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‘Examining evidence for care in the archaeological record, with specific reference to the Neolithic’

By

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Declaration

I certify that:

a) The following dissertation is my own original work.

b) The source of all non-original material is clearly indicated.

c) All material presented by me for other modules is clearly indicated.

d) All assistance received has been acknowledged.

Abstract

The impact of contemporary urbanisation on health has been studied extensively but the study into to the origin and influences of care during prehistoric periods has created debate among scholars. This paper uses the bioarchaeology of care to explore the presence of care in Neolithic Europe and analyses the relationship between the adoption of a sedentary lifestyle that utilises agriculture and pastoralism and the advancements of health-related caregiving such as new medicines and surgeries. Studies have argued that kinship plays a significant role in determining the provision of care and supports why individuals in a subsistence economy expended the time and resources to prolong an individual's life. I also use a case study from three Neolithic Linearbandkeramik (LBK) sites in Central Germany to demonstrate how the poor nutrition obtained from the change in dietary patterns, has also been linked to a reduced immune system and in turn, makes individuals more prone to infections. The Index of Care is applied to three case studies of varying pathologies and quantity of skeletal remains: Neolithic amputation (Burial 416 at Buthiers-Boulancourt, France); skeletal dysplasia (Burial 9 at Schweizersbild, Switzerland); Neolithic trepanation (Eira Pedrinha). The application of the Index of Care in this paper shows both the strengths and weaknesses of the program. The Index of Care provides a universal methodology for the determination of care provision in human remains but can only be accurately applied to articulated remains. The case study of Neolithic trepanation from Eira Pedrinha proves this.

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I would like to dedicate this paper to all those who have struggled and may still be struggling with their mental health. It is nothing to be ashamed of. Be proud of how far you have come and don't give up, no matter how hard it gets because you are stronger than you think and are capable of achieving so much.

Chapter 1: Introduction

1.1 Research Question

The aim of this thesis is to examine how kinship and the levels of sedentism in a community will impact the provision of care provided to those in need, as well as the technology used in the process. Due to the increase in sedentism that has been observed during the Neolithic, communities were more at risk of exposure to new microbes and zoonotic diseases as the livestock themselves would provide a steady supply of disease vectors (Armelagos, Goodman and Jacobs, 1991). Plus, Wadley and Hayden (2015) suggested that there was an increase in the frequency of violence in the Neolithic populations as the greater population densities produced scalar stresses (Friesen, 1999) and facilitated more intense competition between and within sites. This increase has said to be evidenced by an increase in number of mass burials in the Pre-Pottery Neolithic B (PPNB) (Belfer-Cohen and Goring-Morris, 2011). When these factors are considered, it is conceivable to attribute the developments in caregiving practices during the Neolithic to the demand caused from these new circumstances. Kinship also plays an important role in the provision of care. The type and strength of an individual's relationship with members of their kinship group will determine how much they will invest their energy and resources into the caring and/or accommodation to their illness or injury.

1.2 Rationale

Tilley, (2015c) has defined the foundations of the bioarchaeology of care as focusing caregiving being this "quintessentially human behaviour, providing both a conceptual and an applied framework for analysing of archaeological indicators of health-related caregiving practice and, as a consequence of this, deepening our understanding of the past.". The

benefit of using the bioarchaeology of care as the centre for my process of analysing health-related caregiving, is that the principles of the bioarchaeology of care model can be applied to any era and/or culture but has largely been applied in the Palaeolithic and Neolithic period due to the skeletal remains being more accessible for research (Tilley, 2015c). Consequently, certain archaeological assemblages have been examined and discussed by several researchers, each with their own opinion on what happened and how the community operated. When the bioarchaeology of care model is properly applied, a narrative for the reader of who the individual was, where they were from, what period they were from, what happened to them and if they received any form of care will be produced. Once these questions have been answered, a conclusion can be produced that will attempt to explain what kind of care the individual received and why they possibly received it (Tilley, 2015f); it is essential that consideration is taken when discussing an individual's impairment vs an individual's disability as these terms are not interchangeable (Southwell-Wright, 2013). Furthermore, by identifying behaviours associated with the provision of care, archaeologists can begin to unravel the social and cultural environments in Neolithic societies and if there were any developments. If so, infer what may have instigated and/or catalysed these changes. Explanations of which include the role of kinship and social bonds, the adoption of a more sedentary lifestyle and the advancements of medical procedures and pharmacology, will be explored in this paper before conducting my own investigations of three individuals whose remains display indications of them being recipients of health-related caregiving (Buquet-Marcon, Philippe and Anaick, 2007; Beyneix, 2015; Milella, Zollikofer and Ponce de León, 2015).

Moreover, as the transition into the Neolithic period resulted in a more sedentary lifestyle that was accompanied by several developments like the domestication of animals and

plants (Papathanasiou, 2011). These changes in lifestyle and technologies have been closely linked to the changes in dietary habits that often resulted in the lower nutritional quality and a deterioration of particular aspects of human health during the Neolithic (Larsen, 2015).

1.3 Methodology

The period of time that will be studied in this thesis is the Neolithic due to the adoption of agriculture that appeared alongside the more sedentary way of living and will be supported from examples belonging to the Epipalaeolithic and Chalcolithic periods where it is plausible for those examples to have also occurred in the Neolithic or can provide the necessary background information to aid the points being made in my case studies.

Rather than attempting to examine the presence of care in all the geographic locations and cultures that the world has to offer, I'll be focusing my research on Europe. Although this paper will touch on the theoretical aspects of the provision of care that I will expand on later, my primary focus will be on the analysis of physical human remains to form the foundations of my discussions, as such I will be utilising the bioarchaeology of care model to attempt a conflation of social and medical perspectives of my three case studies (Tilley, 2015c) – chosen carefully to allow for the demonstration of how results from using the Index of Care can vary depending on the articulation of the human remains and the type of care the individual would require (direct or accommodation). By including a social perspective to my case studies, I intend to demonstrate that the use of medical jargon and perspectives is not as much as an impediment for researchers to form their own conclusions as Southwell-Wright (2013) would suggest. Southwell-Wright (2013) suggests that use of complex medical language and perceiving disabilities from a biological perspective that primarily focus on anatomical description of palaeopathological changes, often makes it

difficult for disability scholars to interpret the impact of impairments from a social perspective. As such, this has created a situation where people are reluctant to debate the social effects of impairment because they cannot acquire a totalising view of its incidence in the past (Southwell-Wright, 2013).

The Index of Care is an open-access web-based application that was designed to provide support for those conducting bioarchaeological research into health-related caregiving (Tilley and Cameron, 2014). This method allows archaeologists to apply modern clinical research in palaeopathological settings to analyse the structure and any visible pathologies on the human remains to determine the severity of their condition and the impact it would have likely had on the individual's life, e.g., the individual had a pathology that would limit their lower limb mobility. Furthermore, even though archaeologists have been studying the human experience of various impairments, there appears to be a reluctance within some palaeopathological interpretations of human remains to consider those impairments within the context on sociocultural terms and focus solely on the biological repercussions and functionality of the individual (Southwell-Wright, 2013).

