hospitals too. to ensure there is Avery high cooperation and coordination with these sectors, and to expose the medical staff to different types of disaster scenarios (natural or technological) disasters. this will facilitate that will help to facilitate the work between all the sectors. even for the evacuation scenario we

	must ensure there is an agreement and cooperation during and pre and post the disaster event…" H03
Hospital 027	
Hospital 032	"…the challenges, I would say the leadership again and ICS, the correct implementation arises yes, communication with other entity and agency still an issue, coordination still an issue, Patient tracing management of media report…" H32
Hospital 034	"…That does not mean we should not communicate with everyone the one near to us can help us more. but again, they should meet, and unifying the system and make a big umbrella for the disaster in the area. I think this would be better for that planning and for the teaching and improvement…" H34
Hospital 035	

Participant Code	Theme2: Factors and challenges associated with effective emergency response capability of hospitals
	Sub-theme2: Accessibility
	Lack of access
Hospital 01	
Hospital 03	
Hospital 027	
Hospital 032	

Hospital 034	
Hospital 035	"…challenges !! okay, there is a lot of challenges, mainly the way and location of the hospital, our hospital is located in a very congested area, difficult to access from the main agencies like Saudi red crescent (Ambulance) the civil defence (Rescue vehicle). this affects our drills because they cannot come and participate effectively during the drills. This is the major challenge, other challenges I can think of umm ... usually the ability of a disaster-oriented people for 24 hours. So, those people can be the eyes to evaluate the can guide the Hospital evaluation capacity in each disaster or incident…" H35

Participant Code	Theme3: Strategies for improving the emergency response capability of healthcare facilities	
	Sub-theme1: Use of private sector and volunteers	
	Availability of Volunteers	Agreement with private sectors
Hospital 01		
Hospital 03	"…for the volunteers, I have suggested to the minister to create a volunteer department for the volunteers those who are registered to help, particularly in disasters from the physicians, nurses all needed speciality like admin, psychiatrist	"…with the private sector there is an agreement between MoH and the private hospital, in case of regional disaster all the private hospital should be ready to receive cases from any governmental hospital.

	who have the ability to help during the disaster…" H03	private sectors they must be involved in any disaster…" H03
Hospital 027	"…No, at all, we do not have any volunteer or any private hospital in this province…" H027	
Hospital 032	"…In terms of volunteer, we don't have details plan for managing volunteers here in the national guard hospital, but we have used them in the previous disasters basically to donate blood, and maybe to help to identify the victim's stuff like this but not to provide actual patient care or assist inside the hospital, or transportation. there is no plan the concept of volunteers as whole is still new in Saudi Arabia, still we don't have committee, standards or policy, or roles to regulate the volunteer management, civil defence they are doing a great work, and they have a volunteer section. SRCA, I know they have it for ten or 15 years now, The MoH just started this year last year. the big problem is none of them proposed with any billows or	"…I will tell you during the corona outbreaks that we had, we relied a lot on the private sectors, we did an agreement or our sister hospital private hospital, and they did a tremendous help. even if we need a long-term patient, we can send them the patient to them, they helped us a lot during the outbreak.…" H032

	guideline or standard operating procedures for corporation volunteer into disaster. this needs to go first to the MoH, approved from MoH and then probably with go to Saudi health council and then approved by the Saudi health council. whatever we are doing is not govern by anyone…" H032	
Hospital 034	"…There is some need, and we need volunteer…" H034	
Hospital 035		

Appendix C Data Summary

Appendix 3.1 Systematic review search strategy

PubMed, OVID MEDLINE, EMBASE, CINAHL and Google Scholar.

Details of search keywords and syntaxes for article identification

PubMed to 11- 07-2023

- Health Care Facilities [MeSH Major Topic]) OR ("Hospital*" OR "primary care" OR "public health" OR "secondary care" OR "tertiary care" OR "Rehabilitation Cent*" OR "Geriatric Care" OR "Home Care" OR "Health Facilities" OR "Health Workforce" OR "Hospital Department*" OR "Emergency Service*")
- ((Disaster planning* [MeSH Major Topic]) OR ("Prepare*" OR "Plan*" OR " Emergency Prepar*" OR "Emergency Plan*" OR "Disaster plan*"))
- "All hazard*" OR "All-hazard*" OR "Multiple hazards" OR "Multi-Hazard*"
- Disasters*

	Concept	Type of search	Keyword syntax	Result
1	Health Care Facilities	1	(Health Care Facilities [MeSH Major Topic]) OR ("Hospital*" OR "primary care" OR "public health" OR "secondary care" OR "tertiary care" OR "Rehabilitation Cent*" OR "Geriatric Care" OR "Home Care" OR "Health Facilities" OR "Health Workforce" OR "Hospital Department*" OR "Emergency Service*")	8115870

	Concept	Type of search	Keyword syntax	Result
2	Disaster planning	2	"disaster planning*"[MeSH Major Topic] OR "prepar*"[All Fields] OR "plan*"[All Fields] OR "emergency prepar*"[All Fields] OR "emergency plan*"[All Fields] OR "disaster plan*"[All Fields]	3485980
3	All hazards or Multiple hazards	3	"all hazard*"[All Fields] OR "all hazard*"[All Fields] OR "Multiple hazards"[All Fields] OR "multi hazard*"[All Fields]	625
1 and 2	Disaster planning AND Health Care Facilities	Combined with AND	(("disaster planning*"[MeSH Major Topic] OR ("prepar*"[All Fields] OR "plan*"[All Fields] OR "emergency prepar*"[All Fields] OR "emergency plan*"[All Fields] OR "disaster plan*"[All Fields])) AND "Health Facilities"[MeSH Major Topic]) OR ("hospital*"[All Fields] OR "primary care"[All Fields] OR "public health"[All Fields] OR "secondary care"[All Fields] OR "tertiary care"[All Fields] OR "rehabilitation cent*"[All Fields] OR "Geriatric Care"[All Fields] OR "Home	8001674

