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SUN SAFETY IN UK CONSTRUCTION:

A PROFILING AND INTERVENTION STUDY

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Thesis submitted to the University of Nottingham

for the degree of Master of Research

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Abstract

Background: Construction workers spend a large proportion of their work time outdoors, placing them at increased risk for skin cancer. To date, no large-scale studies have examined occupational sun safety knowledge, attitudes, and practices within this group in the UK context. Given the high incidence of skin cancer attributable to sun exposure in construction relative to other occupational groups, interventions to promote sun safety in the UK construction sector are warranted.

Aims: The current investigation has two aims. First, to describe the occupational sun safety knowledge, attitudes, and practices of a large and nationally representative sample of construction workers in the UK. Second, to evaluate change in sun safety knowledge and practices among construction workers in response to an educational intervention.

Methods: The first aim was addressed through the administration of a self-report questionnaire in the summer of 2012. The second aim was addressed through the subsequent administration of a bespoke sector-specific DVD-based intervention. The effectiveness of the intervention was evaluated via the administration of a further questionnaire at 12-month follow-up.

Results: A total of 1,279 workers from 22 organisations completed a baseline (pre-intervention) self-report questionnaire. Findings indicated poor knowledge on the topic and of the measures available to reduce levels of solar ultraviolet radiation exposure. The findings at this stage of the project confirmed the imperative for a tailored, targeted, and evaluable educational intervention that could help to enhance

sun safety knowledge, attitudes and behavior in the sector. In relation to the second aim, analyses were conducted on a sample of 120 workers (intervention group, n = 70; comparison group, n = 50). At follow-up the proportion of intervention group participants that reported correct sun safety knowledge was not significantly greater than at baseline. However, the intervention group demonstrated significant positive change on nine out of ten behavioural measures, the greatest change being use of a shade/cover when working in the sun followed by regularly checking skin for moles or unusual changes.

Conclusions: The profiling exercise indicated that there is a need to raise the profile of occupational skin cancer among this population and increase the priority given to occupational sun safety policies alongside targeted, tailored, and evaluable interventions. Exposure to this intervention was linked to some specific positive changes in construction workers' self-reported sun safety practices. These findings highlight the potential for educational interventions to contribute to tackling skin cancer in the UK construction sector. The findings support the development of bespoke educational interventions for other high-risk outdoor worker groups.

Keywords: Construction, skin cancer, solar radiation, sun safety, intervention, transtheoretical model.

Preface

In 2008, I commenced an MSc in Workplace Health with the Institute of Work, Health and Organisations (IWHO) at the University of Nottingham, deciding on this course due to its unique and contemporary approach and philosophy.

As part of the Masters course I was required to undertake an applied research project. I choose the topic of skin cancer, not, thankfully, due to personal experience but from an interest in this area fuelled by experiences in my career. I remember in the early years of my career, seeing ground workers on site in their rigger boots and safety helmets (as these were site safety rules and legislation that had to be adhered to) accompanied by either a cut down pair of shorts or pants while working in the sun. These people tended not to show what I thought of then as the typical physical signs of sunburn - red or pink skin - but had very dark coloured skin on their backs, which looked to be quite hard or leathery in appearance.

The Masters project gave me the opportunity to examine whether the views I had received over many years from construction workers regarding their awareness and perception of the risks from working outdoors in the sun were widespread across the industry. I surveyed 360 construction workers within the UK and findings indicated that there was a paucity of awareness of the risks of solar ultraviolet radiation (UVR) from working outdoors in the summer. Upon completion of my Masters degree the findings of the applied research project were published in Occupational Medicine under the title ‘Sun safety measures among construction workers in Britain’ (Madgwick, Houdmont, & Randall, 2011).

I felt, following the positive outcome of the project for my MSc, that the next stage in my occupational health academic and practitioner journey might usefully

address the development and evaluation of a sector-specific tool to raise awareness on the topic and encourage positive knowledge, attitude, and behaviour change.

In order for the project to reach the widest and most diverse range of construction workers across the broadest geographical spread, I approached the Institution of Occupational Safety and Health (IOSH). The aim in approaching IOSH was to secure sufficient funding to allow a) the production of a high quality sector-specific intervention in the form of an awareness DVD, and b) the support of an internationally renowned professional body to encourage construction companies to engage with the project. I made the conscious decision to apply for funding from IOSH rather than from a cancer charity to help in engaging health and safety practitioners to get their organisations involved in the research. Following successful submissions and a presentation to the review board, IOSH offered the necessary funding for the project. The development of the intervention (the DVD) was funded through the IOSH Development Fund. The evaluation of the intervention was funded through the IOSH Research Fund.

The IOSH funded element of the project was monitored by a steering group comprising academics with research interests in occupational health interventions and construction sector experts, with Dr. Jonathan Houdmont, the Course Director of the MSc, as academic lead. I had day-to-day responsibility for management of the project. This current project has developed out of my own work on all the various elements including presentations to engage construction companies to be a part of the project; the development, scripting and co-ordination of the filming of the DVD-based intervention; development and administration of questionnaires to evaluate the impact of exposure to the intervention; and analysis of quantitative data.

Acknowledgements

There are many people who have supported me in the production of this thesis and to whom I am eternally grateful. In no particular order, I would firstly like to thank the UK construction companies, managers and particularly those construction workers who engaged in this research, without you this thesis would not have been possible.

Thanks to IOSH, their research fund committee, but in particular Richard Jones and Mary Ogungbeje, for having the trust and belief in me to provide funding to allow a much larger scale research project to be undertaken. The project steering group, especially Ian Strudley, Alex Wilson and John Lacey proved invaluable in the time, support and enthusiasm they offered to both the project and myself. Thanks also to Tyrone and Chris at BESQ for working with me so closely to deliver such a superb film/DVD.

I would also like to thank my supervisors, Dr. Jonathan Houdmont and Dr. Raymond Randall for their guidance, support and encouragement. Jonathan in particular has shown great patience and resilience in his endeavours whilst assisting in turning my passion and enthusiasm for this topic into the thesis you see before you.

Finally, I would like to say a big thank you to my family for their continued love, support and encouragement throughout the production of this thesis. In particular I would like to thank my wife, Maria, for putting up with the highs and lows of this journey and for doing far more than her fair share of the household chores whilst I was sat, often frustrated, developing the project and the resultant thesis you're the best.

Evidence of Contribution and Impact

The research described in this dissertation has produced the following papers, presentations, and policy contributions.

Peer-reviewed academic articles

Houdmont, J., Madgwick, P., & Randall, R. (in press). Sun safety in construction: A UK intervention study. Occupational Medicine.

Practitioner publications

Madgwick, P. (2015). Sun exposure and skin cancer: health advice for outdoor workers. Safety and Health Practitioner. 33(4), 28-29.

Peer-reviewed conference presentations

Madgwick, P., Houdmont, J. & Randall, R. (2014). An evaluation of a sun safety intervention for the UK construction sector using the transtheoretical model of behaviour change. Poster presented at the European Academy of Occupational Health Psychology Annual Conference, London.

Madgwick, P. (2014). Sun exposure and skin cancer: practical choices for those working outdoors. Oral paper presented at the Health and Well Being @ Work Conference, Birmingham.

Madgwick, P., Houdmont, J. & Randall, R. (2013). Relationships between sun safety training and sun safety behaviour. Oral paper presented at the 2nd International Conference of UV and Skin Cancer, Berlin.

Madgwick, P., Houdmont, J. & Randall, R. (2013). Using the theory of planned behaviour to examine facilitators and barriers in the use of sun safety measures in UK construction. Poster presented at the 2nd International Conference of UV and Skin Cancer, Berlin.

Madgwick, P., Houdmont, J. & Randall, R. (2012). Development and assessment of a sun safety training intervention for British construction workers. Oral paper presented at the British Occupational Hygiene Society Annual Conference, Cardiff.

Madgwick, P., Houdmont, J. & Randall, R. (2011). Construction workers awareness of the risks of skin cancer from working outdoors. Oral paper presented at the British Occupational Hygiene Society Annual Conference, Stratford upon Avon.

Other presentations

Madgwick, P. (2015). Sun exposure and skin cancer: practical choices for those working outdoors. Oral presentation at Health and Safety Committee, UK Construction Group, London.

Madgwick, P. (2015). Sun exposure and skin cancer: practical choices for those working outdoors. Webinar presentation for the IOSH Construction Group, Leicester.

Madgwick, P. (2015). The development and evaluation of a sun safety intervention for construction workers. Oral presentation at the IOSH No Time to Lose campaign launch, London.

Madgwick, P. (2014). Sun exposure and skin cancer: practical choices for those working outdoors. Oral presentation at the IOSH Midlands group meeting, Birmingham.

Madgwick, P. (2013). Sun exposure and skin cancer: practical choices for those working outdoors. Oral presentation at the Scottish House Builders Health and Safety Forum, Edinburgh.

Madgwick, P. (2011 & 12). Skin cancer awareness for construction workers working outside: practical awareness training. Oral presentation at the Health & Safety Executive offices, Basingstoke.

Madgwick, P. (2012). Awareness of skin cancer from solar radiation in the UK and introduction to the research project. Oral presentation to the contractors' health and safety directors at the Crossrail project, London.

Madgwick, P. (2012). Awareness of skin cancer from solar radiation in the UK and introduction to the research project. Oral presentation to the House Builders Federation health and safety group, Ashby de la Zouch.

Madgwick, P. (2012). Awareness of skin cancer from solar radiation in the UK and introduction to the research project. Oral presentation to the H.S.E.'s CONIAC health risks group, London.

Policy contributions

The research described herein has formed a central component of the IOSH 'No Time To Lose' 2015 occupational skin cancer campaign.

The DVD-based educational intervention developed for and evaluated within the current investigation has received in excess of 6,000 views on YouTube between April and December 2015.

1. Introduction

Skin cancer is the most common cancer in the UK with just under 116,000 new cases reported annually (Cancer Research UK, 2014). Cases have increased overall by six to eight per cent every year since the 1960s whilst the number of cases of the most serious form of skin cancer has quadrupled since the 1970's (Cancer Research UK, 2014a).

From an occupational perspective, skin cancer had the second highest number of occupational cancer cases in men and third highest in women. Of all occupations, the construction industry had the most skin cancer registrations, with 55 per cent of all registrations. It also accounted for 58 per cent of total deaths (Rushton et al., 2010), with construction workers over 6 times more likely to get skin cancer than all other employment sectors combined (Stocks, McNamee, Carder, Aguis, 2010).

The high incidence and heightened risk of skin cancer within the construction sector in the U.K. along with the potential to prevent skin cancer through relatively basic techniques presented the imperative for this project which was the development, implementation and evaluation of interventions focused on raising awareness of sun safety in the U.K. construction sector.

1.1 Skin –its Physical Make Up

When evaluating a study of skin cancer and its relative impact on the body, it is first important to have an understanding of skin, its layers and components. Skin, as the largest organ, is much more than the body's outer covering, giving us our appearance and shape. Skin provides the body with a protective barrier from environmental, thermal and mechanical impacts. Environmental impacts are commonly in the form of chemicals, bacteria and of ultra violet (U.V.) radiation created by the sun. Thermal impacts are caused by extremes of heat or cold.

Mechanical impacts are caused by pressure and force being applied to the body (DermIS, 2014a).

The skin, in addition to offering a covering and protection to the body, provides storage for water, fat and vitamin D, as well as regulating body temperature. It is made up of three main layers, the epidermis, dermis and subcutaneous fat, each of which performs specific functions.

1.1.1 subcutaneous fat

The bottom layer of the skin consists of a large amount of fat which as well as helping to insulate the body by monitoring heat gain and heat loss acts as a protective cushion for muscle, bones and internal organs. This layer also contains loose connective tissue which connects the middle layer of the skin (dermis) to muscles and bones (DermIS, 2014).

1.1.2 dermis

The dermis is the middle layer of the skin and incorporates many functions. Firstly, it contains blood vessels which supply the skin with fresh blood containing nutrients and oxygen. Blood vessels also remove waste products back into the blood stream. Sweat glands are also located in the dermis which produce sweat which, through tiny tubes, come out of holes called pores in the top layer (epidermis) of the skin. Sweat is part of the body's mechanism for thermoregulation. Another element of thermoregulation is created through hair follicles, the root of each hair on the skin. When the body gets cold, the hair, which passes through a pore, stands upright. Detecting this, the arrector pili muscle closes the pore, keeping body warmth in. Another gland within the dermis is the sebaceous glands which make and secrete seburn, an oily substance which is a natural moisturiser for hair and the skin, keeping it soft, smooth and waterproof. The final significant element within the dermis are

nerve endings. The nerve endings through nerve fibres send signals to the brain warning of pain, temperature changes and itchiness to the skin (American Academy of Dermatology, n.d.; DermIS, 2014).

1.1.3 epidermis

The epidermis is the top or outer layer of skin and is the one of most importance when considering skin cancer as this is the layer where it generally develops. The epidermis is constantly creating new skin cells with sub layers of differing size and shape working up to the top layer, known as the horny layer, where they die, become hard and then flake and become discarded. This process takes around a month with the body discarding around thirty to forty thousand old skin cells daily, which sounds a significant amount until it is considered that there are around nineteen million skin cells in every inch of the body. The area where the skin changes layer from the dermis to the epidemis has a membrane in place called the basal cell membrane. Directly above the membrane, are small, round cells called basal cells. At the deepest area of the epidermis, cells called melanocytes produce a dark pigment called melanin. Melanin gives the skin its colour and also offers some ultra violet (U.V.) protection. Above the layer of basal cells and closest to the surface are flat, scale like cells called squamous cells (American Academy of Dermatology, n.d.; DermIS, 2014; MedicineNet, 2002).

1.2 Skin Cancer

Skin cancer develops when the Deoxyribo Nucleic Acid (D.N.A.), which is the molecule within cells that encodes genetic information in humans that determines the structure, function and behaviour of cells within skin cells, become damaged and the body cannot repair the damage. The damaged cells grow, divide and multiply creating a tumour. (SkinCancerNet, n.d.)

There are three principle types of skin cancer. Two of these, basal cell carcinoma and squamous cell carcinoma, are classified as non-melanoma skin cancer, the third is malignant melanoma.

1.2.1 basal cell carcinoma

Basal cell carcinoma (B.C.C.) is the commonest form of skin cancer, with approximately 75% of skin cancers diagnosed being B.C.C. (Cancer Research UK, 2014 b). B.C.C. gets its name as the cancer commences in the basal layer of the epidermis. This type of cancer is found mainly on areas of the skin which contain hair and which are exposed to the sun, typically being the face (especially the nose, forehead and cheeks), scalp, ears and upper parts of the chest, shoulders, back (DermIS, 2014b) and sometimes the lower legs. B.C.C. has several different subtypes, nodular, superficial, morphoeic and pigmented, each of which have their own look and behaviour patterns. Around 50% of B.C.C.'s are the nodular type (Cancer Research UK, 2014b). The most common appearance of B.C.C. is initially as a small, red coloured, slightly raised translucent nodule with tiny blood vessels visible. It can also appear as a red to white- brownish scaly patch. The B.C.C. may itch, be sensitive to the touch and even bleed. In the majority of cases, the B.C.C. grows slowly and rarely spreads to other parts of the body, however in later stages ulceration and disfigurement can occur. The ulcer, referred to as a rodent ulcer can cause deep tissue and even bone damage (DermIS, 2014b). Epidemiological evidence indicates that short, burning, and intermittent episodes of sun exposure are more important than a cumulative lifetime of exposure to the sun in the creation of B.C.C. risk (MacKie, 2006)

1.2.2 squamous cell carcinoma

Squamous Cell Carcinoma (S.C.C.) is the second most common form of skin cancer with about 20% of all skin cancers diagnosed being this type. S.C.C. is found in the top layer of the epidermis in the squamous cells and is faster growing than B.C.C.. S.C.C. is most commonly found in areas that have been exposed to the sun, typically parts of the head, neck and the backs of hands and forearms, although it can also be found to develop in scars and areas of skin that have previously been burnt or are ulcerated (Cancer Research UK, 2014 b). S.C.C. usually begins as a small area of crusty skin similar to eczema, then turning into a grey or yellow – brown coloured skin blemish resembling a wart. The affected area will often start bleeding easily when brushed against something. Growth of the S.C.C. is commonly slow and painless in the early stages. In later / advanced stages, the cancer can spread quickly, working its way down to the dermis from where it can spread cancerous cells to other parts of the body, typically through lymph nodes and the lymphatic system. This type of skin cancer, whilst looking reasonably small on the skin's surface can have affected a large area of cells below. This spread of the cancerous cells is often likened to an iceberg (DermIS , 2014c). Epidemiological evidence indicates that total cumulative lifetime of exposure to the sun is directly related to S.C.C. risk (MacKie, 2006)

1.2.3 malignant melanoma

Malignant Melanoma (M.M.) is the least common, but most aggressive and life threatening form of skin cancer. M.M. develops from melanocytes located in the deepest areas of the epidermis. There are four main types of M.M., superficial spreading melanoma, which is the commonest form of M.M. with around 70% of cases. There is also nodula melanoma, lentigo maligna melanoma and acral lentiginous melanoma. The main feature of M.M. is that affected melanocytes

multiply rapidly, spreading to the upper areas of the skin commonly causing a mole or dark spot to appear on the skin's surface, although pre-existing moles can be affected. The affected mole has a different appearance to a typical mole with common 'tell tale' signs being of non-symmetrical shape, the mole having irregular shaped borders, being of several colours (shades of brown, black, red, blue or white), being of a diameter larger than six millimetres and being quite elevated from the surrounding skin. The area can become ulcerated which can lead to infection. The location of the cancer does not have to be in an area of skin exposed to the sun. Growth and spread of the M.M. is commonly fast and after initial growth at the visible area / surface of the skin, the cancer grows quickly down into deep areas of the skin where it will spread cancerous cells through the lymphatic system and lymph nodes. In its later stages, M.M. can affect internal organs such as the respiratory system, liver, brain and bones. (Newcombe, 2010) A significant difference between M.M. and the two N.M.S.C.'s is that a much younger age range are being diagnosed with M.M. than the two N.M.S.C.'s, it is now one of the most common types of cancer in the age range 15 to 34 (Cancer Research UK , 2014a). Evidence has indicated that an increased risk of M.M. is found with intermittent sun exposure, mainly from recreational activities, and especially from getting sun burnt, rather than from a cumulative lifetime of exposure associated with an outdoor occupation. Several studies have found that a history of sunburn is an important risk factor, as is the level of sun exposure in childhood (Vecchia, Hietanen, Stuck, van Deventer & Niu, 2007)

1.2.4 areas of the body affected

Skin cancer affects areas of skin that are uncovered and therefore open to exposure from an element known to cause skin cancer. Cancer Research UK reports the following parts of the body, by sex, (based on cases in the UK 2008-2010) as

being diagnosed with skin cancer (specifically the malignant melanoma). Males: trunk (41%), head and neck (22%), arm (19%), leg (13%) and non-specific or overlapping areas (4%). Females: leg (39%), arm (24%), trunk (20%), head and neck (14%) and non-specific or overlapping areas (3%) (Cancer Research UK, 2013). The difference in percentage distribution of cases diagnosed between males and females is principally due to clothing or coverage of different areas of exposed skin. For example, females commonly have longer hair than males, which would explain the lower percentage of head and neck cases, whereas the increase in female cases involving legs would be explained by the wearing of skirts and dresses.