As such, the Index of Care will be the basis for my own investigations into the presence of health-related caregiving among Neolithic human remains. In doing so, gaining insight to how some members of communities respond to their kin falling sick or getting injured and how that impacted the wider community.

I will demonstrate of how diverse the application of the Index of Care is through the analysis and comparison of the case studies from the remains of the Man Bac burial (M9) (Oxenham, Matsumura and Kim Dung, 2011) and the Lanhill burial (LB7) (Tilley, 2015b) in which the Index of Care has already been applied, will be conducted later in this paper.

In addition to the comparison of the M9 and LB7 where the Index of Care has already been completed and the provision of care has been inferred in several papers (Oxenham *et al.*, 2009; Oxenham, Matsumura and Kim Dung, 2011; Tilley and Oxenham, 2011; Tilley and Cameron, 2014; Tilley, 2015b; Schrenk and Tilley, 2018), I will conduct my own Index of Care for three individuals of different age, severity of injury and location to support the universality and reliability of the Index of Care developed by Tilley and Cameron (2014). I will use the theory behind the why and how people cared for each other in the Neolithic that I will have laid out in the early parts of this paper to provide a well-rounded conclusion of what happened to the three individuals in my case studies and how they compare to each other and what this means for the research into the bioarchaeology of care.

I will be assessing the developments in the archaeology of care from several points of view, one being the role that kinship played. Kinship are the social bonds that form many of the foundations in the creation of relationships, social groups and organised activities (Peoples and Bailey, 2014a). By utilising the more anthropological perspectives on how communities function, it becomes possible for us to use kinship to examine the archaeological record when investigating the bioarchaeology of care as it allows for the inclusion of perspectives that would otherwise be dismissed if the focus lied solely on the organic and material cultures of archaeological sites.

1.4 Case Studies

In addition to my review of the application of the Index of Care to the LB7 and M9 case studies, I will conduct my own application of the Index of Care to three case studies – Burial 416, Buthiers-Boulancourt (Buquet-Marcon, Philippe and Anaick, 2007), Schweizersbild Burial 9, Switzerland (Milella, Zollikofer and Ponce de León, 2015) and Eira Pedrinha, Portugal(Gama *et al.*, 2003).

These case studies were selected based on the varying pathologies and number of identifiable skeletal remains to demonstrate the strengths and weaknesses of the Index of Care. These case studies will show the benefits of using the Index of Care on the articulated remains individuals who required direct care for the long term and those who were able to transition from direct care to just needing lifestyle and environmental changes to accommodate their new disability. Plus, I will show how the Index of Care struggles to produce an informative report of the provision of care when applied to a case study in which there is few identifiable remains due to the level of disarticulation.

1.5 The Origins of Care

It has been argued that the practice of caregiving is not a default response in *Homo sapiens* but it is an conscious choice that must require a form of motivation or reward for the caregiver (Sugiyama, 2004; Tilley, 2017). However, the presence of care can be traced back to a specimen from the Lower Palaeolithic site of Dmanisi, Georgia which dates to 1.77 Ma (Lordkipanidze *et al.*, 2006). A cranium and the associated mandible (specimens D3444 and D3900 respectively) show that every tooth except for the lower left canine was lost antemortem; all but one of those teeth were lost a long period of time before the individual's death (Lordkipanidze *et al.*, 2005, 2006). Therefore, it is acceptable to assume that the individual relied on some form of group co-operation to help obtain the necessary nutrition for survival. The individual would have not been able to eat hard or chewy foods, therefore, must have relied on soft, most likely plant-based food stuffs and/or by the help of other individuals in the community (Lordkipanidze *et al.*, 2006). These actions of care and accommodation by early hominins show that the presence of care was prominent a long time prior to the Neolithic period. Plus, the mass adoption of forming sedentary communities for the utilisation of agriculture and pastoralism provided the necessary

environment that catalysed the developments in how individuals provided health-related caregiving (Tilley, 2015c).

1.6 Summary

The thesis will be structured to provide a coherent narrative and analysis of the presence of care in the Neolithic period, starting with the impact of sedentism before then discussing the role kinship groups has when determining the provision of care. This will be followed by a discussion of the techniques and resources used in the health-related caregiving process before. Finally, I will conduct my own analysis using the Index of Care on three chosen case studies to I which I will then discuss the ease and success of the application of the Index of Care and a breakdown of my results before I produce the conclusion of my thesis.

Chapter 2: The Impact of Sedentism on the Advancements and Provision of Care

One of the major developments attributed to the transition from Palaeolithic period to the Neolithic period was the adoption of a sedentary lifestyle and agricultural production for communities which facilitated the long-term storage of food (Childe, 1951;Page *et al.*, 2016). This change of diets and lifestyle had a significant impact on the overall health of humans (Latham, 2013). With the domestication of animals and flora, storage of food, and the establishment of permanent settlements, societies started to trade and communicate with each other. The growing population density in settlements lined the way for epidemics and pandemics, which were furthered enabled by long-distance journeys, trade, and migration by ships or by horses (Høiby, 2021). What is more, animal domestication created favourable conditions for zoonotic infections to adapt to humans such as measles, tuberculosis, and smallpox from cattle, influenza from pigs and ducks, and pertussis from pigs and dogs (Høiby, 2021).

2.1 Accumulation and Long-Term Management of Resources

The domestication of crops and livestock relieves the pressure on a community to hunt and gatherer food and other resources.

The Neolithic social investment model (NSIM) was produced by Shults and Wildman (2018) in their simulation of the Neolithic transition with a focus on the lifestyle conversion within a constrained geographic area i.e. nomadic vs agricultural societies. They separated the Neolithic lifestyles into two categories, low-investment (LI) and high-investment (HI). The LI lifestyle pertains to a lifestyle which encompasses hunter-gatherer communities and people who utilise farming techniques without adopting the intensified levels of sociality and

human-object relationships that can be seen at Çatalhöyük (Hodder, 2010). The result of this lifestyle is that members of this type of community would be able to delay gratification and plan for the future without the level of attachment to people, places and objects that would be associated HI, sedentary agricultural communities (Shults and Wildman, 2018).

In contrast, the HI lifestyle is better associated with sedentary agricultural settlements with elevated levels of entanglement with the environment, which includes people, animals, plant life, objects and the presence of ancestral spirits (Shults and Wildman, 2018). It is for that reason, communities with a HI lifestyle are much more sedentary than those of a LI lifestyle as they have a sense of attachment to their environment which prevents those people choosing to relocate elsewhere. Even so, the HI lifestyle might not have always required a fully sedentary community. A good example of a HI society in the Neolithic that had substantial mobility, perhaps even pastoralism, can be found at Hambledon Hill in Dorset, England. The HI lifestyle can be inferred from the presence of permanent structures and evidence of the surrounding fields displaying indicators that they were used for agricultural purposes (Mercer and Healy, 2014). But the Sr levels of the many of the individuals and material culture excavated from the site display readings that would be more consistent from originating at least 40km away within regions of the South-West peninsula of England such as Somerset, Devon and Cornwall (Neil et al., 2018), thus supporting the high levels of mobility in the society at Hambledon Hill. The HI lifestyle allows societies to grow in status as people are able to consolidate agricultural and pastoral knowledge, thus expanding and improving the resources they have available to them.