	Concept	Type of search	Keyword syntax	Result
			Care"[All Fields] OR "Health Facilities"[All Fields] OR "Health Workforce"[All Fields] OR "hospital department*"[All Fields] OR "emergency service*"[All Fields])	
1 and 2 and 3		Combined with AND	((("disaster planning*"[MeSH Major Topic] OR ("prepar*"[All Fields] OR "plan*"[All Fields] OR "emergency prepar*"[All Fields] OR "emergency plan*"[All Fields] OR "disaster plan*"[All Fields])) AND "Health Facilities"[MeSH Major Topic]) OR ("hospital*"[All Fields] OR "primary care"[All Fields] OR "public health"[All Fields] OR "secondary care"[All Fields] OR "tertiary care"[All Fields] OR "rehabilitation cent*"[All Fields] OR "Geriatric Care"[All Fields] OR "Home Care"[All Fields] OR "Health Facilities"[All Fields] OR "Health Workforce"[All Fields] OR	328

	Concept	Type of search	Keyword syntax	Result
			"hospital department*"[All Fields] OR "emergency service*"[All Fields])) AND ("all hazard*"[All Fields] OR "all hazard*"[All Fields] OR "Multiple hazards"[All Fields] OR "multi hazard*"[All Fields])	

Ovid MEDLINE(R) ALL <1946 to July 06, 2023>

#	searches	Results
1	("Disaster*" or "mass casualty incident" or "hazard*" or "catastrophe" or "tragedy*" or "emergenc*" or "crisis").mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word]	1060460
2	exp Disasters/	99976
3	exp Mass Casualty Incidents/	2548
4	1 or 2 or 3	1080177

#	searches	Results
5	("preparedness" or "readiness" or "preparation" or "management" or "mitigation" or "response*" or "planning" or "plan" or "model" or "protocol" or "program*" or "countermeasure*" or "strategy" or "prevention").mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word]	10547053
6	4 and 5	489896
7	("Disaster Preparedness" or "Emergency Preparedness" or "Disaster Planning" or "Hospital Emergency Preparedness" or "Health Emergency Preparedness" or "Preparedness Response" or "Emergency Readiness").mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier,	18834

#	searches	Results
	synonyms, population supplementary concept word, anatomy supplementary concept word]	
8	exp Disaster Planning/	15846
9	7 and 8	15759
10	6 or 9	489896
11	("Hospital*" or "clinic" or "infirmary" or "hospice" or "health cent*" or "emergency service*" or "emergency department" or "primary care" or "public health" or "secondary care" or "tertiary care" or "rehabilitation cent*" or "geriatric care" or "home care" or "health facilities" or "health workforce").mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word]	2845077
12	("Hospital*" or "clinic" or "infirmary" or "hospice" or "health cent*" or "emergency service*" or "emergency department" or "primary care" or "public health" or "secondary care" or "tertiary care" or "rehabilitation cent*" or "geriatric care" or	2845077

#	searches	Results
	"home care" or "health facilities" or "health workforce").mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word]	
13	exp Hospitals/	317774
14	exp Health Facilities/	895212
15	exp Health Care Facilities/	3334053
16	exp Health Services/	2431206
17	exp Health Personnel/	612549
18	exp Hospital units/	134972
19	12 or 13 or 14 or 15 or 16 or 17 or 18	4913712
20	("All hazard*" or "All-hazard*" or "Multiple hazards" or "Multi-Hazard*" or "Multi-vulnerabilit*" or "Multiple vulnerabilities" or "Multi-risk" or "Multiple risk*" or "All-risk*" or "Multiple crises" or "Multiple Emergencies").mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating	7675

#	searches	Results
	sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word]	
21	10 and 19 and 20	515

Embase <1974 to 2023 Week 27>

EMBASE

#	Searches	Results
1	exp Disaster Planning/	14557
2	disaster preparedness.mp.	2777
3	1 or 2	15501
4	exp hospital units/ or exp hospitals/	1419544
5	exp Health Facilities/	1943584
6	exp Health Services/	6823869
7	exp Health Personnel/	1987562
8	4 or 5 or 6 or 7	8580395
9	checklist/ or "surveys and questionnaires"/	928553
10	(toolkit* or tool kit* or checklist* or check list*).mp.	105166

11	9 or 10	989167
12	All-hazards.mp.	331
13	All-risk*.mp.	5670
14	Multi-Hazard.mp.	84
15	Multiple hazards.mp.	114
16	12 or 13 or 14 or 15	6177
17	3 and 8 and 11 and 16	7

CINAHL to July 11,2023

#	Query	Limiters/Expanders	Last Run Via	Results
S20	((S13 AND S18) AND (S3 AND S4 AND S7 AND S18)) AND (S3 AND S4 AND S7 AND S12)	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	324
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	
			Database - CINAHL Ultimate	

#	Query	Limiters/Expanders	Last Run Via	Results
S19	S13 AND S18	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	4
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	
			Database - CINAHL Ultimate	
S18	all hazards OR All-risk OR Multi-hazard OR multiple hazard	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	4,793
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	
			Database - CINAHL Ultimate	