1.3 Causal agents

Historically, when a large amount of employment within the U.K. was in the heavy engineering and mining industries, a large number of cases of skin cancer were caused by welding burns, ionising radiation and from contact with chemicals, typically arsenic and polycyclic aromatic hydrocarbons (P.A.H.'s) which include coal tar, soot, pitch, creosote and refined petroleum based products such as motor, mineral and shale oils (Gawkrodger, 2004; Turner et al, 2014).

A shift in industry sectors in the U.K. with a decrease in heavy engineering and mining and a large increase in service related industries marked a change in the profile of skin cancer cases, but of significance to the change was the improvements to working conditions especially good hygiene controls (Smedley, Dick, & Sadhra, 2013) and risk reduction techniques, largely brought about by an introduction of legal requirements to adequately assess chemicals used or produced in the workplace and to implement suitable and sufficient control measures to protect the health of workers. The legal imperative imposed in the U.K. was by the introduction of the Control of Substances Hazardous to Health Regulations (C.O.S.H.H.) in 1988. The regulations

placed a legal duty that ‘Every employer shall ensure that the exposure of his employees to substances hazardous to health is either prevented or, where this is not reasonably practicable, adequately controlled’- Regulation 7(1). (H.S.E.,1988).

The main cause of skin cancer presently is from a form of non-ionising radiation, ultra violet (U.V.), created by the sun and also artificially through UV tanning beds, with significant lifestyle changes, including outdoor leisure time activities, foreign holidays and the social fashion / desire for a sun tan creating the significant levels of skin cancer worldwide currently (Gawkrodger, 2004; Turner et al, 2014). From reviewing information on cases reported by consultant dermatologists on the EPIDERM scheme funded by the U.K.’s Health and Safety Executive between February 1993 and January 1999, 96% of all skin cancer cases cited sunlight or UV radiation, commonly referred to as solar radiation, as the suspected causal agent, with other causes, such as P.A.H.’s and ionizing radiation accounting for less than one percent (Turner et al, 2014;Young, 2009).

1.4 Solar radiation

The sun has many elements with a direct and positive effect on planet Earth including the giving of warmth and light, both of which are vital for survival. However there are other attributes that are not visible and cannot be felt or sensed by a person but which can lead to damaging effects and even cancer. The energy created by the sun is through nuclear fusion. The reaction created by the fusion creates electromagnetic energy at different intensities, known as wavelengths (DermIS, 2014d). These different wavelengths, measured in nanometers (nm), when plotted, create the spectrum of electromagnetic radiation. The spectrum includes radar, television and radio waves at the longest wavelengths through to gamma rays at the shortest wavelength. The shorter the wavelength, the more dangerous forms of

radiation to humans and animal life, but less able to penetrate into the skin (W.H.O., n.d.).

When looking at the elements of the spectrum of electromagnetic radiation there are three different kinds of light. The first kind of light is infrared light, which has the widest wavelength of the three (700 – 1000+ nm), is not within the range of sight of the human eye, but can be sensed through heat / warmth produced. The second kind of light is visible light, which can be seen by the human eye with a spectrum of colours across a wide wavelength range (400-700nm). The third form of light is ultraviolet light (100 – 400nm), which humans cannot see or sense without specialist monitoring equipment. It is this last kind of light within the spectrum of electromagnetic radiation that is broadly referred to as solar radiation, which has the most potential risks to humans (DermIS, 2014e). Solar ultraviolet radiation (UVR) is a leading contributor to the development of skin cancer (Ichihashi et al, 2003; Polefka et al, 2012), with data for 2010 indicating that solar UVR was responsible for an estimated 90% of cases of melanoma in men in the UK (Parkin et al, 2011).

1.5 Ultraviolet light

Ultraviolet light has three forms, each at different wave lengths. Each form has harmful consequences upon exposure but with different intensities of risk to humans, ranging from sunburn, photoageing of the skin, pigmentary disorders through to skin cancer. (Del Bino and Bernerd, 2013).

1.5.1 uva

The first type is UVA (315-400nm), which has the longest wavelength of the three types of UV radiation (UVR) but accounts for approximately 95% of the UVR reaching the surface of Earth. UVA rays penetrate to the deeper layers of the skin. The rays activate melanin pigment in the upper skin cells that creates the immediate

tanning of the skin which lasts for a short period of time. Prolonged exposure to UVA leads to the skin losing its natural elasticity causing premature ageing and wrinkling of the skin (W.H.O.,n.d.: W.H.O., n.d.,a). After reviewing new data, the International Agency for Research on Cancer, classified UVA, both from sunlight and tanning devices as carcinogenic to humans - Group 1 (IARC, 2006).

1.5.2 uvb

The second type is UVB (280-315nm) which being a shorter wavelength causes far greater biological damage than UVA rays upon contact with unprotected skin, although thankfully most UVB rays are filtered by the ozone layer and prevented reaching Earth (W.H.O., n.d.). The UVB rays stimulate production of new melanin which leads to a darkening of the skin after a day or so and which lasts for a longer time than the changes caused by UVA rays. Prolonged exposure to UVB enhances skin ageing, with exposure to high levels of UVB rays causing sun burn and the associated blistering and peeling of the surface area of the skin. Sunburn increases the likelihood of developing skin cancer (W.H.O., n.d., a).

1.5.3 uvc

The third type is UVC (100-280nm) which being the shortest wavelength of the three forms of UVR would create the greatest biological damage. However, all UVC rays are filtered by the ozone layer and prevented reaching Earth (W.H.O., n.d.).

1.6 Environmental impact on UVR levels

There are significant environmental factors that affect the type and intensity of the UVR received on Earth. The amount of UV reaching the ground in any given place depends on a number of factors including the time of day, season within the year, latitude, altitude of the location and level of cloud cover.

The latitude and season are significant to the ambient UV exposure levels (Sliney & Wegraitis, 2006). with those countries closer to the Equator having the higher UV radiation levels (W.H.O., 2009) as the sun's rays have a shorter distance to travel through the atmosphere (W.H.O. , n.d., b). The UK is at a latitude of 50 degrees North, which is expected to have a low pressure atmosphere with precipitations (snow or rain), whereas most of Australia (70%) is at a latitude of 30 degrees South, which is expected to have high pressure atmosphere with sunshine and minimal amounts of wind (Lucas, McMichael, Smith and Armstrong, 2006). The higher the sun is in the sky the higher the UVR levels as the rays can take the most direct vertical path to the Earth at these times. In the summer between the hours of 10am and 4pm the sun is the most powerful in the UK. Altitude is also a significant factor as it is the atmosphere that absorbs UVR and the higher the altitude the thinner the absorbing atmosphere (W.H.O., 2009), with every one thousand metres in altitude UV levels increase by approximately ten percent (W.H.O., n.d., b). Cloud cover will absorb some of the UV rays, however significant levels will still pass through the cloud, but a cloudy day or when a cool breeze is sensed can lead people to be fooled into thinking that there will not be any UV rays affecting them, however light cloud cover may even enhance UV levels because of scattering (W.H.O., n.d., b). Another way that UVR can be received unknowingly and add to the overall UV levels experienced is through reflection off of the ground or surface the person is on, with up to ten percent reflection from grass, soil, concrete and water, fifteen percent from dry beach sand, twenty five percent from sea foam and up to eighty percent from fresh snow (W.H.O., 2009).

1.7 Benefits from UV

Exposure from UV radiation form the sun onto unprotected/uncovered skin for short periods of time forms the main source of vitamin D in the body, which is

important for bone health, prevention of the onset of rickets and other health benefits (Joshi, Center, & Eisman, 2010), the dilemma across the world's medical and science professions is how much unprotected sun exposure is needed and recommended to create the levels of vitamin D required. A systematic review of the wide range of studies on this topic was undertaken by QIMR Berghofer Medical Research Institute in Brisbane, Australia as part of their D-health Trial of 25,000 Australians to trial the wider benefits of Vitamin D. Their study concluded that based on the various current studies and literature reviewed that it was difficult to draw any firm conclusions about the optimal levels of ultra violet radiation exposure required for suitable vitamin D levels. (Khan, Whiteman, Lucas, Kimlin, & Neale, 2015).

1.8 UV Index

The solar UV index was developed by the World Health Organization and was initially introduced in 1995, being further enhanced and re-launched in 2002. The index was created as a health education tool to inform and educate the public in ultraviolet radiation health risks and to offer advice on suitable protection measures to be used at the various ultraviolet radiation levels detailed in the index (WHO, 2002).

The index describes the level of solar UV radiation at the Earth's surface. The levels are then adapted to indicate a value from one to eleven plus (WHO, 2002). The values are then typically grouped into categories, low, moderate, high, very high and extreme, with guidance on what is required for sun protection detailed for each category.

The index has had limited success; a systematic review of its effectiveness of the index after ten years of operation found it had only raised public awareness to an extent but had not significantly improved sun protection practices (Italia & Rehfuess,

2012). Cancer Research UK in its annual tracking survey analysing trends in awareness and behavior to UV and sun protection found that of those surveyed that the use of the UV index was the least used sun protection measure with only 3.4% using this measure. The percentage has remained the same since this item started to be assessed back in 2007 (Cancer Research UK, 2014 d, pp.9).

1.9 Prevalence of skin cancer

The three principle types of skin cancer; malignant melanoma, squamous cell and basal cell carcinoma are all associated with exposure to solar radiation, however numerous epidemiological studies have provided conflicting findings on which type of skin cancer has prevalence in chronic (extended, continuous) or intermittent (infrequent, short duration) exposures (Elwood, 1992; Gandini et al, 2005; Oliveria, Saraiya, Geller, Heneghan & Jorgensen, 2006). Changes in lifestyle over the last few decades, typically foreign holidays to destinations with longer hours of sunshine and higher UV radiation levels than the UK and the use of tanning beds which operate with UV tubes commonly by people who have limited exposure to the outdoors (e.g. office workers) would be defined as intermittent UV radiation exposures. These two changes are offered as an explanation in the large increase in cases of malignant melanoma (Bentham & Aase, 1996; Glass & Hoover, 1989).

The most recent global figures for skin cancer from the World Health Organization (WHO) advise in their report, the global burden of disease from solar ultraviolet radiation, published in 2006, based on figures for the year 2000 that between two and three million non-melanoma skin cancers (NMSC) occurred annually (WHO, n.d., c). The WHO report also advised that globally, based on figures for the year 2000, around 20% of the 16 million people globally who are currently blind as a result of cataracts may be due to UV radiation exposure and estimated that

around 1.5 million disability adjusted life years (DALYs) were lost annually through excessive UV exposure. (WHO, n.d., c)

Cancer Research UK advises that malignant melanoma is the 19th most common cancer worldwide with around 232 000 new cases diagnosed in 2012, when compared to Europe where it is the ninth most common cancer with over 100 000 new cases diagnosed in 2012. Worldwide there were around 55,500 deaths from malignant melanoma in 2012, with around 22 000 deaths recorded in Europe which makes it the 19th most common cause of cancer death in Europe (Cancer Research UK, 2014 (c))

The Skin Cancer Foundation in America highlighted a study in the Archives of Dermatology which revealed that more than two million people in the USA alone were diagnosed with over 3.5 million NMSC cancers annually, which constituted a 300 percent increase since 1994 (The Skin Cancer Foundation, 2015). Between 3,900 and 8,800 people died from the squamous cell carcinoma form of NMSC in America in 2012, with 3,000 deaths from basal cell carcinoma form of NMSC. It is estimated that there will be 73,870 new cases of malignant melanoma diagnosed in America in 2015 and 9,940 deaths. One in five Americans will develop skin cancer in the course of their lifetime (The Skin Cancer Foundation, 2015, (a)).

Australia, where at least two in three individuals will be diagnosed with skin cancer before the age of seventy, has high levels of skin cancer, with rates per 100,000 of population two to three times that of Canada, the United States of America and the UK. Skin cancer accounts for around 80% of all newly diagnosed cancers, with 47% of patient consultations with general practitioners annually being for skin cancer. The most recent figures from the Cancer Council Australia show that 767,347 NMSC's were treated in 2010 and 11,570 malignant melanomas in 2011. There were 2,209

deaths recorded in 2013, 1,617 from malignant melanoma and 592 from NMSC (Cancer Council Australia, 2015).

Skin cancer is the most common type of cancer in the UK and on the rise (National Cancer Intelligence Network, 2014; Cancer Research UK, 2014). In the UK, 96 per cent of all skin cancer cases reported cited sunlight or ultra violet radiation, commonly referred to as solar radiation, as the cause (Young, 2009). Cancer Research UK advises that malignant melanoma is the fifth most common cancer in the UK with 13,500 cases registered in the UK in 2012 and 2,100 fatalities. Incidence rates of malignant melanoma in Great Britain have more than quadrupled, a 345% increase since the late 1970's (Cancer Research UK, 2014,c). Registration data for England show a 56% increase in melanoma skin cancer for men between 2002 and 2011 (Office for National Statistics, 2013).

Cancer Research UK advises that there were 98,368 cases of NMSC registered in the UK in 2012 and that there were 638 deaths from NMSC in the UK in 2012 (Cancer Research UK, 2014, c). However, Public Health England has advised that there is a vast under-reporting of NMSC cases and it estimates that the actual number could be up to 46% more (National Cancer Intelligence Network, 2014). Cases have increased overall by six to eight percent every year since the 1960s (Cancer Research UK, 2014,e) and the incidence rate for non-melanoma skin cancer appears to be rising faster in the UK than in the rest of Europe (Lomas et al., 2012).

1.10 Cost

A systematic review was undertaken of national studies estimating the costs of skin cancer from ten countries (Australia, New Zealand, Denmark, Sweden, United Kingdom, Germany, France, United States of America, Canada and Brazil). The study firstly amended all data so that it was based on 2012/13 values using the countries

specific inflation rates and then converted the amounts to Euros to aid comparison. The study found that in terms of direct cost to the health system, that the USA spent the most at 612 million euros (589 million – NMSC, 23 million, MM). Australia was next spending 423 million euros (365 million – NMSC, 58 million – MM), followed by Germany which spent 234 million euros (160 million – NMSC, 74 million – MM). The United Kingdom was the fourth largest spender on skin cancer at 152 million euros (122 million – NMSC, 30 million – MM). The total cost for all ten countries was 1,754 million euros, however France only had data for MM cases (Gordon and Rowell, 2014; Gordon, September 2013).

When comparing the overall cost to the size of population then a change was noted with Australia having the highest cost at 18.31 million euros per million of population, followed by New Zealand at 8.34 million euros per million of population, Sweden at 6.71 million and Denmark at 6.45 million euros per million of population. The UK was the sixth largest spender per million of population at 2.37 million euros, just in front of the USA at 1.97 million euros per million of population (Gordon and Rowell, 2014; Gordon, September 2013).

A study using data from 2008 aimed to establish the cost to the NHS in England of treating skin cancer, both NMSC and MM. The estimate used information from the South West Public Health Observatory on the ratio of NMSC to MM cases in two regions which estimated that within the United Kingdom that the incidence of NMSC was 8.5 times that of MM. The costs for 2008 were estimated at £106.4 - £112.4 million (Vallejo-Torres, Morris, Kinge, Poirier, & Verne, 2014). A previous study estimated the cost to the NHS of skin cancer in 2002 at £101.6 million (Morris, Cox and Bosanquet, 2009). Vallejo-Torres et al. (2014) estimated costs per MM case being £2607 and £889 per NMSC case, which highlights that the actual cost of

treating skin cancers are not that high but are large due to the volume of cases. Projecting the cost of skin cancer to the NHS in 2020, Vallejo-Torres et al. (2014) estimated the costs as being between £170.9 million and £190.5 million.

Costs of managing skin cancer are predicted to increase quickly, not just because of an increasing number of cases of skin cancer but due to advances in medical science which in turn can create more expensive health services, typically due to increased frequency of examination and monitoring. There are also the costs associated with new technologies and techniques to deal with the cancer (Gordon and Rowell, 2014).

Economists in Europe believe that the current growth in healthcare spending is not sustainable but warn that government cost cutting initiatives is not the answer, advising that focusing on innovative ways to improve efficiencies and reduce wasteful spending is the answer to the current problem (Gordon and Rowell, 2014).

Gordon and Rowell analyzed seven studies that evaluated the cost effectiveness of skin cancer screening and prevention. The studies ranged from health education campaigns in different settings, a school based programme through to regulation of sun bed use and were undertaken in Australia, the USA and Italy. The analysis found that skin cancer prevention programmes or policies were consistently cost effective and may achieve cost savings in the future through reductions in skin cancer (Gordon & Rowell, 2014).

1.11 Risk groups

1.11.1 sports professionals

A risk group that spends a substantial percentage of their work time outdoors are those connected with the sports and recreation industry as well as professional sportsmen and women and athletes. Typical examples are: life guards and pool

attendants, sports instructors, professional cricketers, golfers, tennis players. Extra emphasis is required for those undertaking or instructing on water sports as the reflection from the water can increase the UV rays received (WHO, 2009). The activities undertaken create risks through lack of shade or cover with clothing only offering low levels of solar protection, particularly over a prolonged period of time. Sporting activity can create sweating and friction both of which will have an impact on the effectiveness of sunscreen used (Moehrle, 2008). Cancer Research UK advises that all professional cricketers are now screened for skin cancer (Cancer Research UK, 2009) however no evidence was found that bodies in charge of other professional outdoor sports are insisting on the same (Jones, Eagle, Kemp, Verne, & Hughes, 2011)

1.11.2 children

Research has shown that the formative years during childhood are important when considering future risk of skin cancer. Several studies suggest that early life exposure may be an important factor in the biological events leading to the risk of MM and NMSC in later life (Armstrong & Kricker, 2001; Gallagher & Lee, 2006). A study from Australia reviewed migrants arriving in Australia after the age of 15 from countries with lower UV levels, such as the UK, had a substantially lower mortality risk from MM than those who arrived at a younger age (Khlat, Vail, Parkin & Green 1992). A further study by Holman and Armstrong (1984) which compared native Australians to migrants arriving in Australia after the age of nine also demonstrated substantially reduced risk from MM. A study from the USA showed that those who spent their early years in the southern states with high UV levels had an increased risk of MM in adult life even if they had moved later in childhood to an area with lower UV levels (Mack & Floderus, 1991).