Much like other computer-based simulations, the NSIM cannot definitively prove that archaeological theories such as HI lifestyles being an influential factor that determines the

agricultural and pastoral success of a society. It is only capable of offer an alternative theory for researchers to accept to the theories that have been developed from archaeological assemblages (Shults and Wildman, 2018). In the same paper that Shults and Wildman introduce the NSIM, they propose a new model which they hope will assist in providing a simulation that will give us an insight into characteristic changes in the Neolithic. This simulation is set to be called the Çatalhöyük House Entanglement Model (CHEM). CHEM will utilise Geographic Information Systems data and unlike the NSIM, will be an agent-based model that will use houses and settlements rather than people as its agents (Shults and Wildman, 2018). CHEM will intend to explain that settlements and houses will "decide" where to get built based on several variables, such as availability of material resources (mud, clay, and water) and social resources (builders, people with know-how and motivation).

Early Neolithic agricultural sites can provide an insight into crop domestication as well the domestication and herding animals. Cueva de Chaves is a cave located in NE Iberia in the Prepyrenean mountain range of Sierra de Guara and was occupied during the Palaeolithic, Neolithic and intermittently in the Bronze Age and Late Roman periods (Villalba-Mouco *et al.*, 2018). During the several excavations seasons between 1984 and 2007, two Neolithic deposits were uncovered, Ia and Ib (radiocarbon dated 5600-5300 Cal. BC and 5300-5000 Cal. BC respectively). In those two deposits, four individuals (three adults and one sub-adult) that have been dated to the Neolithic have been found (Villalba-Mouco *et al.*, 2018). This is a very significant find as it allows for the opportunity to analyse the human remains to their diet. Thus, providing the necessary evidence to either endorse or disprove the conclusions that can be drawn from the stable isotope analysis of other archaeological material found at the site such as, faunal remains and material culture. The Neolithic deposits from Cueva de

Chaves have the highest abundance of faunal remains when compared to other Early Neolithic sites in the Iberia, 49.6% of the total remains belong to domestic animals and 51.4% belong to wild animals (Castaños, 2004). Of the 593 MNI belonging to 19 different

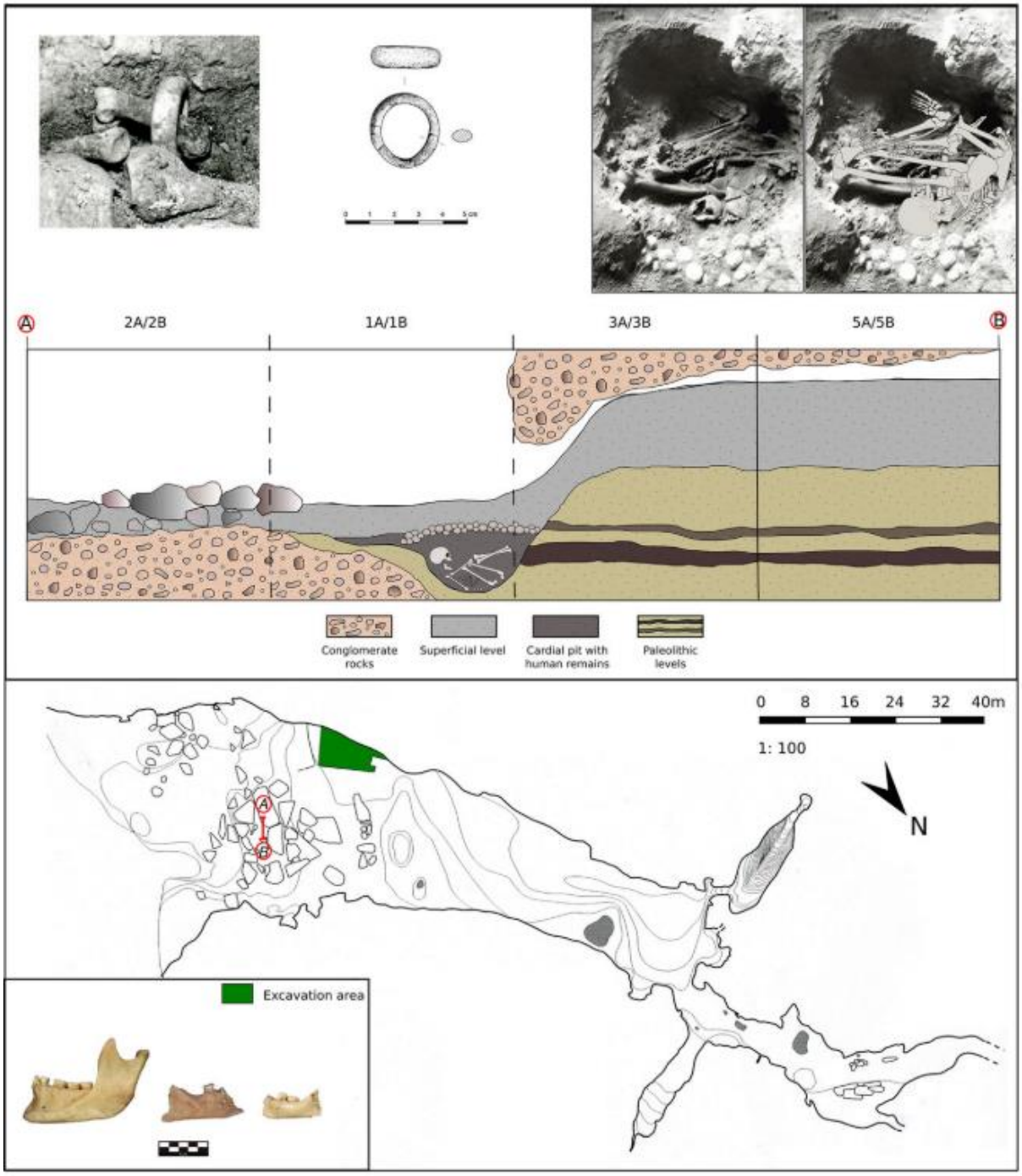

Figure 2.1: Early Neolithic human remains from Cueva de Chaves and their position in the topography. (a) Early Neolithic human remains sampled and recovered from the excavation area reflected in the topography; (b) Stratigraphic profile in the area where the Cardial burial was found; and (c) Detailed picture of the ring recovered from the Cardial burial and the archaeological drawing detailing the position of the skeleton (Villalba-Mouco et al., 2018)

species of taxa, 68 samples from 14 species, including four samples from the human

remains that were found at the site, were selected for stable isotope analysis at the University of Cape Town. Isotopic analysis of the herbivore taxa shows no significant difference in the diets between domestic and wild species. This suggests a possible common plant resource was consumed by both wild and domestic herbivores; possibly a result of a common feeding pasture or a common plant food resource being widely available for the animals to consume or being fed. Alcolea *et al.* (2017) has suggested the use of wild plants such as *Juniperus* for foddering in an anthropological study of the Ib deposit.