#	Query	Limiters/Expanders	Last Run Via	Results
S17	multiple hazard	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	32
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	
			Database - CINAHL Ultimate	
S16	Multi-hazard	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	14
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	
			Database - CINAHL Ultimate	

#	Query	Limiters/Expanders	Last Run Via	Results
S15	All-risk	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	1,060
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	
			Database - CINAHL Ultimate	
S14	all hazards	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	3,700
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	
			Database - CINAHL Ultimate	

#	Query	Limiters/Expanders	Last Run Via	Results
S13	((MH "Checklists") OR (MH "Questionnaires+") OR (MH "Surveys") OR ((toolkit* or tool kit* or checklist* or check list*))) AND (S3 AND S4 AND S7 AND S12)	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	3, 240
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	
			Database - CINAHL Ultimate	
S12	(MH "Checklists") OR (MH "Questionnaires+") OR (MH "Surveys") OR ((toolkit* or tool kit* or checklist* or check list*))	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	650,046
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	

#	Query	Limiters/Expanders	Last Run Via	Results
			Database - CINAHL Ultimate	
S11	(toolkit* or tool kit* or checklist* or check list*)	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	59,783
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	
			Database - CINAHL Ultimate	
S10	(MH "Surveys")	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	165,736
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	

#	Query	Limiters/Expanders	Last Run Via	Results
			Database - CINAHL Ultimate	
S9	(MH "Questionnaires+")	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	494,374
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	
			Database - CINAHL Ultimate	
S8	(MH "Checklists")	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	37,906
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	

#	Query	Limiters/Expanders	Last Run Via	Results
			Database - CINAHL Ultimate	
S7	((MH "Health Facilities+") OR (MH "Hospital Units+") OR (MH "Hospitals+")) OR (MH "Health Personnel+") OR (MH "Health Services+")	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	1,939,311
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	
			Database - CINAHL Ultimate	
S6	(MH "Health Services+")	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	1,181,721
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	

#	Query	Limiters/Expanders	Last Run Via	Results
			Database - CINAHL Ultimate	
S5	(MH "Health Personnel+")	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	639,002
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	
			Database - CINAHL Ultimate	
S4	disaster preparedness OR (MH "Disaster Planning+")	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	15,926
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	

#	Query	Limiters/Expanders	Last Run Via	Results
			Database - CINAHL Ultimate	
S3	(MH "Health Facilities+") OR (MH "Hospital Units+") OR (MH "Hospitals+")	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	529,546
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	
			Database - CINAHL Ultimate	
S2	disaster preparedness	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	11,261
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	

#	Query	Limiters/Expanders	Last Run Via	Results
			Database - CINAHL Ultimate	
S1	(MH "Disaster Planning+")	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	15,373
		Search modes - Boolean/Phrase	Search Screen - Advanced Search	
			Database - CINAHL Ultimate	

Appendix 4.3 Data tables for the observed hazards at the Healthcare facilities in Riyadh region

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H06	Active Shooter	1	6	6
H11	Active Shooter	1		
H16	Active Shooter	1		
H28	Active Shooter	1		
H45	Active Shooter	1		
H54	Active Shooter	1		
H06	Acts of Intent	1	3	4
H07	Acts of Intent	1		
H12	Acts of Intent	2		
H27	Centeral telephone not working	Not working for more than 2 years	1	0

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H50	Chemical Exposure, internal (Water Implant cleaning)	2	1	2
H01	Communication / Telephony Failure	1	11	18
H11	Communication / Telephony Failure	1		
H13	Communication / Telephony Failure	2		
H18	Communication / Telephony Failure	1		
H19	Communication / Telephony Failure	4		
H22	Communication / Telephony Failure	1		
H26	Communication / Telephony Failure	1		
H28	Communication / Telephony Failure	4		
H34	Communication / Telephony Failure	1		
H43	Communication / Telephony Failure	1		
H54	Communication / Telephony Failure	1		
H01	Epidemic	1	11	12
H06	Epidemic	1		
H07	Epidemic	1		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H08	Epidemic	1		
H16	Epidemic	1		
H18	Epidemic	1		
H26	Epidemic	1		
H28	Epidemic	1		
H41	Epidemic	1		
H43	Epidemic	1		
H57	Epidemic	2		
H01	Evacuation	1	9	9
H02	Evacuation	1		
H06	Evacuation	1		
H15	Evacuation	1		
H16	Evacuation	1		
H25	Evacuation	1		
H34	Evacuation	1		
H36	Evacuation	1		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H41	Evacuation	1		
H57	External Flood	1	1	1
H06	Fire alarm Failure	1	6	7
H08	Fire alarm Failure	1		
H18	Fire alarm Failure	1		
H20	Fire alarm Failure	1		
H26	Fire alarm Failure	2		
H53	Fire alarm Failure	1		
H03	Flood	1	3	3
H04	Flood	1		
H10	Flood	1		
H03	Forensic Admission	2	10	40
H04	Forensic Admission	2		
H06	Forensic Admission	1		
H07	Forensic Admission	1		
H08	Forensic Admission	1		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H15	Forensic Admission	1		
H18	Forensic Admission	1		
H19	Forensic Admission	10		
H27	Forensic Admission	20		
H57	Forensic Admission	1		
H22	Gas / Emissions Leak	1	1	1
H18	Generator Failure	1	3	3
H22	Generator Failure	1		
H26	Generator Failure	1		
H01	Hazmat Incident	1	5	6
H34	Hazmat Incident	1		
H36	Hazmat Incident	2		
H41	Hazmat Incident	1		
H50	Hazmat Incident/Internal Limbs labs Prosthetists and Orthotists (P&Os)	1		
H07	Hostage Situation	1	2	2