A study of Danish parents and their children showed that parental behaviour and attitudes, such as parents allowing themselves to become sun burnt and liking to have tanned skins, affected the risk for their children to be sun burnt. The children, through observational learning, would develop behaviours' similar to their parents (Beherens, Thorgaard, Philip & Bentzen, 2013). For behavioural strategies to be most effective in creating a suitable attitude and behavior, the correct perceptions and ideas should be developed as life-long prevention habits. Such habits are developed in the most flexible way when commenced during childhood (Girgis, Sanson-Fisher & Watson, 1993) and can be learnt through adults including through their school.

1.11.3 users of UV emitting tanning devices (sun beds)

Indoor tanning booths and sunbeds, either used in a tanning salon or at home have been available since the 1980's. The tubes used in this equipment emit UV rays. Modern sunbeds emit mostly UVA rays, but also UVB rays, which are connected to sunburn, can make up anywhere from 0.5 to 4 percent of the total output which emits UVA ten to fifteen times higher levels than the midday sun. Such levels of UV can lead to DNA damage and ultimately skin cancer (Cancer Research UK, 2015). People advise that they use sunbeds to get a base tan before sunbathing to prevent sun burn. Research was undertaken to calculate the association between MM and indoor tanning. Participants were excluded if they had been burnt using a sun bed and where asked to indicate the number of times they had been sunburnt in their life. Following statistical testing it was shown that there was an increased risk of MM from using sunbeds compared with those who had never used a sunbed (3.87; 95% confidence interval = 1.68to 8.91; P = .002), including those who had never had a sun burn from being outdoors (Vogel et al., 2014).

Extensive research has linked indoor tanning to B.C.C., S.C.C. and M.M. (Karagas et al, 2002; Ting, Schultz, Cac, Peterson and Walling, 2007; Zhang et al, 2012:). Cancer Research UK (2013) highlighted other research which showed that the risk of S.C.C. is at least 67% higher, the risk of B.C.C. is up to 29% higher and M.M. is 16 – 25% higher in people who have ever used a sun bed at any age compared to those who have never used a sun bed (Boniol, Autier, Boyle & Gandini, 2012; Wehner et al., 2012; Colantonio, Bracken, & Beecker, 2014).

After reviewing a combined analysis of over 20 epidemiological studies (WHO - IARC, 2006), the findings of which showed that the risk of M.M. increased by 75% when tanning devices were used before the age of 30, the International Agency for Research on Cancer, classified UV emitting tanning devices as carcinogenic to humans - Group 1 (WHO - IARC, 2006). The UK governments (England, Wales and Northern Ireland) passed legislation, The Sunbed (Regulation) Act 2010 which banned those under the age of 18 from being allowed to use commercial tanning salons, and for the salons to provide / display prescriptive health information and have protective eyewear available for use when using the tanning beds. In Scotland, under part eight of the Public Health (Scotland) Act, 2008, legislation requires the same as the U.K. but prohibits the sale or hire of sunbeds to persons under 18 and requires supervision to be in place in tanning salons. Within Europe, legislation with more in-depth requirements has been put in place in Belgium, Finland, France, Norway, Portugal, Spain and Sweden. Brazil has imposed a nationwide ban on the public use of sunbeds and Australia is understood to be in the process of installing a similar ban (The All Party Parliamentary Group on Skin, 2014)

1.11.4 outdoor workers

It is perhaps an obvious statement, however people whose work places them predominantly outdoors have been identified as being at greater risk of NMSC's than those who work indoors due to their prolonged exposure to the sun, with NMSC's twice as prevalent in outdoor workers as in indoor workers (Girgis et al., 1994). What is perhaps not considered is how diverse the term outdoor worker is. When reviewing the incidence data from 2004 and mortality data from 2005 in Britain, whilst the construction sector had 841 new cancer registrations (54%) and is often considered when thinking of outdoor workers, the service industry sector had 402 registrations (26%). The services industry sector had several elements where registrations were noted, including public administration and defence (240 registrations), sanitary and similar services (68 registrations) recreational and cultural services (55 registrations). The manufacturing sector had 163 registrations (11%) from which electricity, gas and steam (53 registrations), mining (31 registrations, water works and supply (26 registrations) and the manufacturing of pottery, china and earthenware (23 registrations). The other sector which is often considered, like construction, as having outdoor workers is the agricultural sector, however, of the four groupings used for the research data, agriculture had the lowest number of registrations with 135 (9%) with farming (128 registrations) and forestry (7 registrations) (Rushton et al., 2010).

1.12 Risk of skin cancer among outdoor workers

The UK construction industry is a vast sector which contributed £103 billion pounds in 2014 which is 6.5 percent of the total economic output. 2.1 million jobs, 6.3 percent of all employment within the UK is within the construction industry (Rhodes, 2015). However for all the positives that the construction industry brings to the UK, it experiences some of the highest annual rates of workplace deaths, accidents and

injuries when compared to other sectors (Burns & Conchie, 2014), and has the largest number of occupational cancer deaths and new registrations (HSE, 2015). From an occupational perspective, skin cancer has the second highest number of occupational cancer cases in men, after lung cancer, and third highest in women, after breast and lung cancer. Of all occupations, the construction industry has the most skin cancer registrations, with 55 per cent of all registrations. It also accounts for 58 per cent of total deaths (Rushton et al., 2010).

Outdoor workers are at significantly increased risk for skin cancer attributable to solar UVR (Lucas et al, 2006; Schmitt, Seidler, Diepgen, & Bauer, 2011). Data reported by physicians between 2002 and 2008 to The Health and Occupation Reporting Network (THOR) showed that for skin cancer, male UK construction industry workers aged under 65 had a significantly raised standardised incidence rate ratio relative to all other UK industries combined (SRR 4.2, 95% CI 3.3-5.3). Exposure to solar UVR was the suspected causal factor in all but a single reported case with construction workers being up to 6.6 times more likely to get skin cancer than all other employment sectors combined (Stocks et al., 2010) with the risk being particularly high among roofers, labourers and painters and decorators in the building and woodwork trades (Stocks et al., 2011).

On the basis of incidence data from 2004 and mortality data from 2005 in Britain it has been estimated that occupational exposure to solar UVR leading to NMSC resulted in 12 deaths, of which 7 (58%) are from the construction sector and 1541 new registrations, of which 841 (54%) were from the construction sector (Rushton et al., 2010).

A recent study of occupational exposure to solar UVR leading to MM using incidence data from 2011 and mortality data from 2012 estimated 47 deaths, 39 being

male and 8 being female and 241 new registrations, 184 being male and 57 being female in a typical year in Britain, with the construction industry accounting for 45% of the overall MM deaths (49% of the total male, 25% of the total female) and 42% of the overall MM registrations (49% of the total male, 19% of the total female) (Rushton & Hutchings, 2015).

Construction works include a large element of outdoor work. Engaging with construction workers has always been difficult, possibly due to its unique characteristics which include a largely transient , project based workforce, a large number of which are young and inexperienced, subcontracted and sometimes migrant workers (Lingard & Rowlinson, 2005) for whom English may not be their first language.

Sun safety knowledge and use of protective and precautionary practices are low within the UK construction sector (Madgwick, Houdmont, & Randall, 2011). This indicates that relatively simple interventions could result in significant positive health outcomes.

1.13 Sun safety intervention for outdoor workers – a literature review

Many interventions have been created to raise awareness of skin cancer caused by solar radiation with the aim to both educate and reduce the number of cases globally. Following the United Nations Conference on Environment and Development in 1992, the INTERSUN programme was set up. Working with national institutions which became WHO Collabororating Centres, including Australia, Germany, United Kingdom, Bolivia, and France, and international organizations, INTERSUN's goals were to provide information, practical advice and sound scientific predictions on the health impact and environmental effects of UV exposure; to encourage countries to take action to reduce UV-induced health risks , and to provide guidance to national

authorities and other agencies about effective sun awareness programmes (WHO, n.d., d) .

Over the last three decades a number of studies have been conducted that have involved the administration of a sun safety intervention for manual outdoor workers and the evaluation of the intervention in terms of its impact on sun safety knowledge, attitudes, and/or behaviors. The following section provides a descriptive overview and critical evaluation of five key studies.

1.13.1 Azizi et al. (2000)

Azizi et al. (2000) undertook an intervention study amongst outdoor workers working in four units for Mekorot, the Israeli National Water Resource Company. The workers were approximately 50% maintenance staff and the rest engineers, supervisors and electricians. 144 workers completed all stages of the project. The four work units taking part were located in Israel, with three of the units located in the South and the final unit located centrally.

The study was constructed so that all workers completed a pre- intervention questionnaire to establish a baseline with a further two questionnaires which were administered approximately eight months after each of the two intervention programs were delivered. The interventions were undertaken in June 1995 and June 1996.

The full intervention program consisted of three elements; the first being the training and deployment of local safety officers to act as champions for the intervention; the second, an awareness session on the risks from and preventative measures of skin cancer and sun exposure followed by a full body, skin and eye examination by a physician, during which a blood sample was taken to establish levels of Vitamin D3 in the body: and finally, the third being the supply of sun protective equipment (wide rimmed hats, sunglasses and sunscreens).

To allow evaluation, not all of the workers received the full program. One of the work units received the complete intervention program, which comprised for the first phase, the first and second elements, followed in the second phase by all three elements. Two work units received the partial program, which comprised the first phase, the first and second elements, followed in the second phase by the third element only. The final work unit, located in central Israel received the minimal program, which comprised the first phase, no elements, followed in the second phase by the second element only.

The project evaluated three outcomes. The first concerned the frequency of use of sunscreen. This increased in each of the three groups. The group that received the complete intervention experienced an 80% increase in sunscreen usage, the partial intervention group 52%, and the minimal intervention group 25%. The second evaluated outcome was skin self-examination. The rate of workers undertaking a self-examination of their skin at least annually increased in each of the three groups with the complete group showing the highest increase, achieving a 42% increase at the interim stage and a further 20 % at the post intervention stage. The partial group had the highest increase at the interim stage before dropping at the post intervention stage to an increase of 59% over the pre-intervention level. The minimal group had increases at each phase, but was 35% lower than the other groups. The final outcome assessed was the area of skin exposed to UVR, which showed that through increased use of sun protection equipment that reductions of up to 35% were achieved in all three groups, however the reductions at the interim stage were greater than the post-intervention stage. Indeed for the partial group, levels had returned to their pre-intervention level.

The study has several strengths. The multifaceted approach through the use of questionnaires, awareness sessions, skin and eye examinations, blood sampling to detect vitamin D3 levels and provision of sun protective clothing, assessed at several stages over the duration of the study gave breadth and meaningful results to the study. The study also managed to achieve an equal mix of blue and white collared workers. Both of these elements produced results that were generalisable across the organisation's entire outdoor worker employee base.

The study also has weaknesses. The obvious weakness is that the study is based on only one organisation and therefore the policies, procedures and culture within that organisation could have an impact on the results. The extent to which the results could be generalised to other organisations or sectors is unclear. Another issue with the study is that there was no actual control group, which had completed questionnaires at the prescribed intervals but not received any awareness training on the topic. The study had a high refusal rate (35%) from workers, which would suggest that perhaps the initial approach produced to encourage workers was not entirely suitable or that the level of buy in from the company's senior managers was not strong. This may also explain the reduction in levels of change between the interim and post interventions. When analysing the data for use as a comparison to a UK based study, there are several limitations, these being that the geographical location, UV intensity and hours of sunshine of Israel are different. There is also a much higher percentage of participants of African / Asian decent in this study (mean: 65.5%) when compared to the paler skin types of UK-born workers.

1.13.2 Borland, Hocking, Godkin, Gibbs and Hill (1991)

Borland, Hocking, Godkin, Gibbs and Hill (1991) analysed a skin cancer awareness campaign developed by a marketing company on behalf of Telecom

Australia. The study of the campaign was designed to be quasi-experimental with an intervention and a control group, which was derived from blue collar outdoor workers located in six depots across the Melbourne metropolitan area and Geelong in Australia. The participants worked in teams, with team size ranging from one to four persons. The study used observations of each team and its members to gather the required information. There were 525 observations, pre and 460, post intervention, after discounting any observations undertaken during overcast conditions.

The intervention for this study took the form, for the intervention group, of an education package produced by a marketing company for the employing company. A pack for each depot consisted of a series of posters and a video showing an extract from a documentary of a young man dying from melanoma, as well as instructions on where and when to display the posters. Each participant received a folder with a brochure introducing the campaign, a supportive letter from management, four badges and several leaflets on sun protection and early detection from a skin cancer organisation. The campaign featured a former Olympic gold medalist as a role model. Participants were encouraged to maximise their sun protection. The control group merely received their normal level of health and safety care.

The study, through observation, recorded on a checklist for each team in both groups; the time of day, location, weather conditions, an indication of the temperature and the availability of shade. The following observations were rated against pre-determined variables, each member of the team was assessed on hat use and shirt use, with the mean level of the team recorded. Shade use was assessed across the team as a whole and finally a score was given for protection overall which included an additional weighting based on use of shade by the team. All of the observations were undertaken by the company's senior line staff, who had received training by

occupational health nurses. The pre-intervention observations were undertaken over a two week period, completing in early December, 1989. The post intervention observations were undertaken over the last three week period of the campaign, completing in early March, 1990.

Analysis of the data revealed that the type and use of hats or utilisation of shade did not alter as a result of the intervention. The type and use of shirts did increase in the intervention group ($p < 0.02$) with more long and short sleeved shirts being worn, although the control group had a higher mean score than the other group in the pre-intervention observations but the score reduced post intervention. The overall protection score also increased ($p < 0.02$) in the intervention group.

This study showed that a focused awareness campaign can achieve improvements even if it is not devised and delivered by a specialised cancer based organisation. The campaign led to an increase in sun protection of between five and ten percent, the results of which are even stronger when recognised that the organisation already had a skin cancer protection programme in place before this campaign commenced.

The study also has some weaknesses, many of which are created by the lack of data detailed in the paper, which does not allow replication of the study to understand some of the issues and to allow new research to address these. There was no detail on the inclusion criteria (minimum hours of outside work or frequency of work outside) for participants. There was also no detail on why there was a variance in downtime related to skin cancer in the depots or the frequency of showing the video to the intervention group. Whilst the concept of a campaign being developed through marketing techniques has been proven to be successful in this study, the fact that the organisation already had a skin cancer protection programme in place limits the

generalisation of the results across other sectors where such existing programmes do not exist.

1.13.3 Girgis, Sanson-Fisher and Watson (1994)

Girgis, Sanson-Fisher and Watson (1994) undertook an intervention study amongst outdoor workers working from 12 depots for the electric supply authority in the Hunter Region of New South Wales, Australia. The workers selected for the study were manual workers who were outside for at least 80% of their working day. A total of 142 workers took part in the complete study, a randomised control trial. 65 workers were in the intervention group and 77 in the control group.

All participants completed a questionnaire and self-reporting diary on two occasions, the first pre-intervention and the second a month after the intervention phase was completed. The questionnaire established skin type (pre-intervention only) and assessed skin self-checking behaviours, as well as knowledge and attitudes to solar protection and skin cancer. In addition, a self-reporting diary was completed in four blocks of two hour duration daily for five consecutive working days. The diary assessed the weather as well as the participant's clothing and sunscreen use. The intervention, undertaken over a one week period, consisted of a screening session and an education session. In the screening session, each participant's skin condition was checked by a dermatologist against scales for photo damage, pre-malignant and malignant damage. The education session was a 30-minute awareness lecture. The control group where offered the intervention after completing the second phase questionnaire and self-reporting diary.

The study evaluated four outcomes. The first was that the intervention would increase the proportion of participants achieving high solar protection levels measured against nine body regions. 66% of the intervention group achieved this level post

intervention compared to the 49% pre-intervention. The control group remained at their pre-intervention level of 49%. The second and third outcomes respectively were that there would be an increase in knowledge of and attitudes towards skin cancer and solar protection following receipt of the intervention. The knowledge score improved for both the intervention and control groups. The intervention groups had a correct responses level against a set series of questions of 55% pre and 62% post-intervention. The control group had a correct responses level of 55% pre and 58% post-intervention. The improvements assessed in the knowledge score were not replicated in the assessment of attitude. The intervention group's pre-intervention score of 50% reduced to 49% post-intervention. The control groups also reduced from 49% pre to 48% post-intervention. The final outcome was that there was a positive relationship between the degree of photo damage and pre-malignant and malignant change in the skin. Analysis of the screening results found a significant correlation between the two scales indicating a positive relationship.

The study's main strength is that it has clearly demonstrated that a basic awareness briefing and supporting literature can make a significant improvement. The results produced are generalisable across the organisation's entire outdoor worker employee base.

The study also has weaknesses. The obvious weakness is that the study is based on only one organisation and therefore the policies, procedures and culture within that organisation could have an impact on the results. The sample size of 142 is also a weakness. A larger sample size may have produced significantly different results, therefore the extent to which the results could be generalised to other organisations or sectors is unclear. Another issue when reviewing the paper produced from the study is that some of the information gathered has not been detailed, an

example being a breakdown of skin type. Commonly, Australian citizens are of a paler skin type. Skin type is important information in establishing whether the findings are of relevance for cross comparison against other studies. The study would have been stronger if further phases of evaluation had been undertaken over a prolonged timeframe to ascertain if the improvements were maintained, or even improved beyond the evaluation which was undertaken one month post intervention. When analysing the data for use as a comparison to a UK based study, there are several limitations, these being that the geographical location, UV intensity and hours of sunshine of Australia are different.

1.13.4 Rye et al (2014)

Rye et al (2014) undertook an intervention study applying a comprehensive health promotion intervention to 14 workplaces (seven with over 100 employees and seven with under 30 employees). The participating outdoor workers (150 at pre-intervention stage and 86 at post-intervention stage) were from four different industry types, building and construction; local government; rural and farming; and the public sector. All workplaces were within Queensland, Australia.