The domestic pig (*Sus domesticus*) livestock that was sampled show no significant difference in the δ13C and δ15N levels when compared to the herbivores that were sampled (Villalba-Mouco *et al.*, 2018). These isotopic signals could be explained by a free-range approach to the management of livestock where they feed on their own and most of their diet will derive from plants (Madgwick, Mulville and Stevens, 2012).

The use of wild plant species as fodder for domestic animals and the lack of available evidence that would suggest intensive crop domestication, reflect that the population of Cueva de Chaves relied more on animal husbandry than agricultural practices. This hypothesis agrees with palynological studies that suggest a low impact of crop management at the site except during the last stages of the Early Neolithic (López-García and López-Sáez, 2000). Alternatively, the dependence on animal husbandry could be the result of not having the potential agricultural fields close to Cueva de Chaves (Mazzucco *et al.*, 2015). Further excavations of the Neolithic deposits at Cueva de Chaves would allow for the collection of more archaeological material that could be analysed and used to answer the gaps that have been left but in 2007, the Neolithic levels at the site were intentionally destroyed to build an

illegal enclosure for animal son a private hunting ground situated around the cave. Almost nothing is now left at the site (Villalba-Mouco *et al.*, 2018).

2.2 Consequences of transitioning from a nomadic to a sedentary lifestyle

Despite the adoption of agriculture and animal husbandry in the Neolithic period which provided several benefits to humans, it also subjected them to new microbes and parasites. This in turn influenced the occurrence and spread of zoonoses and diseases such as *mycobacterium tuberculosis* (TB) and tapeworm (*Taenia saginata*) (Nicklisch *et al.*, 2012; Anastasiou *et al.*, 2018). The domestication and herding of animals increased the risk of exposure to zoonotic diseases as the livestock themselves would provide a steady supply of disease vectors. In addition, animal products such as milk, hair and skin would allow for an easy transference of small insects such as fleas to areas of the environment that the livestock could not get access to as they can remain alive long enough for to transfer to a human while being handled (Armelagos, Goodman and Jacobs, 1991).

Examinations of the human remains from the Neolithic allowed archaeologists to identify trends in who was affected by specific diseases and who the most at risk groups were to succumb to infections such as cholera (*Vibrio cholerae*). Armelagos, Goodman and Jacobs (1991) identified infants, young children, and the elderly would have been most at risk and that individuals who reached reproductive age had likely developed a higher resistance to those diseases. However, the increase in infectious diseases did not necessarily result in an increase in mortality rates in all Neolithic societies, even among the most at risk demographic but created a new health profile that has regional variations (Eshed *et al.*, 2010).

In addition to the young and old being in the 'most at risk of infection' category, the individuals who already ailed, particularly if they have limited mobility, could be too. As it is possible that parasitic infections played a role in the transmission of diseases through the incapacitation of the host's immune system, if their immediate environment were not kept clean and faecal matter was prominent in their proximity. Thus making it easier for harmful pathogens to infect their host (Armelagos, Brown and Turner, 2005; Nicklisch *et al.*, 2012).

To further my previous point on how an individual's immediate environment can negatively impact their immune system, I will demonstrate that the same result can occur from having a poor diet. A study by Nicklisch *et al.* (2012) on 118 individuals from three Neolithic sites in Saxony-Anhalt, Germany that date to 5400-4800 BC, exhibit a community that display indications that these individuals suffered from TB in the form of lesions on their ribs. The ribs of these individuals were first macroscopically examined and any rib lesions that were found were graded on a scale of 0 – 4; grade 4 displaying extensive new bone formation (NBF) and the presence of several lytic lesions (Nicklisch *et al.*, 2012). Once the morphological examination was completed and the rib lesions were identified, microscopic techniques were utilised to positively identify the rib lesions as TB (Nicklisch *et al.*, 2012). Histological analysis revealed that there are multiple layers of NBF in the areas of the rib lesions. As the areas of the NBF had been identified, it was essential to uncover the relationship between the original bone surface and the NBF. Therefore, micro-CT scans of the NBF showed that the new layers of bone rest upon the original bone surface without any infiltration or destruction of the original bone surface. This suggests that the inflammatory process originated in the soft tissue area instead of inside the rib bone; a key factor in the diagnosis of TB (Nicklisch *et al.*, 2012).

Once the presence of TB was confirmed in these individuals, further investigation was conducted to be able to discuss how TB impacted the health of the inhabitants of these sites. Of the three sites (Halberstadt, Larsdorf and Derenburg), isotope analysis revealed that the individuals that resided at Derenburg consumed less animal protein than those who lived at the other sites as well as no substantial dairy component to their diet meaning that individual in this community were likely to be more nutrient deficient than their counterparts (Oelze *et al.*, 2011). The long-term effects of an individual being nutrient deficient include a weakened immune system which gives rise to that individual being at a higher risk of infection (Nicklisch *et al.*, 2012). The protein deficiencies and other dietary imbalances that have been observed in the inhabitants of Derenburg may explain why the individuals at this site display a higher frequency of lung infections and more severe rib lesions that have been attributed to the presence of pulmonary TB (Nicklisch *et al.*, 2012).

As Neolithic societies become more sedentary, they will be exposed to the same environment for longer periods of time. As a result, they become more susceptible to diseases and parasites that were not of significant concern prior to the change in lifestyle (Armelagos, Goodman and Jacobs, 1991). The increased risk would have not only been caused by the constant and close proximity to livestock (as discussed above) but also close proximity between habitation areas and waste deposit sites; a risk heightened if the waste deposit sites also contaminate water sources which can result in an outbreak of diseases such as cholera (Armelagos, Goodman and Jacobs, 1991).

The Neolithic site of La Draga, Spain is a good example of how the lifestyle choices, dietary habits, and poor hygiene of a sedentary lakeside community can negatively impact the health of its inhabitants. During excavations, soil samples were systematically collected

across the site and analysed to produce distribution maps of parasites , which could then be compared with the distribution of archaeological artefacts (Maicher *et al.*, 2017). The analysis of the samples showed that 93% of the samples collected tested positive for least one of nine different ancient gastrointestinal parasites, of which geohelminths such as whipworm and roundworm develop in environments associated with poor sanitation and inadequate management of organic resources (Maicher *et al.*, 2017).