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H22	Hostage Situation	1		
H01	HVAC Failure	1	16	27
H06	HVAC Failure	1		
H07	HVAC Failure	1		
H08	HVAC Failure	1		
H16	HVAC Failure	1		
H18	HVAC Failure	1		
H19	HVAC Failure	11		
H20	HVAC Failure	1		
H25	HVAC Failure	2		
H26	HVAC Failure	1		
H36	HVAC Failure	1		
H41	HVAC Failure	1		
H43	HVAC Failure	1		
H53	HVAC Failure	1		
H54	HVAC Failure	1		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H57	HVAC Failure	1		
H08	Infant Abduction	1	1	1
H07	Infectious Disease Outbreak	1	9	20
H08	Infectious Disease Outbreak	1		
H12	Infectious Disease Outbreak	2		
H20	Infectious Disease Outbreak	1		
H22	Infectious Disease Outbreak	2		
H25	Infectious Disease Outbreak	8		
H34	Infectious Disease Outbreak	3		
H41	Infectious Disease Outbreak	1		
H43	Infectious Disease Outbreak	1		
H01	Internal Fire	1	16	16
H02	Internal Fire	1		
H03	Internal Fire	1		
H04	Internal Fire	1		
H06	Internal Fire	1		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H07	Internal Fire	1		
H08	Internal Fire	1		
H09	Internal Fire	1		
H10	Internal Fire	1		
H12	Internal Fire	1		
H15	Internal Fire	1		
H18	Internal Fire	1		
H20	Internal Fire	1		
H41	Internal Fire	1		
H54	Internal Fire	1		
H57	Internal Fire	1		
H01	Internal Flood	1		
H02	Internal Flood	1		
H03	Internal Flood	1	11	11
H04	Internal Flood	1		
H06	Internal Flood	1		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H07	Internal Flood	1		
H34	Internal Flood	1		
H36	Internal Flood	1		
H41	Internal Flood	1		
H43	Internal Flood	1		
H53	Internal Flood	1		
H03	IT System Outage	1	18	45
H04	IT System Outage	1		
H06	IT System Outage	1		
H08	IT System Outage	1		
H10	IT System Outage	1		
H11	IT System Outage	1		
H12	IT System Outage	1		
H15	IT System Outage	1		
H16	IT System Outage	1		
H19	IT System Outage	21		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H20	IT System Outage	1		
H22	IT System Outage	1		
H25	IT System Outage	3		
H28	IT System Outage	6		
H43	IT System Outage	1		
H50	IT System Outage	1		
H53	IT System Outage	1		
H54	IT System Outage	1		
H08	Mass Casualty <5	1	11	62
H11	Mass Casualty <5	15		
H15	Mass Casualty <5	1		
H16	Mass Casualty <5	1		
H19	Mass Casualty <5	21		
H20	Mass Casualty <5	1		
H43	Mass Casualty <5	1		
H45	Mass Casualty <5	17		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H53	Mass Casualty <5	1		
H54	Mass Casualty <5	1		
H57	Mass Casualty <5	2		
H15	Mass Casualty >5	1		
H20	Mass Casualty >5	1		
H01	Mass Casualty >5	2		
H21	Mass Casualty >5	5		
H03	Mass Casualty >5	19		
H04	Mass Casualty >5	15	11	153
H13	Mass Casualty >5	3		
H27	Mass Casualty >5	100		
H34	Mass Casualty >5	3		
H36	Mass Casualty >5	2		
H41	Mass Casualty >5	2		
H11	Medical Gas Failure	1	4	4
H15	Medical Gas Failure	1		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H13	Medical Gas Failure	1		
H22	Medical Gas Failure	1		
H56	Newspaper burned	1	1	1
H22	Pandemic (TB)	1	1	1
H01	Patient Surge	2	17	39
H02	Patient Surge	2		
H03	Patient Surge	1		
H04	Patient Surge	1		
H08	Patient Surge	1		
H11	Patient Surge	1		
H12	Patient Surge	1		
H15	Patient Surge	1		
H16	Patient Surge	1		
H19	Patient Surge	4		
H20	Patient Surge	1		
H21	Patient Surge	5		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H25	Patient Surge	7		
H28	Patient Surge	4		
H36	Patient Surge	1		
H41	Patient Surge	2		
H45	Patient Surge	4		
H10	Planned Power Outages	1	13	24
H11	Planned Power Outages	1		
H12	Planned Power Outages	2		
H13	Planned Power Outages	2		
H15	Planned Power Outages	1		
H26	Planned Power Outages	2		
H27	Planned Power Outages	3		
H28	Planned Power Outages	4		
H45	Planned Power Outages	1		
H50	Planned Power Outages	4		
H53	Planned Power Outages	1		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H54	Planned Power Outages	1		
H56	Planned Power Outages	1		
H02	Power Outage	1	8	10
H03	Power Outage	1		
H04	Power Outage	1		
H09	Power Outage	1		
H19	Power Outage	3		
H22	Power Outage	1		
H45	Power Outage	1		
H56	Power Outage	1		
H07	Sandstorm	2	8	15
H36	Sandstorm	1		
H15	Sandstorm	1		
H20	Sandstorm	1		
H13	Sandstorm	3		
H21	Sandstorm	3		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H27	Sandstorm	3		
H12	Dust storm	1		
H01	Seasonal Influenza	1	8	8
H02	Seasonal Influenza	1		
H03	Seasonal Influenza	1		
H04	Seasonal Influenza	1		
H22	Seasonal Influenza	1		
H34	Seasonal Influenza	1		
H36	Seasonal Influenza	1		
H41	Seasonal Influenza	1		
H10	Sewer Failure	1	6	25
H13	Sewer Failure	15		
H27	Sewer Failure	5		
H28	Sewer Failure	2		
H36	Sewer Failure	1		
H53	Sewer Failure	1		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H57	small Internal Spill	1	1	1
H10	stray dogs	1	1	1
H45	Strikes / Labor Action / Work Stoppage	1	1	1
H02	Suicide	1	4	5
H07	Suicide	2		
H12	Suicide	1		
H18	Suicide	1		
H02	Supply Chain Shortage / Failure	1	10	38
H10	Supply Chain Shortage / Failure	1		
H13	Supply Chain Shortage / Failure	10		
H19	Supply Chain Shortage / Failure	16		
H25	Supply Chain Shortage / Failure	5		
H26	Supply Chain Shortage / Failure	1		
H28	Supply Chain Shortage / Failure	1		
H34	Supply Chain Shortage / Failure	1		
H36	Supply Chain Shortage / Failure	1		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H50	Supply Chain Shortage / Failure	1		
H10	Suspicious Odor	1	5	7
H12	Suspicious Odor	2		
H45	Suspicious Odor	1		
H56	Suspicious Odor	1		
H13	'Suspicious Odor	2		
H25	Temperature Extremes	6	2	8
H27	Temperature Extremes (Radiology)	2	1	2
H16	Transportation Failure	1	6	18
H18	Transportation Failure	1		
H21	Transportation Failure	1		
H25	Transportation Failure	4		
H27	Transportation Failure	10		
H45	Transportation Failure	1		
H02	Trauma	1	14	86
H03	Trauma	34		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H04	Trauma	7		
H11	Trauma	1		
H12	Trauma	2		
H19	Trauma	21		
H21	Trauma	5		
H27	Trauma	5		
H34	Trauma	1		
H43	Trauma	1		
H45	Trauma	5		
H53	Trauma	1		
H54	Trauma	1		
H57	Trauma	1		
H13	valley	1	1	1
H02	VIP Situation	1	6	32
H19	VIP Situation	11		
H25	VIP Situation	10		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H28	VIP Situation	8		
H54	VIP Situation	1		
H57	VIP Situation	1		
H09	Water Contamination	1		
H16	Water Contamination	1		
H26	Water Contamination	1	5	8
H27	Water Contamination	2		
H28	Water Contamination	3		
H11	Water Disruption	1		
H26	Water Disruption	1		
H27	Water Disruption	20	6	25
H43	Water Disruption	1		
H53	Water Disruption	1		
H54	Water Disruption	1		
H11	Weapon	1	1	1
H13	Workplace Violence / Threat	3	12	48