The intervention was multifaceted, expanding on previous seminal research on outdoor workers and sun protection behaviours. The focus of the intervention was health promotion, which was achieved by assisting workplaces in developing six distinct areas. The first area looked at the development of a workplace sun protection policy. The second addressed structural and environmental matters through the provision of portable shade and elimination, where practicable, of reflective surfaces in the work area. The third area was that of suitable personal protective equipment (PPE). The forth area was that of education and awareness which included sun safety awareness through posters, focused inductions and demonstrations on correct PPE

use. The fifth area was the establishment of role models. Typically this was achieved through site supervisors. The sixth area involved skin examination, both by self-examination and use of the workers doctor. The intervention was assessed pre and post intervention through computer assisted telephone interviews with individual participants. A series of questions were developed, some of which had been used in previous research. The questions collected data on sociodemographics, about eye, hair and skin colour, sun burn characteristics and history of skin cancer. The questions then moved onto the participant's attitudes, beliefs and behaviours towards sun protection whilst at work. The final questions related to the particpant's knowledge of and perceptions of their companies sun safety policy and protocols in their workplace. The questions were mainly yes / no or used a five point Likert scale.

The research team recruited workplace champions, mostly health and safety professionals within the workplace, to progress the project until its conclusion. A project web site was developed to provide a comprehensive amount of information to allow the workplaces to develop the six parts of the intervention. In addition the research team contacted (by telephone or email) each workplace weekly throughout the 18-month intervention period. The team also visited each workplace three times, a pre-intervention visit ascertained the existing arrangements for sun protection so that advice and guidance could be offered to assist in establishing the intervention. The next visit was to provide feedback on the baseline information. The final visit was undertaken 18 months later when the post intervention element of the research was undertaken. The individual workers who took part in the computer assisted telephone interviews were also recruited during the first and third visits. There was also a qualitative element to the research, which comprised semi-structured discussion

groups undertaken during the first and third visits, however this data was not included within the research paper critiqued.

Analysis of the data revealed that workers reported increases in both workplace support for and personal use of sun protection ($P < 0.01$). This would correlate with a significant reduction (69% pre, 55% post – intervention, $P < 0.03$) in the number of workers who reported having been sunburnt in the previous 12 months and an increase in the use of natural shade (+20%, $P < 0.01$), wearing broad brimmed hats (+25%, $P < 0.01$), long sleeved collared shirts (+19%, $P < 0.01$) and long trousers (+16%, $P < 0.02$). Increases were also noted in the number of workers checking their skin for skin cancer, and of those who had received sun safety education and training, which lead to an overall increase in the workplace support score (based on workers perception of the level of support from their company). There was however an increase in the number of workers who had been sunburnt more than six times in the last 12 months and no change in the levels of sun screen use, pre and post intervention.

This research has a broad span of companies (14 no.) who utilise outdoor workers as a part of their day to day operations in four different types of industries. The project's intervention is also broad which shows that a comprehensive literature review would have been undertaken to establish the various elements that need to be addressed to deliver a comprehensive sun safe strategy. The approach is designed to ensure participation and action by the companies that, through collaboration with the research team, would create a bespoke solution meeting the organisation's needs. The comprehensive literature review has also provided question sets and structures used on previous research projects that allow for comparison. For example the set of

questions on sun protection behaviours was based on the sun protection index created by Glanz, K., Schoenfeld, E. & Steffen, A. (2010).

The first obvious item missing from the study is a control group to offer data on the intervention effectiveness through comparison between those who did and did not receive the intervention. The researchers screened 125 workplaces finding 38 eligible for invitation to take part (with 14 finally taking part), however the paper does not detail the criteria that was applied in the screening process. The paper does not detail any criteria for the individuals eligibility, in fact there is no question or detail on the minimum time individuals needed to work outdoors to be allowed to participate. Whilst the research notes small and large workplaces, it does not detail the spread of size of workplace across the industries. The level of workers who participated was also low with the risk that those who did agree to participate were already interested in sun protection which could give an inaccurate picture of the workplace and sector. The paper highlights that 53.3% of the workplaces already had some form of sun protection policy in place prior to the research commencing, this would have a potential impact on the levels of knowledge at the pre-intervention stage. The other issue that would have had an effect on results would be that 36 of the 86 post-intervention participants were not pre-intervention participants. The paper highlights that two other workplaces participated in the post-intervention data collection which from analysing table one would make many of these participants local government as there were more post than pre-intervention. This is an issue as the research highlights that local government workers had private health care and were on average 12 years older than workers from the other industries. The research also found that there was an inverse relationship between age and the sunburn score. Despite these issues, the

research results could be generalised to other organisations and sectors provided care was taken with the points highlighted.

1.13.5 Woolley, Lowe, Raasch, Glasby and Buettner (2008)

Woolley, Lowe, Raasch, Glasby and Buettner (2008) undertook an intervention study with workers from Townsville, North Queensland, Australia, which had a tropical environment with year round high levels of ambient UVR. The study had 57 participants, 26 from the main roads department, which had a mandatory sun protection policy in place for over 10 years (mandatory group); and 21 from the builders, Q-Build, whose employees were responsible for implementing their own sun protection measures (voluntary group).

The purpose of the study was to determine whether mandatory use of sun protection measures was associated with a reduction in damage to the skin caused by the sun when compared to outdoor workers without such a structure in place. The study's intervention comprised a self-administered questionnaire, measurement of the level of UVR related darkening of the skin and examination of the skin for skin cancer (NMSC) or solar keratosis. The questionnaire collected data on demographics, sun exposure and damage, knowledge and attitudes to solar protection and skin cancer and assessed sun protective behaviors both at work and leisure time.

Analysis of the data revealed that 69% of the mandatory group and 52% of the voluntary group had skin type one or two on the Fitzpatrick classification. 39% of the mandatory group had a family history of skin cancer, whilst the voluntary group had 60% . This concurs with the increased mean number of solar keratoses found on the voluntary group participants and their increased mean number of previous medically diagnosed skin cancers, both of which were statistically significant. The other statistically significant finding was the wearing of a long sleeved shirt when out in the

sun at work, with 81% of the mandatory group doing this compared to only 29% of the voluntary group. Although 69% of the mandatory group and 76% of the voluntary group worked for more than three hours a day in the sun, both groups reduced to 44% and 43% respectively when asked if they spent over three hours a day in the sun on their days off.

Despite the study only achieving a small number of statistically significant differences, the paper produced from the study has a very thorough design and layout allowing for replication and comparison by other researchers.

The study's obvious weakness is its very small sample size and by only collecting data on one occasion without any further phases of data collection, the study can only offer a snap shot. Whilst one group was a voluntary group without a mandatory policy, the organisation forming the group had a safety officer, undertook regular tool-box talks and had a selection of sun protection measures readily available for workers. Such measures may have created under estimation of sun damage, behaviors etc that would have been witnessed in an organisation with truly no sun protection or awareness measures in place. Another potential weakness was the inclusion criteria for workers, who only had to work a minimum of 30 minutes out in the sun on a usual work-day to be classified as outdoor workers. The location of the study was within the Tropics, therefore the extent to which the results could be generalised to other locations across the world is unclear.

The literature reviewed here has demonstrated that sun safety interventions targeted at manual outdoor worker groups can be effective in successfully encouraging improvements in knowledge, attitudes, and self-reported behaviours. However, the literature review has also revealed that no sun safety intervention studies have been conducted with construction workers in the UK

construction sector and it is not clear whether these existing results can be generalised to this group. All published intervention work has been conducted in geographic regions of the world that experience more intense and prolonged periods of sunshine than the UK, and findings therefore may not transfer into the UK context. Furthermore, due to an established sun safety culture in Australia (Garvin et al., 2001), pre-intervention attitudes towards sun protection found in Australia might differ significantly from those held in the UK.

The high incidence and heightened risk of skin cancer within the construction sector in the U.K. along with the potential to prevent skin cancer through relatively basic techniques presented the imperative for this project which was the development, implementation and evaluation of interventions focused on raising awareness of sun safety in the U.K. construction sector.

1.14 Focus and aims of the current study

In response to the paucity of sun safety research in the UK construction sector, the overall focus of the current study was to develop, implement and evaluate a sun safety educational intervention designed to address the high incidence levels of skin cancer attributable to solar UVR among construction workers within the construction sector in the UK.

The main aims were to:

1. Establish through a large scale, representative and diverse (geographic and skill set) sample, a profile concerning the extent to which UK construction workers possess knowledge, attitudes and awareness of skin cancer from solar radiation, and the positive sun safety practices they employ in an occupational context.

2. Examine the effectiveness of a bespoke sun safety awareness intervention, a DVD based film, developed specifically for UK construction workers. The effectiveness of the intervention was assessed in terms of its influence on advancing the knowledge, attitudes and behaviors of UK construction workers towards skin cancer caused by solar radiation.

2. Methods

2.1 Study context

The study was developed for deployment for those working within the construction sector in the United Kingdom, whether as a sole trader or as an employee of a small (0-49 employees), medium (50 – 249 employees) or large (250 plus employees) organisation, all elements within the construction industry were welcome to participate. The high incidence of skin cancer from solar radiation within this sector and the knowledge that this type of cancer was highly preventable if knowledge of the issue and an understanding of the readily available control measures were known, presented the imperative to develop, deliver and assess awareness in as wide a spread of construction workers as possible.

2.2 Participants

Although it was those workers who worked outdoors daily for construction companies that were required to participate in the study, ways to appeal to and gain contact with individual construction workers were considered unfeasible for a proposed large scale study, so it was decided to contact construction companies. It was important to have as wide and as broad a geographical spread of respondents as possible as both typical daily duration of sunshine and relative risk of skin cancer (malignant melanoma) varied in different geographical locations and subsequent analysis has shown there wasn't the expected correlation between longest daily duration of sunshine and highest risk of skin cancer (Small Area Health Statistics Unit, 2014).

Initially, contacts were made through the personal contacts of the researcher and members of the study's steering group. The steering group comprised; Ian Strudley from the H.S.E., John Lacey from Lincsafe, Alex Wilson from Tata Steel,

Mary Ogungbeje from IOSH, Dr. Jonathan Houdmont from the University of Nottingham and Dr. Raymond Randall from Loughborough University. In addition to existing contacts, details on the proposed study with details on how to get involved were placed in the magazine mailed out monthly to all members of IOSH, under the heading ("Construction industry invited to combat skin cancer", 2012), Safety and Health Practitioner (2012). The project's researcher also utilised the Linkedin business networking application, connecting with construction health and safety managers and subsequently using their contact list connections to widen the approach across the sector.

A presentation to attract construction related companies to get involved was developed detailing the topic of skin cancer from solar radiation, the number of cases and the aims of the project. The presentation was delivered by the project's researcher to numerous meetings, the attendees at which represented a wide variety of bodies within the sector, including construction companies falling into the small, medium and large employer categories, specialist service providers servicing the sector, trade union bodies, large public funded projects utilising large numbers of construction companies to deliver packages of work making up the overall project and the regulatory body covering the construction sector.

Notable presentations given included the health and safety committee of the House Builders Federation, meeting of contractors health and safety directors working on the Crossrail project, CONIAC (Construction Industry Advisory Committee Health Risks Working Group), British Occupational Hygiene Society 2012 Annual Conference, Health and Well Being @ Work Annual Conference, 'Preventing Occupational Disease in Construction' training course for Health and Safety Executive construction inspectors (x2)

Using the various approach techniques detailed, the project researcher contacted and invited 107 construction related companies to participate in the study. The initial contact with each company was via email and in addition to an introductory email, a project information sheet and a project registration form was attached. Companies that having read the email and attachments expressed an interest in participation were asked to complete the project registration form which asked, in addition to the company's contact details, the type of construction related work their company undertook, the geographical location of their work, the number of project sites that they anticipated in getting involved with the sun safety project, an estimate of the total number of workers expected to take part and of these the number who were direct employees and sub-contractors.

A total of 38 companies (35%) returned a completed project registration form. These companies employed between 10 and 66,000 direct employees (mean = 4,729). Most operated nationwide with the minority operating on a regional basis only. Following receipt of the form, the project researcher contacted the co-ordinator detailed by the company to progress their participation. The first question was to confirm that the company would be able administer the pre-intervention questionnaires in the proposed survey administration window (May – August 2012). It was then established how many copies of the intervention DVD that would be required and the form that the company would prefer the questionnaires to be in for administering, the options being online or hard copy, with the copies either supplied by the project researcher or supply of an electronic copy for printing by the company. Regular contact was maintained by the project researcher with each of the 38 companies that returned a completed project registration form in order to maximise

the likelihood of delivery on the agreement and thereby achieve a high number of completed participant's questionnaires.

2.3 Procedure

2.3.1 pre-intervention

Initially, the proposed pre-intervention questionnaire was sent as a pilot to ten construction workers to check that they were happy with the wording and terminology used and also to establish a guide on the typical duration to complete the questionnaire. After receiving feedback and making any minor amendments / alterations, the proposed pre-intervention questionnaires were prepared and forwarded to the participating companies during the spring of 2012. The actual number of participating companies was finalised at 22.

An individual was identified in each of the companies to act as the key point of contact and project champion for their company. The individuals ranged from office based administrators, occupational health nurses, as well as health and safety advisors, managers and directors. The project champion administered the pre-intervention questionnaire in their company, by distributing the questionnaires to workers, within a four-month administration window of May to August 2012. An instruction sheet which included a flow chart detailing the process for the correct administration of the pre-intervention questionnaires and at what point to play the intervention DVD was issued to each project champion. The questionnaires were distributed to the participants, typically as part of a workplace health or health and safety briefing or tool box talk, and collected on the same day with the aim of increasing the number of completed questionnaires in each company. A deadline was given for receipt of the completed questionnaires (28th September, 2012).

Questionnaire completion and return was incentivised by all completed questionnaires being entered into a free prize draw with the chance to win a driving experience day in an Aston Martin or similar performance car on a laid out course. It was anticipated that this particular prize would appeal to construction workers. Whilst it was known that a monetary incentive would almost double the odds of receiving a response (Edwards et al., 2002), it was felt that this could be problematic in ensuring compliance with the University's ethics code so therefore the non-monetary incentive was used which research showed would still increase the odds of receiving a response by over a tenth (Edwards et al., 2002).

Whilst it was envisaged that the participants would complete their questionnaire, place and seal it in the envelope provided and hand it back to the project champion for forwarding onto the researcher, a pre-printed business reply envelope was provided with each questionnaire for participants who were concerned that their personal views might not remain private and confidential or who just preferred to return completed questionnaires directly to the research team without using their employer as a conduit. The questionnaire also contained a hyperlink to an electronic version of the survey (https://www.surveymonkey.com/sunsafetyinconstruction) that participants were invited to use as an alternative to the paper-based form should they prefer. Only four online questionnaires were completed, representing just 0.3% of total responses.

2.3.2 intervention

When developing the project (intervention and pre/post intervention questionnaires), a great deal of consideration was given to ensuring that the project received a suitably high level of acceptance by the construction sector and credibility by its workers so as to make the greatest impact possible. Initial consideration was

given to approaching a cancer related charity, such as Cancer Research UK, to see if they would be prepared to fund and endorse the proposed project. After reading research by Conchie and Burns (2009), which found that the Health and Safety Executive in the UK and safety managers were seen as the most trusted sources of information to communicate risk within the construction sector, the thought process changed. A further study by Weyman, Pidgeon, Walls and Horlick-Jones (2006) had found that the Health and Safety Executive were trusted to the same level as the National Health Service in being considered the highest level of trust above all other information sources. To incorporate the two most trusted sources as noted by Conchie and Burns, an initial approach was made by the project's principal researcher to known contacts, these being, Richard Jones, Head of Policy and Research at IOSH and to Peter Brown, Head of Work Environment, Radiation and Gas Division at the HSE with the aim of securing funding and endorsement for the project. IOSH are the world's biggest professional health and safety membership organisation and the chartered body for health and safety professionals so it was felt that a project funded and actively promoted to their membership would be received positively by construction health and safety managers. IOSH agreed to fund both the costs of implementing the research and for the development and filming of the intervention, a video based DVD. The HSE agreed to endorse the project, with the Chief Inspector of Construction, Phillip White, writing an endorsement included on the DVD case cover. The HSE also had an attendee and contributor within the project steering group, Ian Strudley, Head of Health Risk Management Unit within the Construction Sector of the HSE.

The key element and the reason/incentive for construction companies to volunteer to be involved in the project was to be given free access to a practical

awareness tool that could be administered with minimal effort or organisation across their workforce. When initially developing the design and format of the intervention the need for strong visual images was a key consideration. Previous research in effective health awareness and behaviors had shown the importance of visual images in gaining attention, comprehension and recall to a topic (Houts, Doak, Doak, & Loscalzo, 2006). Consideration was then given to whether the intervention should be a film or a leaflet as both could be developed to deliver a strong message through the use of visual images. Randomised controlled trials have shown video based interventions to be effective in promoting sun screen knowledge and usage and rated by study participants more positively than alternative media such as pamphlets (Armstrong, Idriss, & Kim, 2011; Tuong, Larsen, & Armstrong, 2014).

A systematic review of the effectiveness of video based education in modifying health behaviors undertaken by Tuong et al, (2014) found that there were several advantages. Firstly, that use of a film as an intervention is a less resource intensive way of delivering an awareness or educational project. Secondly, that a film delivered a consistent message and did not risk the person delivering the project deviating from the message and can be administered in the workplace without any requirement for expert knowledge on the part of the administrator. Thirdly, and perhaps a key consideration for some elements of this project's intended audience, is that a film/DVD is a more receptive medium for people with low literacy skills or for whom English is not their native language (Sobel et al., 2009). In England, seven million adults cannot read and write at the level expected of an 11 year old. For 11 percent of the population, English is not their first language (Department for Education & Employment, 2001). Finally that a film can be administered in a very

flexible manner through many formats, including DVD, through the internet, either on a dedicated link or through social media such as You Tube (Tuong et al., 2014).

A video based, online education random controlled trial on behavioral and knowledge outcomes in sunscreen use which had the intervention group viewing a video whilst the control group read a pamphlet during a 12 week study period found that the intervention group had greater improvement in knowledge of the topic ($p < 0.003$), greater adherence to the use of sunscreen ($p < 0.001$), rated their education vehicle more appealing and useful ($p < 0.001$) and referred to the educational material more frequently ($p < 0.018$) than the control group (Armstrong et al., 2011).

After consideration of the aims of the project and of limited resources, both in terms of time and money, for both the project team but more importantly the prospective construction companies that were hoped would become involved in the project, the final decision was to create a film-based intervention. It was felt that film-based interventions could be created at relatively little cost and delivered quickly in the workplace with little disruption to work activities whilst being administered, generally by each companies identified project champion without them to need expert knowledge on the topic.

The script for the intervention was devised by the project's principal researcher, based around the ten sun safety measures that had been developed from the literature review findings of Charlotte Young of the Health and Safety Laboratory (Young, 2009) but modeled to suit the intended audience using the principal researcher's knowledge gained from in excess of twenty years working within the UK construction industry. Several studies have highlighted the importance of personal experience in developing such initiatives (Gherardi & Nicolini, 2002).