In addition to the poor sanitary conditions at La Draga, through zooarchaeological investigation the presence of livestock has been confirmed. What is more, the parasites directly associated with the farming of livestock have been discovered (Maicher *et al.*, 2017). These parasites include flukes (*Dicrocoelium* sp. and *Paramphistomum* sp.) and *Macracanthorhynhus* sp. as well as potentially *Ascaris* sp. However, Tarrús *et al.* (2006) and Palomo *et al.* (2014) has argued that the introduction of these parasites was likely from wild ruminants such as ibex (*Capreolus pyrenaica*), deer (*Cervus elaphus* and *Capreolus capreolus*) and aurochs (*Bos primigenius*) due to their presence during their zooarchaeological studies of La Draga. This is unlikely to be the foremost reason for the presence of these parasites as the wild ruminants only make up a small proportion of the animal bone assemblage (Saña, 2011; Antolín *et al.*, 2014). Therefore, the most likely cause of the parasites is from the domestic animals.

For example, the Increasing Population Density Effect (IPDE) proposed by Macchiarelli and Bondioli (1986), suggests that as population density of Neolithic communities increased, the poor diet and the increased transmission of diseases induced a positive selection for reduced nutritional and metabolic requirements. This consequently resulted in a reduction in body size for domestic animals. On the other hand, the increase in viral, bacterial and

parasitic infections could have been the primary factor that resulted in the reduced nutritional intake that caused deficiencies that impact bone metabolism (Nicklisch *et al.*, 2012).

Despite the IPDE model providing a possible cause and effect for physiological changes in Neolithic humans, the assumed causality cannot be translated into a testable hypothesis as archaeologists are not able to conduct such an experiment using the archaeological remains and other artefacts found in Neolithic sites (Pinhasi and Meiklejohn, 2011).

The activities that were undertaken with the adoption of agricultural lifestyles also had an impact on the demand for health-related caregiving. The agricultural lifestyle and can quite dangerous, leading to broken bones and significant wear on the human body through repetitive tasks. A study conducted by Judd and Roberts (1999), focused on the fracture trauma found on individuals in Raunds, a rural medieval British village in the East Midlands. They found that of the 170 individuals. 33 of them had sustained one or more long bone fractures (19.4%). This figure becomes more so significant when Judd and Roberts compared this sample set to three sample sets from urban sites (St Helen's, Blackfriars and St Nicholas). The results showed that only 4.7-5.5% of the individuals from the urban sites displayed indicators of long bone fractures – significantly lower to that of the individuals from Raunds. It is therefore reasonable to infer that the agricultural lifestyle of those living in rural environments is more dangerous than that of urban lifestyles.

So, with the adoption of agricultural activities in the Neolithic, it is very plausible that the risk and frequency of injuries sustained by individuals who participated in said activities, would increase and as such there would be an increased demand for the development of caregiving practices to attend to the new range of injuries that people were now at risk to.

2.3 Impact of sedentism on the social affairs in the Neolithic

The formation of permanent settlements increases the population densities of the region (Høiby, 2021) and provides the ideal environment to engage with material culture in ways previously not possible (e.g. trade routes) as well as encourage social interactions between members of the community and form new social bonds and strengthen already existing bonds (Gamble, Gowlett and Dunbar, 2014). For example, within these sedentary communities, the close physical proximity, the day-to-day interaction, the daily repetition of activities, and the shared experience of several generations living in the same location would have not only facilitated the strengthening kinships, but they would have actually created social and ritual ties (Souvatzi, 2017).

A significant occurrence that likely contributed greatly to the formation and maintenance of these kinships was communality, the presence of coming together for the shared consumption of food or the exchange of food and drink (Pollock, 2012). These communal acts of a society are an integral social practice in the maintaining social relationships among members of the community (Pinhasi and Stock, 2011). In fact, without the mundane conversations that occur in communal spaces, individuals would not be able to develop trust for each other that is required in the process of deciding if and how to care for each other if one individual is to fall ill or get injured (Pollock, 2012).

2.4 Summary

The transition from nomadic hunter-gatherers to sedentary agriculturists impacted societies on multiple levels, from social interactions to dietary choices. The provision of care was not exempt from this. Neolithic communities were now at risk of infection from a new wave of microbes and parasites that they were not previously exposed to and needed to develop

techniques to combat the new challenges. The increased risk of an individual being infected with these new pathologies which could result into an epidemic within a community were a result of several reasons – increased population densities, poor nutritional diet and more prolonged exposure to livestock (Nicklisch *et al.*, 2012; Høiby, 2021). These combined to allow for the easier transference of zoonotic diseases and other pathologies through the consumption and use of animal products such as milk, hair and skin. It allows for small insects such as fleas to have access to areas of the environment that the livestock could not get access to as they can remain alive long enough for to transfer to a human while being handled (Armelagos, Goodman and Jacobs, 1991).

However, the impact of sedentism on the provision of care was not all negative. Despite the increased exposure to more infectious diseases, it did not necessarily result in an increase in mortality rates in all Neolithic societies but did create a new health profile for societies that has regional variations (Eshed *et al.*, 2010). This infers that communities were able to adapt to their new environment and successfully treat the new diseases and parasites that were ailing members of their community. Furthermore, the HI lifestyle that is often associated with sedentary communities necessitated the development of procedures for the long-term management of the resources gained from the domestication of crops and livestock which relieved pressure on communities to consistently hunt and gather resources.

Chapter 3: Kinship and Care

According to Ensor (2017), there is not a set "kinship theory" rather there is a topic of research that is influenced by theoretical trends that influence what questions are being asked, the methods that are used and how this impacts the interpretations of the data. For example, functionalism exhibits a bias towards material circumstances determining the kinship practices within a society rather than social bonds.

The House Societies model was developed by Claude Lévi-Strauss (Lévi-Strauss and Modelski, 1982), and details that the household is a separate organism from the rest of the community with its own social structure that is not influenced by kinship. Despite providing useful insights into the role of the house in influencing social relations, the House Societies model dismisses the significance of kinship in a social or economic organisation (Joyce and Gillespie, 2000; Souvatzi, 2017). Another major issue with applying the House Societies model to all societies is that it was developed using European societies (Boric, 2008). As a consequence, the House Societies model not universal and is ethnographically over-specific due to assuming all societies have the same culture. Moreover, the House Societies model focuses solely on the house as a separate entity from the rest of the community, therefore overlooking other the fact that houses built within a village are an intentional action to become part of a wider community; a community consisting of varying levels of social hierarchies and organisations such as clans, bloodlines and sodalities (Boric, 2008; Souvatzi, 2017). It is worth noting that during the Neolithic period, a household differs from the contemporary western household which consists of a nuclear family as in the Neolithic, a

household could consist of your immediate blood relatives as well as extended family such as your spouse's family (Peoples and Bailey, 2014a).

Kinship is very important in non-state societies as it is these relations that provide a social structure within the community. Kinship allows it to be possible define all aspects of an individual's life such as, who a person is, their social ranking, the resources and occupations that are available to them and where they may live (Ensor, 2011).