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H16	Workplace Violence / Threat	1		
H18	Workplace Violence / Threat	1		
H20	Workplace Violence / Threat	1		
H21	Workplace Violence / Threat	1		
H25	Workplace Violence / Threat	9		
H26	Workplace Violence / Threat	1		
H43	Workplace Violence / Threat	1		
H45	Workplace Violence / Threat	20		
H50	Workplace Violence / Threat	8		
H53	Workplace Violence / Threat	1		
H57	Workplace Violence / Threat	1		
TOTAL		856		
H17	No actual hazard reported	0	9	0
H32	No actual hazard reported	0		
H33	No actual hazard reported	0		

Hospital code	Top 10 actual alerts	Occurrence	Number of hospitals	Total estimated times of occurrences
H35	No actual hazard reported	0		
H37	No actual hazard reported	0		
H39	No actual hazard reported	0		
H42	No actual hazard reported	0		
H51	No actual hazard reported	0		
H55	No actual hazard reported	0		

Appendix 5.2 Distribution of scores for individual elements of the functional domain across all selected hospitals in Riyadh Region of KSA hospitals in Riyadh Region of KSA

Hospital Code	Ownership	Location to the city	Level of Care	Functional Elements																	Total Score	% of Total Score
				SA (16)	AF (34)	WS (21)	TR (30)	PI (46)	HVA (19)	EP (63)	SC (18)	HR (7)	RP (72)	PD (8)	CI (10)	FM (5)	DS (15)	HF (16)	TD (38)	EV (28)		
H01	Public	Inner	Tertiary	15	26	13	19	17	16	57	16	3	45	4	6	5	10	4	31	25	312	69.96
H02	Public	Inner	Tertiary	13	26	18	19	19	3	44	11	2	45	0	5	0NA	8	3	13	23	252	57.14
H03	Public	Inner	Secondary	14	28	11	11	18	0	40	0	4	18	0	0	5	8	2	25	18	202	45.29
H04	Public	Inner	Tertiary	14	28	11	11	18	0	40	0	3	18	0	0	5	8	2	25	18	201	45.07
H06	Public	Inner	Tertiary	15	12	18	14	8	0	39	0	2	29	0	7	0NA	8	4	28	22	206	46.71
H07	Public	Inner	Secondary	14	23	19	10	11	0	46	0	5	33	8	4	5	9	2	26	18	233	52.24
H08	Public	Outer	Secondary	13	21	19	14	6	13	43	11	4	33	0	0	5	7	5	19	22	235	52.69
H09	Public	Inner	Tertiary	15	17	19	11	9	13	42	11	2	37	0	0	5	10	6	23	23	243	54.48
H10	Public	Inner	Tertiary	9	13NA	17	11	9	0	41	0	4	20NA	NA	0	3	5	2	23	16	140	41.67
H11	Public	Inner	Secondary	14	15	16	13	8	0	27	0	1	19	6	0	5	9	8	23	16	180	40.36
H12	Public	Inner	Secondary	15	24	18	10	19	12	44	0	4	45	3	2	4	11	2	21	21	255	57.17
H13	Public	Outer	Secondary	13	21	16	13	12	0	37	0	3	30	0	5	5	7	5	20	18	205	45.96
H15	Public	Outer	Secondary	13	20	19	15	14	0	43	0	7	30	0	5	3	9	4	27	22	231	51.79