The final product developed as the project's intervention was a 12-minute bespoke film produced for the construction companies in DVD format titled Sun Safety in Construction: A Workplace Health Guidance Film. The film/DVD gave guidance on ways to reduce exposure to the potentially harmful effects of solar (U.V.) radiation when working outdoors. This type of intervention to deal with the topic of skin cancer from solar radiation that had not been produced in the UK before even though there was known low levels of sun safety knowledge and use of associated risk-reduction practices / control measures across the UK construction sector (Madgwick et al., 2011).

The film/DVD was developed as a low-cost educational intervention that could be readily integrated into occupational safety and health briefings on all types of construction sites. The intervention is now freely available at http://www.notimetolose.org.uk as a central part of the IOSH "No Time To Lose" occupational cancer-reduction campaign. The intervention addressed the risk of skin cancer in the UK construction sector, sun safety practices that might be adopted on construction sites, and self-checking of skin for early signs of skin cancer.

The second aim of this study was to evaluate examine the effectiveness of the project's intervention, the Sun Safety in Construction: A Workplace Health Guidance Film, in terms of its influence on sun safety knowledge, attitudes and behaviors. To achieve this aim a post-intervention questionnaire was administered in the summer of 2013.

2.3.3 post-intervention

The post-intervention questionnaire was posted to those respondents from the pre-intervention questionnaire whom, within their completed questionnaire, had voluntarily provided their contact details in order that they could a) be entered into the

prize draw offered in the pre-intervention questionnaire and b) be sent a short follow-up questionnaire. The 906 respondents who provided this information were sent a post-intervention questionnaire in the summer of 2013. The time lag between the pre and post-intervention questionnaires was 12 months (the mean date for completion of the pre-intervention questionnaire was 8th August 2012 and 24th August 2013 for the post-intervention questionnaire).

It was decided that due to the transitory nature of the construction industry, to ensure respondents felt assured of confidentiality of their responses their responses were personal and not required to meet any expectations from the organisation they worked for and also to allow them the flexibility to complete the questionnaire at a convenient time to them that the post-intervention questionnaires would be a direct postal mailing. Direct postal mailings for questionnaires are recognised as often being the only financially viable option for collecting information from large, geographically dispersed populations (Edwards et al., 2007). However, it is also recognised that non-response bias is a critical limitation to mail survey research (King, Pealer, & Bernard, 2001) through direct mailing. To achieve the highest response rate practicable, further investigation was made into techniques that would assist in this regard.

The approach taken to the direct mailing was partially through previous research on the topic and partly from the researchers and colleagues own experiences of direct mailing and what made them want to open mail compared to other mail received which was felt to be junk mail and ended in the bin without ever being opened. Techniques attempting to achieve a high response rate included mailing the questionnaire in a hand-addressed**,** padded envelope. A survey of consumers examining the effectiveness of 10 techniques used that offered a good chance of a

direct mail / marketing envelope being opened found that 90% felt that a hand written envelope and 57% an oversized / not a regular envelope would increase the likelihood of the envelope being opened (James & Li, 1993). In addition, a pen was provided to encourage immediate completion along with a pre-printed business reply envelope. As per the pre-intervention questionnaire, completion and return was incentivised by a prize draw to win one of three driving experiences in an Aston Martin or similar car sports car driving day. A further measure in order to promote a high response rate was that the questionnaire included a photograph of the winner of the pre-intervention questionnaire prize draw being presented with his award and a small text box at the side highlighting the winner, Paul, a joiner from the North-East, as being a construction worker such as themselves.

2.4 Measurement instruments

2.4.1 pre-intervention

2.4.1.1 questionnaire development

During the planning of the study it was felt that the most effective way to be able to engage with a large and diverse range of construction companies across as broad a geographical range as possible was through the use of self-report questionnaires as the approach to measured data collection. This method has been the norm in most sun safety behaviour studies (Glanz & Mayer, 2005). Studies that had applied both observation and self-report methods in this topic, were typically found to have a high level of consistency in the results (Glanz et al., 2010; Oh et al., 2004).

Care was taken during the development of the pre-intervention questionnaire to incorporate question sets and questionnaire items from other studies on the topic area so as to facilitate cross-study comparisons. The need for cross-study comparisons of future research was highlighted in a research study by Glanz et al. (2008) which

noted that "a central concern in monitoring progress and summarizing the evidence for effective prevention strategies with broad applicability is the comparability of assessments across population based surveys and outcome measures used in intervention research" (p. 218). The Glanz et al. (2008) large-scale collaborative project sought to develop a standardised set of core questions on sun exposure and sun protection habits. Since its publication, their set of core questions has been used in several sun safety studies (e.g., Williams, Jones, Caputi, & Iverson, 2012). Some of the core questions from the Glanz et al. (2008) study as well as several questionnaire items informed by the outcomes of other key empirical studies were incorporated into the pre-intervention questionnaire, including questionnaire items used in the Madgwick et al. (2011) pilot study of UK construction workers. In creating the questionnaire, care was taken to adopt their core set of questions used in previous studies, where appropriate, and in doing so to contribute to the creation of a methodologically-consistent knowledge base. The questionnaire was designed to explore respondents' sun safety knowledge, attitudes and worksite behaviours.

2.4.1.2 socio-demographic, personal and occupational variables

Socio-demographic characteristics were assessed so that these variables could be measured against responses to other questions to see if these characteristics affected the responses given. Previous studies (Duffy, Hee Choi, Hollern, & Ronis, 2012; Patel et al., 2010) have assessed gender and age of the respondent, however for this study, the geographical region in the United Kingdom in which the respondent lived were also assessed to give a broader set of social-demographic variables.

Personal skin variances were measured using a set of six statements used to assess the nearest match of the respondents skin colour, hair and eye colour. The

concept of sun-reactive skin types led to the development of the Fitzpatrick Scale (Fitzpatrick. (1988) and whilst used in many studies including Glanz et al. (2008), some have used variations of the scale, for this study the variant developed by the British Association of Dermatologists (2013), “Skindex”, was used as the basis of the statements as this gave detail on hair and eye colour as well as skin tone. The respondent was asked to “Choose the option below which is most like your skin, hair & eye colour”. The statements included in this section of the questionnaire were, Skin type 1:“Very pale coloured skin; a lot of freckles; light blonde, red or ginger hair; light blue, grey or green eyes”; 2: “Fair/pale coloured skin; fair/brown or blonde coloured hair; blue, grey or green eyes”; 3: “Fair to beige coloured skin; usually dark hair; hazel or light brown eyes”; 4: “Olive to light brown coloured skin; dark brown or black hair; dark brown eyes”; 5: “Dark brown coloured skin; dark brown or black hair; dark brown eyes” and 6: “Black coloured skin; black hair; brownish/black eyes”. Skin type was assessed in previous studies as a significant linear trend of increasing risk of skin cancer with decreasing ability to tan (Dublin, Pasternack, & Moseson (1990) and skin type being significantly associated with sunburns (Duffy et al., 2012).

Information was then required from respondents on checking the skin for signs of changes. Three questions used in the research by Glanz et al. (2008) were adapted to suit this study’s respondents. A follow on question was added to one of the questions to add further depth to the information received. The questions were, “Have you ever had your skin checked by a health professional? (e.g. a nurse, G.P., company doctor)”, and “In the last 12 months have you checked the following areas for moles or unusual skin changes: your entire body?; areas of your body regularly exposed to the sun?”, followed by, “If ‘yes’, how many times?” Responses were recorded on a two point scale with the choice of "Yes" or "No", with a number provided if “yes”

was selected on the second question. The third question, “In the last 12 months, how many times have you had a red sunburn that lasted a day or more?” Responses to this question were recorded on a six point Likert scale ranging from “None”(0) through to “5 or more times” (5).

The final personal questions requiring responses related to personal or friends/family with skin cancer. The two questions, developed from questions posed by Patel et al., (2010) were required as variables to see if this had an effect, through confirmation bias or attitude polarisation, on the behaviour and attitude of the respondent to other questions on the questionnaire. Responses to the two questions, “Have you had skin cancer?” and “Have any of your close friends or family had skin cancer?” were recorded on a two-point scale with the choice of "Yes" or "No".

The occupational variables measured established the occupation of the respondent by asking, “What is your job/trade?” This detail would allow any trends in particular occupations to be highlighted. The question, “Is sun lotion / sun screen supplied in your workplace?” allowed attitudes and behaviours to be analysed between those respondents who had the product supplied and those who didn’t. Responses to this question were recorded on a two point scale with the choice of "Yes" or "No". The final occupational variable was derived from a question asked in the research by Duffy et al., (2012). The question asked for this research was “On average, how many hours a day do you work outside?”. It was important to understand the length of time that respondents were working outside on average each day as it is known that the risk of having at least one type of skin cancer, squamous cell, increases with high levels of cumulative sun exposure (Glanz et al., 2008).

2.4.1.3 sun safety practices

The sun safety practices that were measured were adapted from a list of protective and precautionary measures noted as part of a detailed literature review conducted to identify epidemiological papers on solar ultraviolet radiation and skin cancer by Young (2009). Seven of the eight points detailed were expanded and rephrased to create ten sun safety measures developed to suit the construction outdoor worker for whom the questionnaire was intended. The measures included in this section of the questionnaire were, "avoid/minimise work in sunlight in the middle of the day", "swap jobs to minimise the amount of time working in the sun", "use a shade/cover when you're working in the sun", "wear long sleeved, loose fitting tops and trousers", "wear a safety helmet with neck protection", "wear sunglasses", "use sun lotion/sun screen", "drink plenty of water", "check the UV index forecast for the day" and "regularly check skin for moles or unusual changes"

The person completing the questionnaire was asked to respond to each of the ten measures by selecting one of five statements which best described their usual behaviour in relation to each of the measures. Each statement reflected one of the five stages of behavioural change developed from the Transtheoretical Model (TTM) of behaviour change (Prochaska and DiClemente (1982). The model, sometimes referred to as the wheel of change, although originally devised for use with smokers and smoking cessation, has been adapted and developed for many uses including the design and evaluation of numerous sun safety interventions (Borschmann, Lines, & Cottrell, 2012; Kristjansson, Ullen, & Helgason, 2004). Whilst the study by Kritjansson et al. (2004) used TTM as the format to assess the sun protection behaviours through a questionnaire distributed to a random sample of Stockholm

County residents, for this study, the item response format was informed by Arden and Armitage's (2008) study of adolescents' condom carrying behaviour. The five stages of change in the model with the actual statements used in the questionnaire to capture each stage were, 1) "Pre-contemplation – not thinking of changing : I **don't** do this and I'm **not** thinking about starting", 2) "Contemplation – considering change : I **don't** do this but I'm **thinking** about starting", 3) "Preparation- committed to change : I **don't** do this, but I'm **planning** to start in the next month", 4) "Action – having started a change : I **do** this and began to do it in the last 12 months" and 5) " Maintenance – sustaining the new behaviour : I **do** this and have done so for more than a year".

2.4.1.4 sun safety knowledge and attitudes

Sun safety knowledge and attitude was measured using a set of seven statements used to assess the respondents existing knowledge of and attitude towards sun safety. The statements included in this section of the questionnaire were, "I don't need to wear sun lotion/screen on a cloudy or overcast day", "It is important to wear sun glasses to protect the eyes from the sun", "Sun exposure is the important risk factor for skin cancer", "If I apply factor 30 sun lotion, I only need to apply it once a day", "I like to have a sun tan", "I think I am at risk of skin cancer" and "Sun protection is important when working outside for less than one hour". Responses were recorded on a three point scale with the choice of "Agree", "Disagree" or "Don't Know". The statements selected were adapted from the correct knowledge statements and sun protection attitudes question set within the Patel et al. (2010) study, "Skin Cancer Awareness, Attitude and Sun Protection Behaviour Among Medical Students at the University of Miami Miller School of Medicine".

A further primary question with a follow on question was asked relating to sun safety knowledge. The question was, “Have you ever had any training on the risks of working in the sun?”, followed by, “If ‘yes’, was this within the last 12 months ?”. The question was included to establish, through analysis against the responses to the set of seven statements, if the level of existing knowledge shown was enhanced through training received. Responses were recorded on a two point scale with the choice of "Yes" or "No".

Despite the need to incorporate enough questions to be able to develop a detailed understanding of workers current levels of sun safety knowledge, attitudes and worksite behaviours, it was vital to make the document sent to each participant as short as possible given that questionnaire length is inversely associated with response rate in occupational health studies (Edwards et al., 2002; 2007), the questionnaire was limited to two sides of A4 with a single side used as an introduction to the topic.

2.4.2 post-intervention

2.4.2.1 questionnaire development

In order to facilitate the examination of changes in responses between the pre and post intervention questionnaires and to allow cross study comparisons with other research undertaken, including the pilot study undertaken by the researcher in 2010 (Madgwick et al., 2011), many of the question sets remained the same in the post-intervention questionnaire. The question sets on sun safety knowledge, attitudes, and behaviors remained identical to those included in the pre-intervention questionnaire. The socio-demographic characteristics, skin type, occupational factors, skin checking, sunburn and skin cancer experience questions found on the first page of the pre-intervention questionnaire were removed from the post-intervention questionnaire. The socio-demographic, skin type and occupational elements were not required to be

repeated in the post-intervention questionnaire due to this only being sent to previous respondents. The questions on skin checking were not required as this area was questioned within the sun safety behaviours section. The previous questions on skin cancer experience were asked to establish if confirmation bias or attitude polarisation was present in those who had a personal (either themselves or a close friend or family member) experience of skin cancer and so did not need questioning again. The questioning on training in the risks of working in the sun was not required as by viewing the intervention such training would have been received.

In response to the publication of a study from New Zealand which highlighted the importance of sun safety culture in the efficacy of occupational sun safety interventions (Reeder, Gray, & McCool, 2013), the decision was taken to also measure sun safety culture in the post-intervention questionnaire. The three items in the form used by Reeder et al., (2013) were, "Remembering to use sun protection has high priority within my workplace", "I feel comfortable about applying sun screen in front of my work mates", and "I would tell my work mate if I think s/he was getting sun burnt". The three statements used in the post-intervention questionnaire were slightly re-phrased to suit the intended questionnaire recipients, "Remembering to use sun protection has high importance within my workplace", "I feel ok about applying sunscreen in front of my work mates", "I would tell my work mate if I thought he/she was getting sun burnt".

A further item in response to the findings of the pre-intervention survey was that the use of sun safety measures would need to be enforced by site management to be effective, with the attendees using the wearing of personal protective equipment as an example. The HSE representative on the project steering group was keen to explore workers' views that if site rules were applied to the use of sun safety measures that

this might prove an effective means to encourage take up. Therefore one further item was included in the questionnaire: "If use of sun safety measures was a site rule I would follow it." The items required respondents to indicate the strength of their agreement to each question on a five point Likert-type scale with the choice of "Strongly Agree", "Agree", "Neutral", "Disagree" and "Strongly Disagree" with strongly agree (one point) through to strongly disagree (five points). Scores for the three items adapted from the Reeder et al. (2013) study were combined to create a workplace sun safety culture score out of a maximum score of 15 to allow cross study comparison.

Importantly, a single question, *"Have you viewed the Sun Safety in Construction DVD?"* was added as the first question on the post-intervention questionnaire. The question had a yes/no response format and was used to establish whether the intervention had been viewed. The responses to this question permitted the identification of intervention- and control-group participants. In a study of this type, where the objective is to permit changes in knowledge, attitudes, and behaviours to be attributed to the intervention, it is standard practice to allocate participants to either an intervention group or a control group.

The intervention group consisted of participants who (i) returned a completed pre-intervention questionnaire, (ii) returned a completed post-intervention questionnaire, (iii) indicated on the pre-intervention questionnaire that they worked outdoors, and (iv) indicated on the post-intervention questionnaire that they **had** viewed the Sun Safety in Construction DVD.

For this research study, the control group created was a 'naturally occurring control group' which comprised participants who completed pre and post intervention questionnaires, but who failed, for whatever reason, to receive the intervention. The

control group consisted of participants who (i) returned a completed pre-intervention questionnaire, (ii) returned a completed post-intervention questionnaire, (iii) on the pre-intervention questionnaire that they worked outdoors, and (iv) indicated on the post-intervention questionnaire that they **had not** viewed the Sun Safety in Construction DVD.

This design was adopted for three reasons. Firstly, all participating companies wanted to receive the intervention (a wait-list control group was not possible due to time constraints laid out to achieve the various elements of the project). Secondly, due to the transient nature of the construction sector and its workers, work scheduling requirements, absence through illness or holidays, or staff turnover, it was considered unlikely that all workers who completed both the pre and post intervention questionnaires would also be present and available on the day on which the intervention was administered. Thirdly, evidence from previous sun related intervention studies suggests that interventions may fail to be administered across the organisations that agree to participate, thereby creating a naturally occurring control group. For example, an evaluation of the key elements of the Australian Sun Sound intervention found that only 27% of the participant sites involved played the five-second sun safety jingle over loudspeakers at outdoor recreational settings at regular intervals, whilst 45% prominently displayed the promotional materials (posters) (McIver & Rock, 2013).

The benefits afforded by the use of a naturally occurring control group in occupational health research have been demonstrated empirically (Randall, Griffiths, & Cox, 2005). This design achieves two things: "It measures actual exposure to the intervention to allow a valid evaluation of its effectiveness (thus controlling Type III error) [i.e., the mistaken conclusion that an intervention was unsuccessful that can

arise when it is incorrectly assumed that all participants received an intervention as planned], and it permits informative evaluation where [intervention] exposure patterns cannot be planned or tightly controlled" (ibid, 2005, p. 26).

A conscious effort was made to ensure that the post-intervention questionnaire content covered no more than one side of A4 paper. Previous research on methods to increase response rates to postal questionnaires had found that the odds of response were nearly three-quarters higher when using shorter questionnaires (Edwards et al., 2007).

2.5 Ethics

Ethical approval for the research project and its studies was granted by the Research Ethics Committee of the Institute of Work, Health and Organisations at the University of Nottingham on the 9th March, 2012. The Committee in giving consent, required that the research followed the British Psychological Society's (2009) code of ethics and conduct. In addition, the Universities ethical procedures were also to be adhered to when developing and progressing the project.

When developing and undertaking research, ethical considerations are an important element of the overall project to protect both the participants and researcher. The British Psychological Society (BPS), as the UK's principle professional body for psychology, publish guidance for researchers, the key document being the "Code of Ethics and Conduct" (British Psychological Association (BPS, 2009). This key text details the founding principles to be followed. In addition to the code, the University of Nottingham (UoN), as the university supporting the research project through the Institute of Work, Health and Organisations, now a part of the Division of Psychiatry and Applied Psychology within the School of Medicine, has a "Code of Research

Conduct and Research Ethics – Version 3, January 2010" authorised by the Research Committee of the UoN.