Biological relations form the foundations for many social relationships, particularly during prehistory (Johnson and Paul, 2016) but it is important to not restrict the formation and maintenance of kinship groups to biological connections. The principle behind kinship is that social relations are not solely based on biological relationships but can be contributed to one or more factors such as, resource management and place of residence (Ensor, 2011). Many archaeologists focus on the materialistic side of kinship and value resources over social bonding for the creating kinships as this is easier to provide evidence for in the archaeological record (Ensor, 2011; Souvatzi, 2017). This is disappointing as often the physical proximities during the day-to-day interactions and activities provide a shared long-term experience for individuals to form social bonds. A daily activity that would have a large influence over the creation and strengthening of kinships is the presence of communal meals (Souvatzi, 2017). What is more, this can be demonstrated in the archaeological record, as excavations of Neolithic sites in Greece have uncovered large quantities of richly decorated serving pottery. Excavations of the late Neolithic ditched enclosure of Makriyalos I in northern Greece uncovered two large pits that yielded many ceramics and animal bones that appeared to have been accumulated in a relatively short period of time due to the density of the artefacts found in the pits (Halstead and Isaakidou, 2011). Pit 212 contained

several hundred domestic animal carcasses and Pit 214 comprised of 200-300 domestic animal carcasses; all the animal remains display taphonomic indications of being processed for consumption (cut marks) and both pits produced large amounts of ceramic tableware. Although the pits may have been filled over a period of months, the large scale slaughter and carnivory is only comparable to that found at Mycenaean palaces (Halstead, 2001; Bennet, 2008).

The consumption of meat in the Neolithic appears to have taken place in a range of social settings, and the size of the carcasses of the domestic animals can be examined to determine how many people it would feed (Halstead, 2007; Isaakidou, 2007). The consumption of meat commonly took place in groups larger than a single household as the meat would spoil in the Greek climate unless it was properly prepared. The sharing of large animal carcasses would explain the lack of younger domestic animals being found in the pits and suggests that domesticates were being raised so that they could be consumed by social groups larger than one household (Halstead and Isaakidou, 2011).

The special occasions in which these communal activities took place were often marked with the creation of vessels from fired clay. This is significant as this practice echoes the widespread role of cooking with fire in the transforming of natural plant and animal resources into cultural food products (Wrangham and Conklin-Brittain, 2003). Plus, some of these vessels, particularly those that date to the Middle Neolithic onwards, had flat bases which suggests that these vessels were used on flat surfaces such as a table, bench or flat platform which reinforces the formality of communal activities (Sherratt, 1991). The presence of such ornate serving pottery further suggests that the serving and consuming of food and drink was part of an elaborate dining experience, an experience that would be

shared among a group, such as a large-scale feast. Thus offering the opportunity to create and strengthen kinships among the community or possibly with other communities that would allow there to be a sharing of resources (Souvatzi, 2017).

However, it must be noted that these resources were not explicitly shared in communal settings but also on private and/or non-ceremonial occasions, such as family meals and when caring for others. So, if this principle of kinship is to be applied to the caring for others, it is important to not rule out other factors that may have influenced a person's decision to care for an individual in need. As kinship among members within a community would not have been the only factor that would have influenced the level of health-related care an individual would receive. This is due to many Neolithic communities being a subsistence economy. This means that most communities do not have an excess of resources that can be spent on someone who cannot contribute those resources back into the community (Armelagos, Brown and Turner, 2005).

On the other hand, if we were to analyse the provision of health-related care from a social perspective, a less physically able individual may have received care as they would be able to contribute in other ways such as, nursing the young or making tools for others to use. The time that was saved by the more sedentary individuals completing these tasks for others, may have allowed those people to spend more time focusing on agriculture and pastoralism to counteract the negative correlation between the collection and consumption of the resources. For example, the elderly taking care of the young within a community while the more mobile adults focus on providing for the community (see Hawkes and Coxworth, 2013, 2015; Blell, 2018).

As a result of the lack of written evidence, archaeologists must rely on the analysis of skeletal remains and burial practice to determine the provision of care in prehistoric communities. Therefore, archaeologists infer health-related care from the physical evidence in the excavated human remains that show indications that an individual experienced an illness or injury that would have required assistance to ensure they would survive and if they received any care. Some of the indicators that archaeologists look for in human remains is any skeletal or preserved soft tissue that can be used as evidence for i) the presence of lesions associated with an injury or illness that have either healed or have begun process of healing, or ii) the remains exhibit a disability that would suggest it would be impossible for an individual to have functional independence and would require assistance to survive over time (Tilley and Oxenham, 2011).

It is beneficial to consider the anthropological perspectives on kinship as this will provide information on the relationship between health-related caregiving and kinship that has been collected and analysed from observations on contemporary pre-industrial societies such as the Yąnomamö, an Amazonian tribe (Peoples and Bailey, 2014a).

Although the anthropological perspective is mainly comprised of research on modern communities, there is enough similarities between them and Neolithic communities to form a foundational theory as to what happened in the past which can built upon. For example, in a later chapter I will discuss the use of psychoactive substances in shamanistic practices in the Yąnomamö and how it can suggest that the shamans of the Neolithic also partook in similar activities with a similar approach.

Another theory for the caring of those who cannot directly contribute to the community is the presence of a strong social cohesion in which the social bonds are valued more than the

resources. This choice may have been due to the individual who is being cared for being a blood relative and so it would be beneficial for their bloodline if they survived as it would increase the chances that their genetics will be passed on (Tilley, 2015f). Although it is impossible to provide archaeological evidence that directly supports that the carer was of blood relation. So, research must be conducted to find as much indirect evidence as possible to provide the strong foundations to support the importance that the role of family and kinship has when determining the amount of care someone will receive among Neolithic communities.

In addition to the presence of a strong social cohesion within a community being a strong influence on the extent of care an individual receives, there must also be an aspect of altruism having been present. By considering an individual's level of altruism when investigating the economic perspective of the social bonds within a community, from an economic perspective we are able to reason why someone would have been permitted to make use of the valuable resources during their period of receiving care. However, there is more to the consumption of the finite resources than the assessment of the economic efficiency of a Neolithic community. The use of these resources often results in the sustaining of the life of a member of the community, a member of their kin. Therefore, I believe that when a social perspective (and to some extent a biological perspective) is considered, the economic value of these resources is outweighed by the potential positive impact that would occur from the consumption of the resources.

What is more, Sugiyama (2004), argues that any practice of care with regards to an individual's health can serve as a buffer against any health risks for the rest of the community and result in a positive chain of events, i.e. if the healthcare of a community is

improved and individuals begin to live longer and healthier lives, actions such as reproduction do not become as time restricted. For example, as the average age of mortality increases, the need to reproduce at a younger age is delayed, which allows for more members of the community to contribute to the collection and production of resources or being able to expend more energy on the nurturing of already existing offspring thus meaning a lower mortality rate in juveniles. Plus, as there are more juveniles, there is an increased opportunity to facilitate a transfer of knowledge and skills from the adults to the juveniles at a higher level (Sugiyama, 2004). The fact that this chain of events would occur from the choice to care for an individual and expend what would be considered valuable economic resources to do so, and that they having the longer lifespans to see the payoffs occur (Sugiyama, 2004), shows that communities were possibly moving their focus from immediate gratification in the form of stockpiling resources, to the delayed reward of having a larger and healthier community that can attain more resources than they previously would have been able to.