Hospital Code	Ownership	Location to the city	Level of Care	Functional Elements																	Total Score	% of Total Score
				SA (16)	AF (34)	WS (21)	TR (30)	PI (46)	HVA (19)	EP (63)	SC (18)	HR (7)	RP (72)	PD (8)	CI (10)	FM (5)	DS (15)	HF (16)	TD (38)	EV (28)		
H16	Public	Inner	Secondary	13	20	19	8	21	4	46	0	2	35	7	3	5	7	4	26	22	242	54.26
H17	Public	Outer	Tertiary	13	26	20	14	10	5	40	10	2	34	0	7	5	8	1	25	20	240	53.81
H18	Public	Outer	Tertiary	9	17	19	7	11	0	30	0	4	21	0	5	0NA	2NA	0	19	21	163	38.26
H19	Public	Outer	Secondary	16	24	17	16	23	0	52	0	6	53	1	6	4	8	10	27	17	280	62.78
H20	Public	Outer	Secondary	11	18	19	6	12	0	33	0	4	35	0	1	5	7	1	22	14	188	42.15
H21	Public	Outer	Secondary	14	23	16	15	22	0	47	0	7	39	0	7	4	11	5	24	17	251	56.28
H22	Public	Inner	Tertiary	14	21	17	6	22	6	29	0	4	31	0	1	3	8	0	24	21	207	46.41
H25	Public	Outer	Secondary	14	25	17	15	20	0	35	0	5	18	0	4	4	6	8	21	21	213	47.76
H26	Public	Outer	Secondary	15	18	11	9	17	0	36	0	4	36	2	6	4	12	4	22	19	215	48.21
H27	Public	Outer	Secondary	13	23	15	13	10	0	39	0	5	28	0	6	3	6	2	12	20	195	43.72
H28	Public	Inner	Tertiary	16	24	16	18	19	16	47	11	4	50	8	2	2	11	0	27	18	289	64.80
H32	Public	Inner	Secondary	15	24	16	11	18	10	39	0	4	37	5	4	4	13	2	22	15	239	53.59
H33	Public	Inner	Tertiary	15	24	16	11	18	10	39	0	2	37	5	4	4	13	2	22	15	237	53.14
H34	Public	Inner	Secondary	14	24	17	15	21	13	45	0	5	55	4	5	5	13	9	32	23	300	67.26
H35	Public	Inner	Tertiary	15	15	19	9	22	14	36	0	3	47	0	0	0NA	13	5	24	17	239	54.20

Hospital Code	Ownership	Location to the city	Level of Care	Functional Elements																	Total Score	% of Total Score
				SA (16)	AF (34)	WS (21)	TR (30)	PI (46)	HVA (19)	EP (63)	SC (18)	HR (7)	RP (72)	PD (8)	CI (10)	FM (5)	DS (15)	HF (16)	TD (38)	EV (28)		
H36	Public	Inner	Secondary	16	28	19	15	19	8	48	0	4	41	8	1	5	13	9	15	27	276	61.88
H37	Public	Inner	Secondary	15	14	14	10	26	15	47	0	3	35	3	6	4	9	3	17	20	241	54.04
H39	Private	Inner	Secondary	15	22	19	13	12	0	45	0	6	34	0	0	5	11	4	19	23	228	51.12
H41	Private	Inner	Secondary	14	17	19	12	27	0	57	0	5	53	5	0	5	9	6	31	20	280	62.78
H42	Private	Inner	Secondary	12	18	19	11	18	15	50	0	3	45	0	8	4	13	11	25	24	276	61.88
H43	Private	Inner	Secondary	16	29	19	13	20	16	55	11	4	52	8	10	5	12	9	34	23	336	75.34
H45	Public	Outer	Secondary	12	18	17	13	20	0	39	8	6	35	0	4	2	7	3	20	15	219	49.10
H50	Private	Inner	Tertiary	11	24	14	11	19	10	39	0	1	44	1	1	2	8	4	25	26	240	53.81
H51	Private	Inner	Tertiary	13	15	18	8	8	0	28NA	0	4	18NA	NA	2	2	3	1	25	16	115	34.85
H53	Private	Inner	Secondary	13	23	12	11	9	0	37	0	4	32	0	0	3	7	0	25	21	197	44.17
H54	Private	Inner	Secondary	14	21	18	11	30	1	43	0	6	41	4	0	4	8	1	19	20	241	54.04
H55	Private	Inner	Secondary	14	25	19	12	8	10	37	12	2	37	4	0	2	6	1	22	23	234	52.47
H56	Private	Inner	Secondary	16	27	17	9	24	0	45	0	5	39	0	2	4	11	3	29	24	255	57.17
H57	Private	Inner	Secondary	13	17	16	13	25	0	41	0	5	51	0	0	5	11	1	26	25	249	55.83

Key: SA= Site accessibility, AF = Area in the facility, WS = Warning system and safety, TR = Transportation, PI = Public information, HVA = Hazard vulnerability assessment, EP = Emergency and planning group, SC = Subcommittees, HR = Human resources, RP = Response protocol, PD = Patient decontamination, CI = Community involvement, FM = Fatality management, DS = Disease surveillance, HFW = Health facility networking, TD = Training and drills, NA = Not applicable.