In order to satisfy the Ethics Committee, the proposal placed before them had to clearly demonstrate that ethical consideration and compliance with ethical guidelines formed an integral part of the research project. The two fundamental principles that needed to be demonstrated were those of respect and responsibility for participants.

The principle of respect has three key elements; consent, confidentiality and self-determination. To be able to achieve consent, the researcher needs to provide potential participants with sufficient information on the research to allow them to make an informed decision on whether to participate or not. For this research, a cover sheet was attached to the questionnaire. The cover sheet described in clear, understandable text, the purpose of the study, the use of the findings, the anticipated length of time required to complete the questionnaire, the procedure for returning the completed questionnaire, the incentive for participation (entry to a free prize draw to win a driving experience track day) and the researchers contact details.

Confidentiality of participants is an important element in ensuring that information provided is accurate and the genuine personal response of the participant and not tempered to the views of an organisation or peer group due to participants fearing that their anonymity is not assured. For this research, the cover sheet provided assurances that the data collected would remain confidential with neither, the participant's employer or IOSH able to identify individuals. The cover sheet also advised that all data collected would be processed and stored in accordance with the Data Protection Act, 1998. Participants were advised that anonomised data from the research would be used within academic articles and the project lead's PhD studies. At

the end of the question set within the questionnaire, participants were encouraged to supply their contact details to allow a post intervention questionnaire to be forwarded to them with a reminder that none of their contact details would be passed on or shared with any third parties.

The ability for participants themselves to withdraw at any time from participation (self-determination) in research is very important. The cover sheet confirms that completing the questionnaire is voluntary and that, should they wish, they can cease to complete the questionnaire at any point.

The principle of responsibility has two elements, the protection of participants and the de-briefing of participants. When considering the protection of participants, the BPS advises psychologists should "Consider all research from the standpoint of research participants, for the purpose of eliminating potential risks to psychological well-being, physical health, personal values, or dignity"(BPS,2009, p.19). The research aims to achieve this with the statement on the cover sheet advising that participation in the study is unlikely to cause any distress but should any distress be caused, for participants to contact their general practitioner.

It is important that participants have the opportunity to be debriefed on the project they have volunteered to take part in. For research that is taken in one location with all participants together, a debrief is easier to achieve than for projects undertaken in multiple locations and remote from the participants, such as with this research. Participants were advised on the cover sheet when and where a summary of the findings could be obtained and were also given the contact details of the researcher.

2.6 Analytical approach

Analysis was completed using the I.B.M. Statistical Package for the Social

Sciences (SPSS), version 22. Pearson's chi-square test was used to examine the statistical significance of the link between self-reported intervention exposure and changes in knowledge correctness. For each knowledge domain the proportion of participants (intervention versus comparison) that were incorrect at baseline and then correct at follow up were compared. For each behavioural domain the significance of change in the mean score on the stage of change measure was examined using a repeated measures t-test in both the intervention and control group. The proportion of respondents in the action or maintenance stage of change in each group at follow-up was also examined to identify the number of participants crossing the thresholds from inaction to action/maintenance. This approach to reporting is consistent with that employed in previous sun safety intervention studies (Girgis et al., 1994; Rye et al., 2014; Weinstock, Rossi, Redding, & Maddock, 2002).

3. Results: Aim 1

3.1 Baseline questionnaire respondent characteristics

A total of 1,279 workers returned a completed baseline questionnaire. The workers came from 22 companies who actually engaged in the research project process.

Criteria for inclusion in the research project was the requirement that the individual completing the questionnaire indicated that they did work outdoors for some part of each day which was qualified by the question, "On average, how many hours a day do you work outside?". 96 participants indicated that their job did not involve any outdoor work and 29 participants gave no information on the hours they worked outdoors. After removal of the 125 non-compliant questionnaires, analyses were conducted on a final sample of 1,154 participants.

3.2 Respondents' socio-demographic, personal, and occupational characteristics

Key socio-demographic and occupational characteristics of the sample are shown in the following tables. Responses were drawn from across a wide range of trades and size of companies (N = 22) suggesting that the sample was broadly representative of the UK construction sector.

3.2.1 socio-demographic characteristics

The gender of the respondents completing the pre-intervention questionnaire is detailed in Table 1. Unsurprisingly, 97 percent of respondents were male, with 2.5 percent of respondents confirming that they were female.

Table 1:
Gender of Respondents

Gender	N (%)
Male	1,119 (97.0)
Female	29 (2.5)

Not specified	6 (0.5)

Table 2 details the ages of the respondents, with over 70 percent falling within the age range of 21 and 50. There were only a small percentage, 5.9 percent, who were aged under 20 and would commonly be apprentices who would be a logical target group to educate before they developed the typical behaviour traits witnessed in many construction workers with regards to considering their own health and well-being. There were also only a small percentage, 3.1 percent, of workers over the age of 61.

Table 2:
Age of Respondents

Age	N (%)
≤20	68 (5.9)
21-30	284 (24.6)
31-40	257 (22.3)
41-50	268 (23.2)
51-60	176 (15.3)
≥61	36 (3.1)
Not specified	65 (5.6)

The geographic spread of respondents across the U.K., presented in Table 3, gave respondents located in every region.

Table 3:
Geographic Spread of Respondents Across the U.K.

Location	N (%)
South East	158 (13.7)
London	89 (7.7)
South West	34 (2.9)
East Anglia	46 (4.0)
Midlands	228 (19.8)

North	169 (14.6)
North East	140 (12.1)
North West	130 (11.3)
Scotland	85 (7.4)
Wales	25 (2.2)
Northern Ireland	29 (2.5)
Not specified	21 (1.8)
Total	1,154(100)

3.2.2 personal characteristics

Skin type frequencies are shown in Table 4. More than half of respondents (54.8%) were either ‘very pale’ or ‘fair/pale’, the typical skin types for individuals born in Western Europe, indicating that the majority of respondents were at high risk for the possible future development of skin cancer.

Table 4:
Skin Type of Respondents

Skin Type	N (%)
Very pale	86 (7.6)
Fair/pale	536 (47.2)
Fair/beige	275 (24.2)
Olive/light brown	185 (16.3)
Dark brown	42 (3.7)
Black	12 (1.1)

Table 5 presents findings on skin checking. The vast majority of respondents (81.8%) indicated that they had never had their skin checked by a health professional, typically a nurse, G.P., company doctor or specialist occupational health nurse or dermatologist, for signs of skin cancer. Three quarters of respondents (73.4%) indicated that within the last 12 months they had not checked their entire body for moles or skin damage, whilst more than half (60.5%) indicated that they had not

checked areas of their body they considered regularly exposed to the sun within the last 12 months.

Table 5:
Respondents' Skin Checking Activities

	N (%)
Have you ever had your skin checked by a health professional?	
Yes	209 (18.2)
No	941 (81.8)
In the last 12 months have you checked your whole body for moles or skin changes?	
Yes	298 (26.6)
No	824 (73.4)
In the last 12 months have you checked areas of your body regularly exposed to the sun for moles or skin changes?	
Yes	419 (39.5)
No	643 (60.5)

Data on sunburn experience are shown in Table 6. Fewer than half of respondents (40.8%) had not experienced a sunburn that remained red for a day or more within the last 12 months.

Table 6:
Respondents' Experience of Sunburn

	N (%)
In the last 12 months how many times have you had a red sunburn that lasted a day or more?	
0	426 (40.8)
1	291 (27.8)
2	174 (16.7)
3	77 (7.4)
4	28 (2.7)
5 ≥	49 (4.7)

Table 7 presents findings on skin cancer experience. Ninety nine per cent of respondents indicated that they had not had skin cancer however over fifteen per cent of respondents indicated that a family member or close friend had had skin cancer.

Table 7:
Respondents Experience of Skin Cancer

	N (%)
Have you had skin cancer?	
Yes	11 (1.0)
No	1134 (99.0)
Have any family or close friends had skin cancer?	
Yes	175 (15.3)
No	968 (84.7)

3.2.3 occupational characteristics

The mean time the respondents spent working outdoors on a typical working day was 6.7 hours (SD = 3.1), however the distribution of hours worked outdoors was skewed; actually the majority of respondents worked outdoors for approximately eight hours per day (median = 8.0 hours; mode = 8.0 hours).

When questionned on their job or trade, a vast array of occupations were given by the respondents which also helped to suggest that the sample was broadly representative of the UK construction sector.

Table 8:
Occupations of Respondents

	N (%)		N (%)
Apprentice	36 (3.1)	Plant/Machine operator	41 (3.6)
Asbestos remover	3 (<1.0)	Plasterer	22 (1.9)
Banksman	6 (<1.0)	Plater	1 (<1.0)
Bricklayer	99 (8.6)	Rigger	3 (<1.0)
Civil engineer	12 (1.0)	Roofer	16 (1.4)
Cladder	12 (1.0)	Scaffolder	45 (3.9)
Customer care	9 (<1.0)	Snr Construction Manager	24 (2.1)
Diamond driller	7 (<1.0)	Sign maker/fitter	16 (1.4)
Electrician	78 (6.8)	Site engineer	33 (2.9)
Fence erector	2 (<1.0)	Site foreman	19 (1.6)
Fireproofer	3 (<1.0)	Site office staff	55 (4.8)
Fork lift driver	33 (2.9)	Site manager	60 (5.2)
Ground worker	115 (10.0)	Site supervisor	31 (2.7)
Health and safety professional	20 (1.7)	Steel fixer	26 (2.6)
Insulator	2 (<1.0)	Storeman	4 (<1.0)
Joiner	120 (10.4)	Teacher / instructor	1 (<1.0)
Labourer	100 (8.7)	Tiler	1 (<1.0)
Lift engineer	9 (<1.0)	Traffic management	4 (<1.0)
Mech Tech / Plumber	49 (4.2)	Welder	5 (<1.0)
Painter	15 (1.3)	Window fitter	8 (<1.0)
Plant fitter	2 (<1.0)	Not specified	7 (<1.0)

Table 9 details findings on sun safety training and sunscreen provision by employers. The findings appear to give a muddled indication of whether organisations understand the risks of working in the sun. More than half of respondents (60.7%) indicated that sunscreen was supplied in their place of work, whilst almost three quarters (70.4%) indicted that they had never received sun safety training.

Table 9:
Occupational Sunscreen Provision and Sun Safety Training

	N (%)
Is sunscreen supplied in your workplace?	
Yes	664 (60.7)
No	429 (39.2)
Have you ever had training on the risks of working in the sun?	
Yes	341 (29.6)
No	810 (70.4)

3.3 Sun safety practices and behaviors

Table 10 shows that the majority of respondents (more than 50%) were classified as being in the pre-contemplation or contemplation stage of change for seven of the ten sun safety measures. The sun safety measures with the lowest numbers of respondents in either the action or maintenance stages were the 12.2% who checked the UV index forecast for the day. The next two measures concerned minimising direct exposure to UV rays through modifications to work organisation; 12.7% who swapped jobs to minimise the amount of time working in the sun; and the 20.7 % who avoided or minimised their work in sunlight in the middle of the day.

The three sun safety measures where the highest numbers of respondents were in either the action or maintenance stages were measures that could be personally administered by the respondent whilst not necessarily involving their employer or work organisation, these were 84.9% who drank plenty of water; the 56.8% who advised that they used sunscreen; and the 54.8% who wore sunglasses.

Table 10:

Baseline Survey Respondents' Sun Safety Practices

	I don't do this and I'm not thinking about starting (pre-contemplation)	I don't do this but I'm thinking about starting (contemplation)	I don't do this, but I'm planning to start in the next month (planning)	I do this and began to do it in the last 12 months (action)	I do this and have done so for more than a year (maintenance)
	N (%)	N (%)	N (%)	N (%)	N (%)
Avoid/minimise work in sunlight in the middle of the day	651 (59.3)	188 (17.1)	32 (2.9)	49 (4.5)	178 (16.2)
Swap jobs to minimise the amount of time working in the sun	751 (69.5)	156 (14.4)	37 (3.4)	43 (4.0)	94 (8.7)
Use a shade/cover when working in the sun	609 (56.8)	178 (16.6)	33 (3.1)	69 (6.4)	184 (17.1)
Wear long sleeved, loose fitting tops and trousers	463 (42.1)	142 (12.9)	39 (3.5)	131 (11.9)	326 (29.6)
Wear a safety helmet with neck protection	594 (55.4)	198 (18.5)	38 (3.5)	59 (5.5)	183 (17.1)
Wear sunglasses	314 (28.8)	137 (12.6)	42 (3.8)	126 (11.5)	472 (43.3)
Use sunscreen	264 (24.2)	159 (14.6)	48 (4.4)	122 (11.2)	498 (45.6)

Drink plenty of water	77 (6.9)	62 (5.6)	29 (2.6)	128 (11.5)	818 (73.4)
Check the UV index forecast for the day	679 (62.8)	223 (20.6)	49 (4.5)	46 (4.3)	85 (7.9)
Regularly check skin for moles or unusual changes	310 (28.2)	257 (23.4)	78 (7.1)	115 (10.5)	339 (30.8)

Table 11:

Baseline Survey Respondents' Sun Safety Practices

Having reviewed respondents' existing sun safety behaviours measured through the five stages of behaviour change to the ten sun safety measures listed, Table 11 presents sun safety behaviours by skin type. The pre-action column represents the responses to each question by those respondents at the pre-contemplation, contemplation and planning stages, whilst the action/maintenance column represents the remaining two stages of behaviour change developed from the Transtheoretical Model.

From analysing responses from those who were within the action/maintenance stages, respondents with very pale or fair/pale skin types had the highest levels for avoiding/minimising work in the sun in the middle of the day and for the use of a shade/cover when working in the sun. However when compared to respondents of other skin types within the action/maintenance stages, respondents with very pale skin reported a greater proportion of wearing long sleeved, loose fitting tops and trousers (50.0%); using a helmet with neck protection (28.8%); and using sunscreen (64.6%) than respondents in the remaining skin type categories.

Table 11:

Baseline Survey Respondents' Sun Safety Behaviors By Skin Type

	Pre-action	Action/ Maintenance
	N (%)	N (%)
Avoid/minimise work in sunlight in the middle of the day		
Very pale	62 (78.5)	17 (21.5)
Fair/pale	402 (78.4)	111 (21.6)
Fair/beige	210 (79.2)	55 (20.8)

Olive/light brown	149 (82.3)	32 (17.7)
Dark brown	30 (75.0)	10 (25.0)
Black	9 (100.0)	--
Total	871 (79.3)	227 (20.7)
Swap jobs to minimise the amount of time working in the sun		
Very pale	73 (92.4)	6 (7.6)
Fair/pale	435 (86.3)	69 (13.7)
Fair/beige	230 (88.8)	29 (11.2)
Olive/light brown	156 (87.6)	22 (12.4)
Dark brown	31 (77.5)	9 (22.5)
Black	9 (100.0)	--
Total	944 (87.3)	137 (12.7)
Use a shade/cover when working in the sun		
Very pale	60 (75.0)	20 (25.0)
Fair/pale	371 (74.3)	128 (25.7)
Fair/beige	200 (77.8)	57 (22.2)
Olive/light brown	144 (80.9)	34 (19.1)
Dark brown	30 (75.0)	10 (25.0)
Black	8 (77.8)	1 (22.2)
Total	820 (76.5)	253 (23.5)
Wear long sleeved, loose fitting tops and trousers		
Very pale	41 (50.0)	41 (50.0)
Fair/pale	292 (56.7)	223 (25.7)
Fair/beige	160 (60.8)	103 (39.2)
Olive/light brown	117 (65.7)	61 (34.3)
Dark brown	22 (52.4)	20 (47.6)
Black	6 (75.0)	8 (25.0)
Total	644 (58.5)	457 (41.5)
Wear a safety helmet with neck protection		
Very pale	52 (71.2)	21 (28.8)
Fair/pale	392 (77.8)	112 (22.2)
Fair/beige	203 (78.4)	56 (21.6)
Olive/light brown	136 (78.6)	37 (21.4)
Dark brown	35 (85.4)	10 (14.6)
Black	7 (77.8)	2 (22.2)
Total	830 (77.4)	242 (22.6)
Wear sunglasses		
Very pale	38 (46.3)	44 (53.7)
Fair/pale	230 (45.0)	281 (55.0)
Fair/beige	120 (46.5)	138 (53.5)

Olive/light brown	80 (45.2)	97 (54.8)
Dark brown	16 (38.1)	8 (61.9)
Black	6 (75.0)	2 (25.0)
Total	493 (45.2)	598 (54.8)
Use sunscreen		
Very pale	29 (35.4)	53 (64.6)
Fair/pale	224 (44.0)	285 (56.0)
Fair/beige	106 (40.6)	155 (59.4)
Olive/light brown	86 (47.8)	94 (52.2)
Dark brown	15 (38.5)	24 (61.5)
Black	7 (77.8)	2 (22.2)
Total	471 (43.2)	620 (56.8)
Drink plenty of water		
Very pale	12 (14.8)	69 (85.2)
Fair/pale	77 (14.7)	448 (85.3)
Fair/beige	42 (15.6)	228 (84.4)
Olive/light brown	28 (16.0)	147 (84.0)
Dark brown	4 (10.0)	36 (90.0)
Black	4 (40.0)	6 (60.0)
Total	168 (15.1)	946 (84.9)
Check the UV index forecast for the day		
Very pale	70 (87.5)	10 (12.5)
Fair/pale	444 (88.1)	60 (11.9)
Fair/beige	227 (87.6)	32 (12.4)
Olive/light brown	159 (89.3)	19 (10.7)
Dark brown	34 (85.0)	6 (15.0)
Black	8 (88.9)	1 (11.1)
Total	951 (87.9)	131 (12.1)
Regularly check skin for moles or unusual changes		
Very pale	48 (58.5)	34 (41.5)
Fair/pale	295 (57.3)	220 (42.7)
Fair/beige	156 (59.8)	105 (40.2)
Olive/light brown	108 (60.0)	72 (40.0)
Dark brown	22 (53.7)	19 (46.3)
Black	8 (88.9)	1 (11.1)
Total	645 (58.7)	454 (41.3)

3.4 Sun safety knowledge and attitudes

Table 12 details findings on sun safety knowledge and attitudes. The results for some statements appeared to show respondents knowledge of the topic to be quite muddled. There was good awareness of sun exposure being the most important risk factor for skin cancer (85.1%) and the importance of wearing sunglasses to protect the eyes (84.7%). Respondents agreed that sunscreen should be applied even when working outdoors for less than an hour (66.2%) and disagreed with the statement that factor 30 sunscreen only needed to be applied once per day (64.8%). However there were in particular two statements which appeared to highlight that there was an apparent short fall in education on the topic. On the subject of sun tans, respondents indicated that they like to have a tan (70.1%) but perhaps of more concern, whilst relatively few respondents (33.6%) thought they were at risk of skin cancer, a further thirty nine percent indicated that they did not know if they were at risk.