In the fields of cognitive psychology and behavioural economics, delayed gratification is also known as delay discounting (Kirby and Maraković, 1996), time discounting (Frederick, Loewenstein and O'donoghue, 2002) and temporal discounting (Read *et al.*, 2005). Even though there is different terms for delayed gratification, they all follow the same principle of resisting the urge to claim a reward immediately and potentially gaining a better reward with more benefits in the future (Cheng, Shein and Chiou, 2012). According to Stevens and Stephens (2008), a important contributing factor as to why humans favoured short-termism was its use as a survival strategy because the immediate consumption of available resources was more beneficial than delaying consumption when their future was uncertain. This would explain why it was not as common to see delayed gratification in the archaeological

record until the Neolithic period when the sedentary lifestyles were adopted, and agriculture was utilised to ensure resources were more consistently available all year round.

Much like the principles of kinship have been discussed, it is important to discuss the principles of caregiving. Tilley (2017) organised health-related caregiving into two clear principles. Firstly, bioarchaeology and bioanthropology must be used in unison to develop a more complete picture of the caregiving practices and reasoning behind them. This is a result of a limited number of pathologies that may be biologically determined through analysis of the skeletal remains. Plus, the concept of an individual's health is likely to be defined quite differently in different cultures and in different time periods.

The second principle that Tilley (2017) outlined was the acknowledgment of that agency is central to all aspects of health-related caregiving behaviours. Moreover, all caregiving actions will involve intent regardless of the length of the caregiving period as the caregiver will act on a series of choices that they either opted for or rejected.

It has been argued that the practice of caregiving is not a default response in *Homo sapiens* but it is an conscious choice that must require a form of motivation or reward for the caregiver (Sugiyama, 2004; Tilley, 2017). If this is to be believed, then all case studies that have been conducted for the research into the bioarchaeology of care would indicate that the caregiver always benefits from their actions in some form e.g., their offspring survives and is able to carry on their bloodline. Likewise according to psychology literature, the simple act of helping another individual has the potential to improve the helper's psychological and emotional state (Luks and Payne, 2001; Schwartz *et al.*, 2009), which can improve an individual's physical health as it is understood that there is a positive correlation

between a person's mood and the strength of their immune system (Masih, Belschak and Verbeke, 2019).

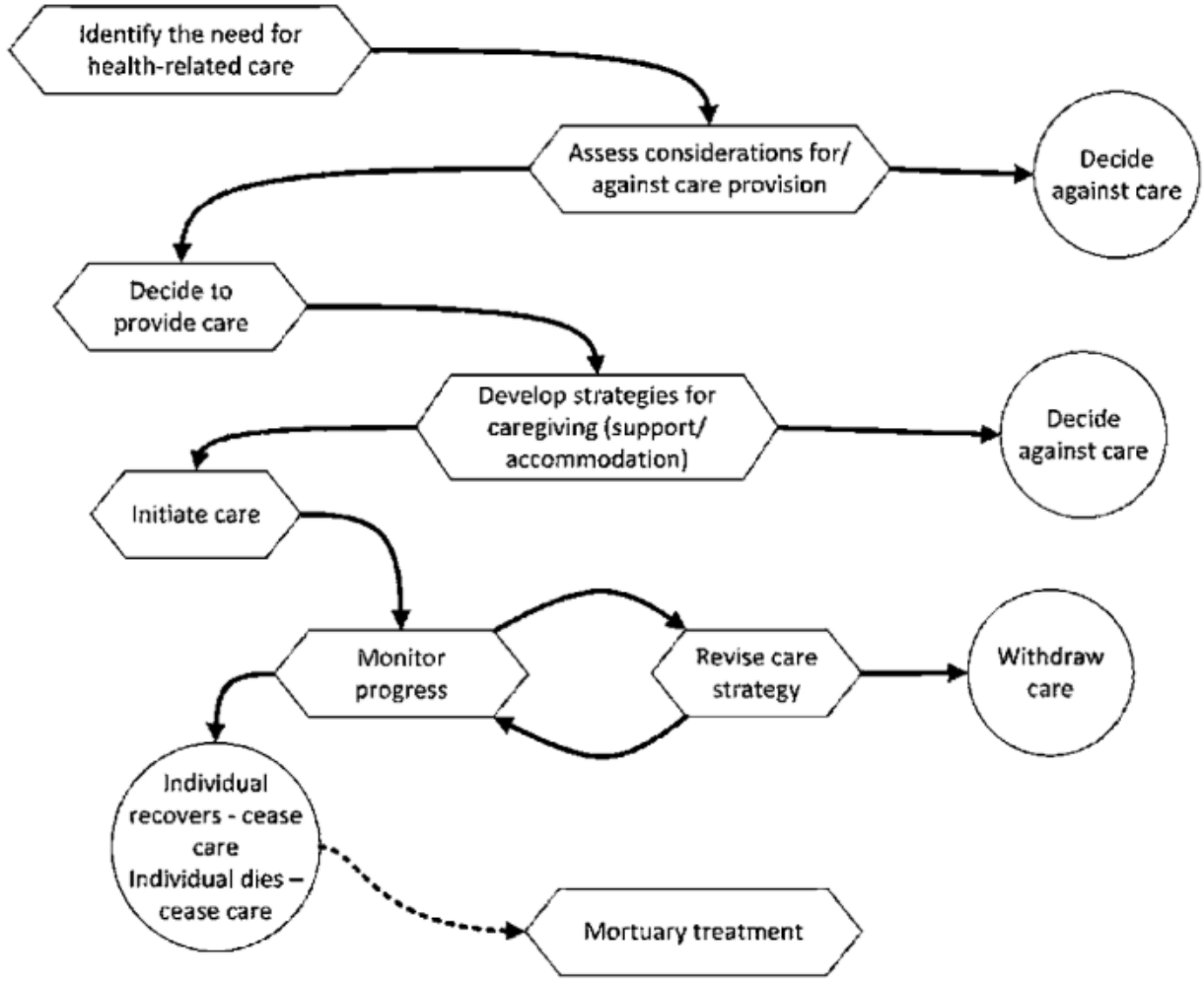

Figure 3.1: Generic 'decision path': decision-making points in the health-related caregiving process (Tilley, 2017).

3.1 Methodologies into determining the presence of care

The bioarchaeology of care approach was developed to be used by archaeologists at a case study level. The initial analysis of the human remains focusses on the probable impact of a

serious pathology upon an individual's ability to effectively operate in their immediate social and physical environments (Tilley and Oxenham, 2011).