Appendix 5.3 Distribution of scores for individual elements of the non-structural domain across all selected hospitals in Riyadh Region of KSA

Hospital Code	Ownership	Location to the city	Level of Care	Non-structural Elements			Total Score	% of Total Score
				EQ (16)	UT (34)	ST (19)		
H01	Public	Inner	Tertiary	49	37	15	101	89.38
H02	Public	Inner	Tertiary	44	38	12	94	83.19
H03	Public	Inner	Secondary	37	35	14	86	76.11
H04	Public	Inner	Tertiary	37	35	14	86	76.11
H06	Public	Inner	Tertiary	36	25	11	72	63.72
H07	Public	Inner	Secondary	42	38	10	90	79.65
H08	Public	Outer	Secondary	43	34	10	87	76.99
H09	Public	Inner	Tertiary	31	31	10	72	63.72
H10	Public	Inner	Tertiary	38	29	5	72	63.72
H11	Public	Inner	Secondary	36	31	6	73	64.60
H12	Public	Inner	Secondary	37	35	11	83	73.45
H13	Public	Outer	Secondary	40	33	9	82	72.57
H15	Public	Outer	Secondary	32	37	10	79	69.91
H16	Public	Inner	Secondary	37	36	11	84	74.34
H17	Public	Outer	Tertiary	40	39	12	91	80.53
H18	Public	Outer	Tertiary	29	26	9	64	56.64
H19	Public	Outer	Secondary	44	36	6	86	76.11
H20	Public	Outer	Secondary	42	33	9	84	74.34
H21	Public	Outer	Secondary	45	39	12	96	84.96

Hospital Code	Ownership	Location to the city	Level of Care	Non-structural Elements			Total Score	% of Total Score
				EQ (16)	UT (34)	ST (19)		
H22	Public	Inner	Tertiary	29	31	6	66	58.41
H25	Public	Outer	Secondary	47	37	6	90	79.65
H26	Public	Outer	Secondary	37	19	8	64	56.64
H27	Public	Outer	Secondary	42	29	7	78	69.03
H28	Public	Inner	Tertiary	48	41	13	102	90.27
H32	Public	Inner	Secondary	39	37	10	86	76.11
H33	Public	Inner	Tertiary	41	37	10	88	77.88
H34	Public	Inner	Secondary	52	38	11	101	89.38
H35	Public	Inner	Tertiary	46	35	11	92	81.42
H36	Public	Inner	Secondary	42	40	11	93	82.30
H37	Public	Inner	Secondary	43	38	11	92	81.42
H39	Private	Inner	Secondary	41	37	10	88	77.88
H41	Private	Inner	Secondary	42	38	10	90	79.65
H42	Private	Inner	Secondary	39	35	9	83	73.45
H43	Private	Inner	Secondary	50	33	13	96	84.96
H45	Public	Outer	Secondary	43	35	4	82	72.57
H50	Private	Inner	Tertiary	42	40	8	90	79.65
H51	Private	Inner	Tertiary	31	29	6	66	58.41
H53	Private	Inner	Secondary	37	37	8	82	72.57
H54	Private	Inner	Secondary	43	36	5	84	74.34
H55	Private	Inner	Secondary	38	41	10	89	78.76

Hospital Code	Ownership	Location to the city	Level of Care	Non-structural Elements			Total Score	% of Total Score
				EQ (16)	UT (34)	ST (19)		
H56	Private	Inner	Secondary	46	38	11	95	84.07
H57	Private	Inner	Secondary	46	30	10	86	76.11

Key: EQ = Equipment and supply UT=Utilities, ST= Security NA = Not applicable

Appendix 5.4 Distribution of scores for individual elements of the functional and the non-structural domains across all selected hospitals in Riyadh Region of KSA hospitals in Riyadh Regio