Table 12:

Respondents' Existing Sun Safety Knowledge and Attitudes

	N (%)
I don’t need to wear sunscreen on a cloudy/overcast day	
Agree	465 (41.0)
Disagree	527 (46.5)
Don’t know	142 (12.5)
It is important to wear sunglasses to protect the eyes from the sun	
Agree	963 (84.7)
Disagree	72 (6.3)
Don’t know	102 (9.0)
Sun exposure is the most important risk factor for skin cancer	
Agree	962 (85.1)
Disagree	31 (2.7)
Don’t know	138 (12.2)
If I apply factor 30 sun screen I need only apply it once per day	
Agree	122 (10.8)

Disagree	730 (64.8)
Don’t know	274 (24.3)
I like to have a suntan	
Agree	787 (70.1)
Disagree	248 (22.1)
Don’t know	87 (7.8)
I think I am at risk of skin cancer	
Agree	379 (33.6)
Disagree	314 (27.8)
Don’t know	435 (38.6)
Sun protection is important when working outside for less than one hour	
Agree	749 (66.2)
Disagree	178 (15.7)
Don’t know	204 (18.0)

4. Results: Aim 2

4.1 Follow-up questionnaire respondent characteristics

A total of 906 respondents (71%) from the 1,279 who returned a completed baseline questionnaire kindly agreed to provide contact details and were sent a follow-up questionnaire. A total of 160 respondents of the 906 who were sent the follow up questionnaire returned a completed follow-up questionnaire, generating an 18% retention rate. The level of response to the post-intervention questionnaire did not permit significance testing as part of the evaluation of the data.

The same criteria for inclusion in the research project was applied to the follow up questionnaire by asking the individual completing the questionnaire to indicate that they did work outdoors for some part of each day which was qualified by the question, "On average, how many hours a day do you work outside?". Forty participants indicated that either their job now did not involve any outdoor work or gave no information on the hours they worked outdoors. After removal of the 40 non-compliant follow up questionnaires, analyses were conducted on a final sample of 120 participants (emergent intervention group n = 70; emergent comparison group n = 50). There were no significant pre-intervention differences between the knowledge and practices reported by the two groups.

4.2 Respondents' socio-demographic, personal, and occupational characteristics

Key socio-demographic and occupational characteristics of the sample are shown in the following tables.

4.2.1 socio-demographic characteristics

The gender of the respondents completing the post-intervention questionnaire is detailed in Table 13. Unsurprisingly, in both the intervention and control groups the majority of respondents were male, ninety four percent and ninety six percent

respectively. The mean age of the respondents in both groups confirms the ageing profile of construction workers in the UK, with the comparison group being slightly older, 45.8 years (SD = 11.6), than the intervention group, 41.2 years (SD = 12.3), $P<0.05$.

Table 13:
Gender of Respondents

Gender	Intervention Group N (%)	Comparison Group N (%)
Male	66(94)	48(96)
Female	4(6)	2(4)

The geographic spread of respondents across the U.K., presented in Table 14, gave respondents located in every region with the exception of Northern Ireland. There was a large number of the respondents in both groups that indicated they lived in the Midlands, North or North East.

Table 14:
Geographic Spread of Respondents Across the U.K.

Location	Intervention Group N (%)	Comparison Group N (%)
South East	6 (9)	10 (20)
London	3 (4)	1 (2)
South West	2 (3)	3 (6)
East Anglia	1 (1)	--
Midlands	17 (24)	8 (16)
North	25 (36)	9 (18)
North East	13 (19)	9 (18)
North West	1 (1)	5 (10)
Scotland	1 (1)	2 (4)
Wales	1 (1)	2 (4)
Not Specified	--	1 (2)
Total	70	50

4.2.2 personal characteristics

Skin type frequencies are shown in Table 15. Both groups had over forty percent of respondents having ‘fair/pale’ skin type, however only a small number of respondents had either ‘very pale’ or ‘dark brown’ skin type. No ‘black’ skin type construction workers were respondents for the post-intervention phase.

Table 15:
Skin Type of Respondents

Skin Type	Intervention Group N(%)	Comparison Group N(%)
Very pale	1 (1)	4 (8)
Fair/pale	29 (41)	24 (48)
Fair/beige	21 (30)	14 (28)
Olive/light brown	18 (26)	6 (12)
Dark brown	1 (1)	1 (2)
Black	--	--
Not Specified	--	1 (2)

Table 16 presents findings on skin cancer experience. None of the respondents within the emergent intervention group indicated that they had not had skin cancer and only one person within the comparison group. When asked if a family member or close friend had had skin cancer, seventeen percent of respondents in the intervention group and twenty per cent in the comparison group advised that they had.

Table 16:
Respondents Experience of Skin Cancer

	Intervention Group N (%)	Comparison Group N (%)
Have you had skin cancer?		
Yes	--	1 (2)
No	70 (100)	49 (98)

Have any family or close friends had skin cancer?		
Yes	12 (17)	10 (20)
No	58 (83)	40 (80)

4.2.3 occupational characteristics

The mean time the respondents spent working outdoors on a typical working day varied considerably between the two groups of respondents. The emergent intervention group's mean hours were 4.4 hours (SD = 2.8) compared to 5.9 hours (SD = 4, $P<0.01$).

Table 17 details findings on sun safety training and sunscreen provision by employers. Nearly half of respondents , fifty percent of the intervention group and forty eight percent of the comparison group indicated that sunscreen was supplied in their place of work. The findings on whether the respondents had ever received sun safety training was surprising with seventy one percent of those in the intervention group which had, as part of their process, seen the Sun Safety awareness DVD intervention advising that they had not ever received training on the risks of working in the sun. Fifty four percent of the comparison group advised that they had not ever received such training.

Table 17:
Occupational Sunscreen Provision and Sun Safety Training

	Intervention Group N (%)	Comparison Group N (%)
Is sunscreen supplied in your workplace?		
Yes	35 (50)	24 (48)
No	34 (49)	23 (46)
Not Specified	1 (1)	3 (6)
Have you ever had training on the risks of working in the sun?		
Yes	20 (29)	22 (44)
No	50 (71)	27 (54)

Not Specified	--	1 (2)

4.3 Sun safety practices and behaviours

Table 18 shows the mean scores on the stages of change measures for each sun safety practice along with the percentage of respondents that reported being in the action or maintenance stage of change. The intervention group demonstrated significant positive change on nine behavioural measures compared to two for the comparison group. The strongest changes, all of which exceeded a movement of 20% of the emergent intervention group into the action/maintenance stage, when comparing the numbers at the baseline and subsequent follow up questionnaire stages, were as follows: the use of a shade/cover when working in the sun (+33 %) , regular checking of skin for moles or unusual changes (+27 %), rotating job tasks to minimise amount of time spent working in the sun (+24 %), wearing sunglasses (+21 %), and minimising work in direct sunlight in the middle of the day (+21 %).

The emergent comparison group demonstrated the same level of significant positive change (+27%) as the emergent intervention group had achieved for the sun safety practice of regularly checking skin for moles or unusual changes. The only area where the emergent comparison group showed a greater positive increase of movement into the action/maintenance stage (+11 %) than the emergent intervention group (+2 %) was for the sun safety practice of drinking plenty of water. This was also the only sun safety practice for which the emergent comparison group had a higher percentage of respondents in the action/maintenance stage than the emergent intervention group with 98% compared to 93%.

Table 18:

Sun Safety Practices of Respondents' in the Action or Maintenance Stage

	Intervention Group			Comparison Group		
	Respondents in action /maintenance stage (Baseline)	Respondents in action /maintenance stage (Follow-up)	Change	Respondents in action /maintenance stage (Baseline)	Respondents in action /maintenance stage (Follow-up)	Change
	Mean (%)	Mean (%)	Mean (%) [no. of respondents]	Mean (%)	Mean (%)	Mean (%) [no. of respondents]
Avoid/minimise work in sunlight in the middle of the day	2.29 (28)	3.06 (49)	0.77** (+21) [66]	2.33 (29)	2.72 (40)	0.39 (+11) [43]
Swap jobs to minimise the amount of time working in the sun	1.98 (22)	2.85 (46)	0.87*** (+24) [66]	1.93 (20)	2.24 (30)	0.31 (+10) [42]
Use a shade/cover when working in the sun	2.31 (26)	3.34 (59)	1.03*** (+33) [67]	2.36 (32)	2.57 (31)	0.21 (-1) [42]
Wear long sleeved, loose fitting tops and trousers	2.87 (46)	3.50 (60)	0.63** (+14) [68]	3.31 (58)	2.98 (46)	-0.33 (-12) [48]
Wear a safety helmet with neck protection	2.02 (21)	2.46 (30)	0.44* (+9) [63]	2.04 (20)	2.04 (21)	0.00 (+1) [46]

Wear sunglasses	3.00 (50)	3.84 (72)	0.84*** (+22) [64]	3.53 (62)	3.55 (61)	0.02 (- 1) [47]
Use sunscreen	3.49 (60)	4.02 (77)	0.53* (+17) [68]	3.66 (64)	4.06 (76)	0.40 (+12) [47]
Drink plenty of water	4.60 (91)	4.67 (93)	0.07 (+2) [67]	4.47 (87)	4.85 (98)	0.38* (+11) [47]
Check the UV index forecast for the day	1.77 (13)	2.20 (23)	0.43* (+10) [66]	1.53 (4)	1.64 (10)	0.11 (+6) [45]
Regularly check skin for moles or unusual changes	3.13 (52)	4.07 (79)	0.94*** (+27) [67]	3.21 (49)	4.11 (76)	0.90** (+27) [47]

4.4 Sun safety knowledge and attitudes

Table 19 shows the percentage of respondents in the emergent intervention and comparison groups that reported correct knowledge on each knowledge domain at baseline and the subsequent 12-month post-intervention follow-up. The intervention group had the strongest percentage change of 33% for the knowledge domain, I don't need to wear sun screen/lotion on a cloudy/overcast day, with 56 of the 69 respondents in the post-intervention questionnaire correctly answering that they disagreed with that statement. The intervention group had the strongest percentage change for four out of the five knowledge domains. The emergent comparison group had a higher percentage of change for the correct answer to the sun safety knowledge statement, If I apply factor 30 sun screen I need only apply it once per day, with a positive change of sixteen percent compared to seven percent for the emergent intervention group. The reason for the emergent comparison group having this result may be because those in this group worked significantly more hours outside on a typical working day.

After using the chi-square test to compare the proportion of participants , intervention versus comparison groups, whose answers were incorrect at baseline and then correct at post-intervention follow up, all changes failed to reach statistical significance ($p<0.05$).

Table 19:

Respondents' Correct Understanding of Sun Safety Knowledge and Attitudes

	Intervention Group			Comparison Group		
	Selection of the correct answer (Baseline) n [valid cases]	Selection of the correct answer (Follow-up) n [valid cases]	% Change*	Selection of the correct answer (Baseline) n [valid cases]	Selection of the correct answer (Follow-up) n [valid cases]	% Change*
I don't need to wear sunscreen on a cloudy/overcast day	33 [70]	56 [69]	+33	30 [49]	38 [50]	+16
It is important to wear sunglasses to protect the eyes from the sun	56 [69]	67 [70]	+16	42 [50]	43 [50]	+2
Sun exposure is the most important risk factor for skin cancer	61 [69]	67 [70]	+9	46 [50]	43 [50]	-6
If I apply factor 30 sun screen I need only apply it once per day	52 [69]	57 [70]	+7	36 [50]	44 [50]	+16
Sun protection is important when working outside for less than one hour	7 [69]	6 [70]	-1	9 [50]	6 [50]	-6

*All changes failed to reach statistical significance at $P < 0.05$

5. Discussion

5.1 Overview of Findings: Aim 1

This study represents the first large scale, nationally representative report on the existing levels of knowledge, attitudes and awareness among construction workers in the UK to the subject of skin cancer caused by solar radiation and to understand the positive sun safety practices already employed in the workplace. The results from this pre-intervention stage self-administered questionnaire highlight the lack of construction workers knowledge on the topic and of the measures available to reduce levels of exposure. The results confirm those of a previous small-scale pilot study (Madgwick et al., 2011) in demonstrating that there is considerable room for improvement in terms of knowledge, attitudes and practices. The findings at this stage of the project suggest there is an imperative for tailored, targeted, and evaluable educational interventions that could, in conjunction with employers implementing and enforcing occupational sun safety policies and procedures, be invaluable in helping to enhance sun safety knowledge, attitudes and awareness in the sector.

5.1.1 consideration of findings in relation to the existing literature: aim 1

Many of the questions where derived from question sets used in other research (Duffy et al, 2012; Patel et al., 2010) and some from a list of core questions which were established by a work group of researchers established in the research topic of sun exposure and protection (Glanz et al., 2008). However, it was necessary to make minor adaptions to the questions based on this studies aims and the unique characteristics of the intended respondents.

‘Self-report measures are limited by individual’s recall errors, difficulty in estimating the frequency of common habits, and social desirability’ however, they are

commonly used as they are the most feasible measure for large scale surveys and intervention studies (Glanz et al., 2008) – Measures of sun exposure and sun protection practices for behavioural and epidemiologic research.

5.2 Respondents' socio-demographic, personal, and occupational characteristics

5.2.1 socio-demographic

Unsurprisingly, 97 percent of respondents were male. A review by the union, UCATT, of statistics held by the Office for National Statistics highlighted that in the U.K. only 11 percent of the construction workforce are female, with just one percent of construction workers physically working on site being female (UCATT, 2015).

The age range of the respondents was as expected with 70 percent being in the age range of 21 to 50. The age of construction workers plays an important part in changes in the workplace. Leathley, (2015) found in her review on older workers that research undertaken for the HSE by Loughborough University and UMIST showed that older people had entrenched views and a lack of patience when younger workers tried to highlight better practice, putting up barriers.

The spread of respondents meant that all geographical regions across the UK had some representation, with the Midlands having the largest share of respondents at just under 20 percent. Although the latitude of the UK is the same throughout, there is a variance of levels of MM. The Environment and Health Atlas created by the Small Area Health Statistics Unit of Imperial College, London (2014) using data from Cancer Research UK showed that the South West of England (Cornwall, Devon, Somerset, Dorset and Hampshire) had the highest levels of MM with Greater London, Kent and parts of Lincolnshire having the lowest levels (Small Area Health Statistics Unit, 2014)

5.2.2 personal

5.2.2.1 skin type

Skin type frequencies are shown in Table 4. It was important that the description for each skin type was as detailed as possible. A representative telephone survey of 1501 German residents aged over 14 found that less than 10% could correctly interpret their own skin type (Borner, Schutz, & Wiedemann, 2010).

There is sometimes an assumption that outdoor workers typically have a skin type that can cope better with solar radiation (Reinau, Surber, Jick & Meier, 2013). However, in their systematic review of the literature on sun safety among outdoor workers, Reinau and colleagues showed that although multiple USA studies found that construction workers (mostly Latinos) had low sun sensitivity, this was not generally the case. The current study similarly challenges this myth by showing that within the UK construction sector individuals with a skin type indicating a high UV radiation sensitivity constitute the majority. It is important to remember that although cases of skin cancer are less common in dark skinned people that the prognosis is often worse because of presenting to the doctors generally at a later stage of the cancer's development (Nyiri, 2005).

5.2.2.2 skin checking

Table 5 presents findings on skin checking. The vast majority of respondents – four out of five – indicated that they had never had their skin checked by a health professional for signs of skin cancer.

Reinau et al.'s (2013) review of the literature on sun safety in outdoor workers found that researchers have largely neglected skin checking. 59% of respondents in the current study indicated that they did not regularly check their skin for moles or unusual changes (compared to 52% in the pilot study). In two USA studies, 40% of farmers (Robinson et al., 2004) and watermen (Bridges & Ehrlich, 2005) reported that

they checked their skin occasionally or never. Although the literature available for comparison purposes is limited, it would appear that skin checking among UK construction workers is particularly poor.

5.2.2.3 sunburn experience

Data on sunburn experience is shown in Table 6. Fewer than half of respondents had not experienced a sunburn that remained red for a day or more within the last 12 months.

This finding is consistent with Reinau et al.'s (2013) review of the literature which found that across nine occupational sun safety studies that reported data on sunburn experience between 50% and 80% of outdoor workers had been sunburned in the year (or season) prior to data collection. An observational and qualitative study in Denmark found that young men perceived getting a sunburn as masculine, perceiving taking precautions as feminine (Larsen & Frederiksen, 2015).

5.2.2.4 skin cancer experience

Table 7 presents findings on skin cancer experience. Ninety nine per cent of respondents indicated that they had not had skin cancer. Approximately one in seven respondents indicated that a family member or close friend had had skin cancer.

5.2.3 occupational characteristics

5.2.3.1 hours worked outdoors

The selection of occupations amongst the 1,154 respondents who indicated that their work involves outdoor activity was very diverse, with the largest grouping, joiners, still only accounting for 10.4% of all the respondents. The mean time spent working outdoors on a typical working day was 6.7 hours (SD = 3.1). This finding was consistent with the mean of 6.6 hours found in the pilot study (Madgwick, et al., 2011). The distribution of hours worked outdoors was skewed; the majority of

respondents worked outdoors for approximately eight hours per day (median = 8.0 hours; mode = 8.0 hours).

5.2.3.2 sun safety training and sunscreen provision

Table 9 shows findings on sun safety training and sunscreen provision by employers. More than half of respondents indicated that sunscreen was supplied in their place of work and almost three quarters indicted that they had never had sun safety training.

5.3 Sun safety practices and behaviours

5.3.1 sun safety behaviours

Table 10 shows that the majority of respondents (equal to or more than 50%) could be classified as being in the pre-contemplation or contemplation stage of change for seven of the ten sun safety measures. The minority regularly used measures concerned with minimising direct exposure to UV rays through modifications to work organisation. For example, 21% regularly avoided or minimised their exposure to direct sunlight in the middle of the day; 13% regularly swapped jobs to reduce exposure to direct sunlight; and 24% regularly used a shade or cover when working outdoors in the sun. For clothing, 42% reported that they wore long-sleeved loose-fitting tops and trousers when working outdoors in the summer while 23% wore a safety helmet with neck protection. 88% did not regularly check the UV index forecast and 59% did not regularly check their skin for moles or unusual changes. For only three sun safety measures – wearing sunglasses, using sunscreen, plentiful water intake – were the majority of respondents in the action or maintenance stage, i.e., regularly applying the measure.

It may not always be possible for construction workers to work in the shade. As such, it is perhaps not surprising that only one in four respondents indicated that

they typically erect a shade when working in the sun. Although it might not always be feasible to work in the shade, UVR exposure can be substantially reduced by taking breaks in the shade (Parisi & Kimlin, 1999; Thieden et al., 2005). One Australian study found that 91% of workers took their breaks in the shade (Gies & Wright, 2003). Similarly, 21% of workers in the current study reported that they typically avoid working in the midday sun; a finding consistent with that of the pilot study (Madgwick et al, 2011). Given the operational constraints that may limit workers' ability to work in the shade or avoid the midday sun, it would be interesting for future studies to examine whether construction workers in the UK attempt to mitigate for that by taking breaks in the shade.

Reinau et al.'s (2013) review of the literature showed that across eight studies of farmers and construction workers conducted in the USA, Australia, Britain and Japan, more than half (50-80%) reported never or rarely wearing a long sleeved shirt when working in the sun. More recently, a study of New Zealand forestry workers found that 24% wore shirts with long sleeves (Reeder, McNoe, Lovelock, & Gray, 2013). In the context of these findings, the fact that 42% of respondents in the current study reported regularly wearing long sleeved tops and trousers might be seen as encouraging.

Little research has been conducted on the extent to which outdoor workers wear helmets with neck protection. The current study found that 23% of workers regularly wore a helmet with neck protection. This compares favourably with 7% found in a study of forestry workers in New Zealand (Reeder et al., 2013, September).

Fifty five per cent of respondents indicated that they regularly wore sunglasses when working outdoors in the sun. This is encouraging and consistent with other studies (Reinau et al., 2013). However, it is unclear whether sunglasses are primarily

worn for their sun-protective purpose; it is possible that they are worn to protect against glare than UVR (Weber et al., 2007) or as a fashion statement.

Sunscreen is the sun safety measure with which people are probably most familiar. Used properly it can be highly effective in the fight against skin cancer: One randomised control trial involving Australian adults found that the regular application of sunscreen reduced the occurrence of squamous cell carcinoma by 40% in a 4.5 year period (Green & Williams, 2007). Despite the effectiveness of sunscreen which when used properly, protects against sunburn and the subsequent development of skin cancers (Darlington et al, 2003; Bodekaer et al., 2008), outdoor workers (with the exception of those employed in the outdoor recreation activities such as ski instructors and lifeguards) appear reluctant to adopt this measure as a standard means of skin protection; indeed research by Reinau et al. (2013) found that the vast majority of agriculture and construction workers reported never or rarely using sunscreen, with Shoveller et al. (2000) finding from a national survey of Canadian outdoor workers that less than half use sunscreen appropriately.

Reinau and colleague's review of the literature found that outdoor workers have reported time-consuming application and unpleasant sticky consistency as barriers to the regular use of sunscreen. It is therefore encouraging that 57% of respondents in the current study reported that they regularly use sunscreen when working outdoors. Sunscreen can be effective in blocking UV radiation, however previous studies have shown that it is often not applied or reapplied in-line with the manufacturer's instructions detailed on the bottle (Autier, Boniol, Dore, 2007, Bimezok, Gers-Barlag, Mundt, Klette, Bielfeldt, Rudolph, 2007). Sunscreen is obviously not an effective sun safety measure for those who do not intend to be consciously exposed to UV radiation, for example, construction workers who work

outside for a short period of time e.g. less than an hour. Sunscreen use can be incorrectly used as a means to extend the time working outdoors and exposed to UV radiation which can lead to increased risk of sun burn and potential for skin cancer (Autier, 2009).

Only 12% of respondents were in the action or maintenance stage in respect to regular checking of the UV index. Among the 10 sun safety measures this particular measure was the least used. A systematic review of the WHO Global Solar Index found that there was only low to moderate levels of awareness to the index. The studies reviewed found that the index did not influence knowledge or attitudes to the topic and had been unsuccessful at either reducing unprotected sun exposure or improving sun safety practices (Italia & Rehfuess, 2012). The review reported a low level of understanding of the UV index, which concurs with a survey of 404 residents of Perth, Western Australia, 61% of whom were not aware that the UV index was independent of temperature (Carter & Donovan, 2007).

Although the literature on the usage rate for this measure is limited, it would appear that results can be very varied. A random telephone survey of 501 adults in Australia noted that utilisation of the index in Australia remained extremely low at approximately five percent (Blunden, Lower, & Slevin, 2004). A representative telephone survey of 1501 German residents aged over 14 found that only 27% had ever heard of the UV index and only 17% claimed to consult the index when planning their sun habits (Borner, Schutz, & Wiedemann, 2010). Contrary to the findings of the German survey, a Danish community survey found that 75% of respondents at least occasionally checked the UV index (Bentzen, Krarup, Munksgaard, & Rasmussen, 2013). The low rate of both knowledge of and usage of this sun safety measure

suggests that further work is required to bring the concept of the UV index and checking this on a daily basis to the awareness of the construction worker community.

5.3.2 sun safety behaviours by skin type

Table 11 presents sun safety behaviours by skin type. A greater proportion of respondents with very pale skin reported (i) wearing long sleeved, loose fitting tops and trousers, (ii) using a helmet with neck protection, and (iii) using sunscreen when working outdoors in the summer than respondents in the remaining skin type categories.

When considering sun safety behaviours it is worth noting that construction workers physical working conditions, the workers around them and the value of health and safety communicated by management (on & off site) are significant factors in the behaviors and attitudes developed (Pritchard & McCarthy, 2002).

5.4 Sun safety knowledge and attitudes

Table 12 details findings on sun safety knowledge and attitudes. Relatively few respondents – one third - thought they were at risk of skin cancer and a further one third indicated that they did not know if they were at risk. Almost three quarters indicated that they like to have a tan. There was good awareness of sun exposure being the most important risk factor for skin cancer and the importance of wearing sunglasses to protect the eyes. In addition, only one in 10 respondents incorrectly indicated the belief that factor 30 sunscreen need only be applied once per day when working outdoors, and most respondents indicated the belief that sunscreen should be applied even when working outdoors for less than an hour.

Sixty six per cent of respondents indicated that they were either not at risk or they did not know if they were at risk for skin cancer. This is of concern given that respondents worked outdoors for an average of almost seven hours per day and the

majority were of a high-risk skin type. Nevertheless, the finding is consistent with that found in previous studies. Reinau et al.'s (2013) review of the literature found that across nine occupational sun safety studies that reported data on knowledge of solar UV radiation risk awareness was generally poor.

A qualitative study in South Australia on sun protection practices and policies in small outdoor workplaces found that whilst participants interviewed had a reasonable understanding of the risk factors for skin cancer, their knowledge of the consequences of being diagnosed with skin cancer were generally poor. The routine use of sun protection measures was found to be low, with workplace cultural norms seen to significantly influence the sun protection practices on individuals (Todorov, Day, Corsini, Sharplin, & Wilson, 2014).

It is also noteworthy that 70% of respondents indicated that they like to have a suntan. This is consistent with the five previous studies that have posed a similar question to outdoor workers, although not necessarily construction workers (Reinau et al., 2013), and the 'suntan culture' that exists within construction (Cioffi, Wilkes, & Hartcher-O'Brien, 2003).

It is recognised that for the construction industry, the complex relationship between attitudes and belief presents one of the biggest challenges to implementing successful health promotion (Pritchard & McCarthy, 2002) such as the intervention produced for this project.

5.5 Limitations: Aim 1

Key strengths of this study include the large sample size and inclusion of construction workers from across the UK. The securing of a sample in excess of 1,000 participants was a considerable achievement given that the summer of 2012 - the period during which data collection took place - was the wettest on record in the UK

since records began in 1910 and in terms of hours of sunshine the second dullest since 1910. In the face of persistent rain and an absence of sunshine the perceived relevance of the project to employers and managers was inevitably low. As a result it proved extremely difficult to secure the active participation of those organisations that earlier in the year had expressed their intent to participate. Furthermore, many of the organisations that did participate appeared to do so without their initial enthusiasm, but out of a feeling of obligation rather than in response to a perceived imperative for the research.

Nevertheless, several design-related issues need to be addressed. Firstly, data were collected via self-report, leading to possible recall bias or socially desirable responses. However, previous studies of postal delivery workers have shown that subjective and objective measures of sun safety behavior are comparable (Oh et al., 2004), suggesting that these issues are unlikely to have presented a problem. Second, the study measured the wearing of trousers and long sleeved tops using a single-item, resulting in the amalgamation of these two protective behaviors. It is possible that respondents interpreted this questionnaire item to refer to either long-sleeved tops or trousers. Future studies should assess these behaviors separately. Thirdly, the item on sunscreen usage applied in the study did not identify location of application, rather it examined only whether or not sunscreen was used. Future studies should separately examine the extent to which sunscreen is applied on each exposed area of the body. Finally, data were cross-sectional, indicating that any inferences regarding direction of findings or causality must be made with caution.

5.6 Overview of findings: Aim 2

This study found that self-reported exposure to a sun safety intervention delivered to UK constructions workers was associated with movement into action or

maintenance stages of activity for important sun safety practices. Knowledge change was not significant, perhaps partly because of a ceiling effect caused by high levels of baseline knowledge. Nonetheless, this study shows that the intervention could have a significant behavioural impact in groups with pre-existing good levels of knowledge. Research by Burns et al, (2014) to establish from UK construction workers who they preferred to receive information on risks from found that whilst workers' preference was driven by perceived expertise of the person giving the information on the topic, that supervisors and safety managers were generally the most preferred sources.

The findings suggest that this type of intervention could help to reduce the incidence of skin cancer in UK construction and might usefully form one element of organisations' legal duty to reduce hazard exposure. The effectiveness of a DVD/ video-based sector-specific intervention suggests that similar sun safety interventions could be developed for other high-risk outdoor worker groups particularly in industries such as farming (8% of skin cancer registrations) and those in the defence sector (16%) (Oh, Mayer, & Lewis, 2004).

Though the positive self-reported change in behaviour seen in the current study is welcome it is noteworthy that at follow-up one third or more of intervention group participants remained in the pre-action stages of change on six of the ten indices. This indicates that a video-based intervention of this type might be insufficient to generate comprehensive sun safety adherence when applied in isolation or when many participants are in pre-contemplation or contemplation stages.

Future studies might usefully examine (a) the extent to which multi-faceted interventions might generate positive change, (b) the impact of employer leadership and enforcement on compliance rates and the development of a culture of sun safety in the sector, and (c) the influence of policies that stipulate requirements to implement

sun safety interventions being detailed within tender or project specifications. Product availability is also likely to influence behaviour change; it is possible that employer- and government-led efforts on sun safety could incentivise manufacturers and distributors into supplying high-risk sectors.

The naturally occurring comparison group design proved an effective means by which to create a comparison group while avoiding the requirement for participating organisations to join a wait-list comparison group and thereby potentially increasing employees' exposure to risk. One of the interesting methodological findings of this study is that the emergent comparison group was of almost equal size to the intervention group. Such study designs can be very useful when evaluating occupational health interventions when exposure to interventions cannot be easily controlled nor systematically denied to participants who may benefit from them. It also underlines the importance of monitoring intervention exposure.

The time interval between the test and retest needs to be sufficiently long for the respondents not to remember the answers reported at the first assessment (Branstrom, Kristjansson, Ullen, & Brandberg, 2002).

5.7 Limitations: Aim 2

It is important to note some potential limitations that should be addressed in future research. First, due to the widespread use of subcontracting in the construction industry we do not have information on how many workers received the baseline questionnaire, thus preventing the calculation of a response rate.

Second, the 18% participant retention rate resulted in a small dataset being available for analysis. This may have raised the risk of type II error, i.e. a failure to detect significant change especially given high levels of baseline knowledge in this sample. The low retention rate may have been due to the transitory nature of the

workforce; previous research in the UK construction industry had achieved low response rates even for one time questionnaires (31%: Pritchard & Dixon, 2008); 46%: Pritchard & McCarthy, 2002).

Due to the transient nature of construction workers and the duration between the pre and post intervention questionnaires it was necessary for the follow-up questionnaire to be sent to participants' home address as opposed to the initial questionnaire which was administered in the workplace where work time was allocated for its completion. It might also reflect the low priority placed on sun safety by construction workers in the UK. Future sun safety intervention studies with outdoor workers might achieve a better retention rate by administering all questionnaires in controlled conditions in the workplace.

Third, baseline data were collected in the summer of 2012, the wettest in the UK since records began in 1910 (BBC, 2012). As such, respondents might have reported greater use of sun safety measures post-intervention owing to contrasting climactic conditions between baseline and follow-up data collection. However, under the same meteorological conditions the comparison group showed no change or change of lesser magnitude on most sun safety practices. In order to control for the possible confounding effects of meteorological differences pre- and post-intervention, future studies ought to run over a period of several years.

Fourth, it is possible that respondents incorrectly recalled whether or not they had been exposed to the intervention, resulting in misclassification into the intervention group or comparison group. We consider a large amount of misclassification to be unlikely for two reasons: Firstly, video-based occupational health interventions are rare in the UK construction sector. Secondly, the video contained some humorous elements in order to engage the viewer. Both of these

factors are likely to have helped the film stick in respondents' minds suggesting that it would be unlikely for a respondent to incorrectly recall whether or not they had viewed the film.

Fifth, it is also possible that the behaviour of comparison group participants was influenced by that of the intervention group. For example, if a worker who viewed the DVD subsequently used sunscreen when working outdoors, and that individual worked alongside someone who had not viewed the DVD, it is possible that the sun safety practices of the latter individual might have been influenced by the former. This could help to explain improvements in sun safety practices among emergent comparison group participants.

Sixth, the intervention was of a one-size-fits-all type rather than stage-matched and tailored to the needs of participants in particular stages of change. Future studies could usefully explore the development of stage-matched interventions for construction workers.

To embed the sun safety message within an organisation, a wider intervention may be required. To ensure the highest possible levels of positive perceptual and behavioural change, interventions need to offer a multifaceted approach through addressing both the overall workplace arrangements (policy, procedural measures and provision of suitable sun safety measures) and personal factors (heightened awareness of the risks and understanding of the control measures available to eliminate or reduce the risks) – (McCool, Reeder, Robinson, Petrie, & Gorman, 2009).

Future projects to engage with the construction sector to improve sun safety should have a more holistic approach to include a media campaign and a sun safety policy in addition to the sort of practical intervention that this study offered. Research has shown that those of influence within an organisation find the structure provided

by a policy to be important as it offers a ‘common position’ on the topic that all can work to and prevents random practice and personal beliefs and attitudes affecting the outcomes achieved. A mass media campaign would offer an increased focus on the topic, establish a positive attitude to the topic and aid the formulation and implementation of the policy throughout the organisation (Rezai, Thorgaard, & Phillip, 2011).

Subsequent to completion of the project, IOSH used the findings of this project and its intervention to form the integral part of their campaign on solar radiation. Solar radiation was one element of an on-going campaign on occupational cancers titled ‘No Time to Lose’.

Finally, when considering the development of an intervention it is important to understand that those who are placed in the wider arena to provide specialist help and support are actually fully briefed and engaged in the process.

Awareness of sun protection measures and their appropriate use is an important factor in reducing the risk of skin cancer. A survey of UK plastic surgeons found that even though they have a pivotal role in the treatment and outcomes of skin cancer patients, that they themselves have poor knowledge on the topic of skin cancer caused by UVR.

A 12-point questionnaire based on the sun protection information pack produced by the British Association of Dermatology was circulated electronically to members of the British Association of Plastic, Reconstructive and Aesthetic Surgeons. The 73 responses (13.3% response rate) which were made up of 42 consultants, 21 specialist registrars, 7 core trainees and 3 unspecified gave an average of only 52.4% correct answers. Only 9.7% could accurately quantify the role of UV exposure in causation of MM. Only 37.5% identified that the average effective duration of

sunscreen was three to four hours. Half of the respondents were not aware that latitude, altitude and shade could alter sun protection and a similar number could not answer questions on the protective action of clothing.

The information pack from which the questions were formulated would normally be offered to the patient by the skin cancer specialist during the diagnosis process. The results appear to demonstrate that levels of education on the topic need improvement which would ultimately benefit the patients (Magdum, Leonforte, McNaughton, Kim, Patel, & Haywood, 2012).

Consistency of the message is vital to highlight the importance of the topic and to ensure that it becomes the norm for people to consider sun safety measures before the undertake activities, occupational or recreational, outside. An example of current inconsistency of message could be found in the blog of Judith Hackitt CBE, Chair of the UK's Health and Safety Executive of the 29th May, 2015 in which Ms Hackitt stated:

We have seen a significant increase recently in the number of Occupational Safety and Health organisations who are now actively engaged in getting their members and stakeholders to address the real priority workplace health issues – especially the really harmful and often long latency exposures which can lead to life changing and life threatening dieseases. The number of premature deaths caused by harm to health at work is many times more than those killed each year in work place accidents….

The latest focus of IOSH's No Time to Lose campaign … attempts to tackle the subject of skin cancer caused by exposure to solar radiation. Clearly those who work outdoors in sectors like construction and agriculture are more exposed than those of us who work in offices or indoors. But addressing an issue like this with any

workforce or group raises some challenges:- will it be seen as a real priority by the workforce versus other risks in that sector? Is behaviour change about doing the right thing in the workplace or getting employees to change behaviour more broadly in their leisure time as well? Will well intentioned interventions be perceived as ‘nannying’ by the workforce or other observers? (Hackitt, 2015, “The Challenges of getting the workplace health agenda right”)

6. Conclusions

In conclusion, the first part of this study provides an important initial picture of occupational sun safety knowledge and practices among UK construction workers. Results indicate that there is a need to raise the profile of occupational skin cancer among this sector and increase the priority given to occupational sun safety policies alongside targeted, tailored, and evaluable interventions. To that end, the second part of the investigation reported on a sun safety intervention evaluation. This study provided an initial evidence base for the efficacy of sun safety interventions for manual outdoor workers where there exists an under-developed sun safety culture, especially in geographical contexts such as the UK that experience relatively few sunshine hours and high cloud levels during summer months. The findings, considered in tandem with statistical data on skin cancer attributable to occupational solar UVR exposure (Rushton et al., 2010) suggest that employers of outdoor workers in regions without a sun safety culture in place, should administer sun safety interventions for occupational health protection and promotion, providing the workers with the knowledge to understand the risks and empower them to select and use risk reduction measures at their disposal.

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