Healthfacility code	public/Private	site&accessibilitties (16)	areas in the facilities (34)	Equipment and supply (56)	Utilities (42)	warning system and safety (21)	Security (15)	Transportation (30)	Public information (46)	HVA (19)	Emergency and planning group (63)	sub-committee (18)	Human resources(7)	Response protocol (72)	pt Decontamination(8)	community involvement(10)	Fatalities management (5)	Disease surveillance (15)	Health facilities networking (16)	Training and drill(38)	Evacuation (28)	Total score (559)	Percentage
H01	public	15	26	49	37	13	15	19	17	16	57	16	3	45	4	6	5	10	4	31	25	413	73.88
H0 2	public	13	26	44	38	18	12	19	19	3	44	11	2	45	0	5	0 NA	8	3	13	23	346	62.45
H03	public	14	28	37	35	11	14	11	18	0	40	0	4	18	0	0	5	8	2	25	18	288	51.52
H04	public	14	28	37	35	11	14	11	18	0	40	0	3	18	0	0	5	8	2	25	18	287	51.34
H06	public	15	12	36	25	18	11	14	8	0	39	0	2	29	0	7	0 NA	8	4	28	22	278	50.18
H07	public	14	23	42	38	19	10	10	11	0	46	0	5	33	8	4	5	9	2	26	18	323	57.78
H08	public	13	21	43	34	19	10	14	6	13	43	11	4	33	0	0	5	7	5	19	22	322	57.60
H09	public	15	17	31	31	19	10	11	9	13	42	11	2	37	0	0	5	10	6	23	23	315	56.35
H010	public	9	13 NA	38	29	17	5	11	9	0	41	0	4	20 NA	NA	0	3	5	2	23	16	212	43.71
H011	public	14	15	36	31	16	6	13	8	0	27	0	1	19	6	0	5	9	8	23	16	253	45.26
H012	public	15	24	37	35	18	11	10	19	12	44	0	4	45	3	2	4	11	2	21	21	338	60.47
H13	public	13	21	40	33	16	9	13	12	0	37	0	3	30	0	5	5	7	5	20	18	287	51.34
H15	public	13	20	32	37	19	10	15	14	0	43	0	7	30	0	5	3	9	4	27	22	310	55.46
H16	public	13	20	37	36	19	11	8	21	4	46	0	2	35	7	3	5	7	4	26	22	326	58.32
H17	public	13	26	40	39	20	12	14	10	5	40	10	2	34	0	7	5	8	1	25	20	331	59.21
H18	public	9	17	29	26	19	9	7	11	0	30	0	4	21	0	5	0 NA	2 NA	0	19	21	227	42.12
H19	public	16	24	44	36	17	6	16	23	0	52	0	6	53	1	6	4	8	10	27	17	366	65.47
H20	public	11	18	42	33	19	9	6	12	0	33	0	4	35	0	1	5	7	1	22	14	272	48.66
H21	public	14	23	45	39	16	12	15	22	0	47	0	7	39	0	7	4	11	5	24	17	347	62.08
H22	public	14	21	29	31	17	6	6	22	6	29	0	4	31	0	1	3	8	0	24	21	273	48.84
H25	public	14	25	47	37	17	6	15	20	0	35	0	5	18	0	4	4	6	8	21	21	303	54.20
H26	public	15	18	37	19	11	8	9	17	0	36	0	4	36	2	6	4	12	4	22	19	279	49.91
H27	public	13	23	42	29	15	7	13	10	0	39	0	5	28	0	6	3	6	2	12	20	273	48.84
H28	public	16	24	48	41	16	13	18	19	16	47	11	4	50	8	2	2	11	0	27	18	391	69.95
H32	public	15	24	39	37	16	10	11	18	10	39	0	4	37	5	4	4	13	2	22	15	325	58.14
H33	public	15	24	41	37	16	10	11	18	10	39	0	2	37	5	4	4	13	2	22	15	325	58.14
H34	public	14	24	52	38	17	11	15	21	13	45	0	5	55	4	5	5	13	9	32	23	401	71.74
H35	public	15	15	46	35	19	11	9	22	14	36	0	3	47	0	0	0 NA	13	5	24	17	331	59.75
H36	public	16	28	42	40	19	11	15	19	8	48	0	4	41	8	1	5	13	9	15	27	369	66.01
H37	public	15	14	43	38	14	11	10	26	15	47	0	3	35	3	6	4	9	3	17	20	333	59.57
H39	Private	15	22	41	37	19	10	13	12	0	45	0	6	34	0	0	5	11	4	19	23	316	56.53
H41	Private	14	17	42	38	19	10	12	27	0	57	0	5	53	5	0	5	9	6	31	20	370	66.19
H42	Private	12	18	39	35	19	9	11	18	15	50	0	3	45	0	8	4	13	11	25	24	359	64.22
H43	Private	16	29	50	33	19	13	13	20	16	55	11	4	52	8	10	5	12	9	34	23	432	77.28
H45	Public	12	18	43	35	17	4	13	20	0	39	8	6	35	0	4	2	7	3	20	15	301	53.85
H50	Private	11	24	42	40	14	8	11	19	10	39	0	1	44	1	1	2	8	4	25	26	330	59.03
H51	Private	13	15	31	29	18	6	8	8	0	28 NA	0	4	18 NA	0	2	2	3	1	25	16	181	42.69
H53	Private	13	23	37	37	12	8	11	9	0	37	0	4	32	0	0	3	7	0	25	21	279	49.91
H54	Private	14	21	43	36	18	5	11	30	1	43	0	6	41	4	0	4	8	1	19	20	325	58.14
H55	Private	14	25	38	41	19	10	12	8	10	37	12	2	37	4	0	2	6	1	22	23	323	57.78
H56	Private	16	27	46	38	17	11	9	24	0	45	0	5	39	0	2	4	11	3	29	24	350	62.61
H57	Private	13	17	46	30	16	10	13	25	0	41	0	5	51	0	0	5	11	1	26	25	335	59.93
Mean score		13.8	21.6	40.5	34.7	16.9	9.6	12.0	16.6	5.0	41.9	2.4	3.9	36.9	2.1	3.1	4.1	9.1	3.8	23.5	20.2	317.74	
percentage mean		86.01	63.49	72.41	82.65	80.27	64.13	40.16	36.18	26.32	66.55	13.36	55.44	51.28	26.22	19.20	82.29	60.65	23.51	61.72	72.19	56.84	