Prior to the development of the bioarchaeology of care model, it was suggested that many societies favoured the competitive and self-serving lifestyle of the survival of the fittest and almost always abandoned anyone who fell ill or became an unnecessary allocation of valuable resources that would have been required during their period of care (Schrenk and Tilley, 2018). It must be mentioned that this was not always the case as care can be observed in the archaeological record dating back to early hominin (Lordkipanidze *et al.*, 2006, 2007; Martín-Francés *et al.*, 2014). The growing number of studies into the bioarchaeology of care, it is becoming much more apparent that there was an abundance of health-related caregiving behaviour and accommodation. This is a stark contrast to the theory that societies only evolved through self-preservation (Sugiyama, 2004; Tilley and Oxenham, 2011; Milella, Zollikofer and Ponce de León, 2015).

According to Tilley and Oxenham (2011), by referring to modern clinical literature, it is possible ascertain a probable minimum level of practical support or care that would be required for an individual with a disability to survive. The levels of support can be organised into two categories:

- Basic care: this form of care comprises of aid with the daily necessities in life such as providing food, water, shelter, transport and help with daily activities such as getting dressed.

- Advanced care: this is a much more intense form of care that requires caregivers to help an individual maintain a level of personal hygiene and managing any environmental and physical safety concerns.

It is important to note the distinction between the levels of care that have been suggested, become arbitrary when they are applied to an individual with a severe disability (see the Man Bac case study below) because all aspects of the care that they would receive can be classed as vital for their survival. That being said, it can be argued that it is possible to separate the types of care by the amount of energy that will expended completing such actions as those that fall in the 'advanced care' category are much more labour intensive and requires a higher level of skill and/or commitment to ensure an individual's survival than what would be required by the actions that fall within the 'basic care' category. This will be explained through two published case studies from Man Bac, Vietnam, and Lan hill, England.

3.2 Man Bac Burial (M9)

Man Bac is a late Neolithic coastal site in Bach Lien Village, Northern Vietnam that according to several C14 dates on charcoal [2 sigma range calibrations (INTCAL04) after Reimer *et al.* (2004)] sandwich the occupation and burial layers quite narrowly: 3341±38 BP (1737-1524 BC); 3393±36 BP (1775-1608 BC); 3560±30 BP (2066-1775 BC) (Oxenham *et al.*, 2008). During excavations of the burials, an individual (M9) was discovered to have had quadriplegia that began to develop during their juvenile years (Oxenham, Matsumura and Kim Dung, 2011). An illness as severe as this would often result in death soon after onset, all be it not from the illness itself. The individual would be unable to feed and hydrate

themselves let alone defend themselves against injury or predators due to the paralysis. However, after analysis of the skeletal remains, it is understood that M9 lived for about 10 years after onset of the paralytic symptoms that eventually evolved into quadriplegia, which implies that they were cared for by another individual or a group of individuals. To put in context the amount of energy and resources that would have been required to care for this individual, quadriplegia is a devasting pathological condition that is difficult treat in a modern environment with modern medicines, as quadriplegics are often placed on ventilators to help them breathe and require around the clock care (Marino and Goin, 1999; Gormley Jr, Krach and Piccini, 2001; Morrow *et al.*, 2008). So, for a subsistence economy in the Neolithic, the challenges that the caregivers must have encountered and resolved to maintain the health of M9 and provide a quality of life would have been considerable. Nevertheless, M9 lived with quadriplegia from adolescence into his 20s (Tilley, 2015e).

Examination of the skeleton produced several diagnostic indicators of quadriplegia. The recovered long bones display a significantly reduced diaphyseal diameter compared to other adult male remains that were excavated at Man Bac. Furthermore, the slenderness of the lower limbs is signature clinical description of an adult individual with a spinal cord injury (SCI) that occurred as a juvenile (Giangregorio and McCartney, 2007; Oxenham et al., 2009). The bone and muscle loss in M9's lower limbs would have been caused by the absence of mechanical loading that he would have otherwise experienced during the remainder of his adolescence (Giangregorio and McCartney, 2007).

Additionally, the first three thoracic vertebrae and all the cervical vertebrae were completely ankylosed. The remains of M9 also exhibited signs of a permanent torticollis and bilateral temporomandibular joint degeneration. The combination of these pathologies

resulted in a suggested diagnosis of Klippel Feil Syndrome (KFS) Type III by Oxenham et al. (2009).

There is some evidence to suggest that M9 had functional quadriparesis rather than quadriplegia. The upper limb bones were more robust in comparison to the lower limbs bones and there is evidence for the presence of osteoarthritis and use of the right deltoid muscle which suggests M9 may have had intermittent but very limited mobility in his upper limbs (Oxenham et al., 2009). However, the extent of the bone atrophy in the right arm would indicate that he was no longer able to use his arms in a weight bearing capacity which extended to restricting M9's ability to independently transition himself from different sedentary positions (Tilley, 2015e).

As the size and composition of the Man Bac community is currently unknown, it is impossible to determine if M9 received care exclusively from his family or if the wider community assisted in the caring of M9. However, M9 was buried within what appears to be a communal burial site (Oxenham, Matsumura and Kim Dung, 2011), which would suggest that they were not subject to stigmatisation due to their disability. The main difference was seen in the alignment of the remains, as M9 was not aligned east-west like the majority of individuals, instead M9 was aligned north-south on his side in a flexed position facing west (see Figure 3). As such, the question can be raised as to why the alignment and positioning of M9 does not conform to the common mortuary practices of the rest of the burial site (Huffer and Trinh, 2011).

Figure 3.2: Photograph of MB07H1M09 in situ immediately prior to removal; note extreme gracility of limbs. The single preserved grave good (a terracotta pot) was removed at an early stage of the excavation (Tilley and Oxenham, 2011).

The different alignment of the body could be interpreted as a deliberate action by the community to segregate M9 (and the five others found in the same alignment (Oxenham, Matsumura and Kim Dung, 2011)) from the rest of the community in the burial. It is possible that despite the abundance of care that M9 must have received throughout their life to live as long as he did, there may have been an essence of prejudice against M9 for not being able to contribute to the community in the same way the rest of the Man Bac community did, which resulted in atypical burial of M9. On the other hand, as 6 of the 84 individuals (7.14%) are buried with the same alignment (Oxenham, Matsumura and Kim Dung, 2011). This suggests that the burial was somewhat normative and/or that M9 and the five other individuals had something in common such as being part of the same kinship group.

M9 was discovered with grave goods in very close proximity of his remains suggesting that they were buried alongside M9. This would match the pattern among other adults and most

sub-adults where they were all buried with grave goods suggesting that there was an element of an egalitarian social structure in place where individuals were given an identity from an early age (Tilley, 2015e). Moreover, the presence of grave goods found with M9 would suggest that the same burial process was followed for the interment of M9. Analysis of the grave goods showed a positive correlation between the age of the individual at death and the amount and type of grave goods found. Although there were some exceptions, M9 appears to not be one of them as a pedestalled dish with combed decorations was found with two other pieces of pottery, thus suggesting that despite M9's disability, they held a respectable enough position among the social hierarchy to warrant adornment after death (Huffer and Trinh, 2011).

Likewise, the atypical burial of M9 could have been an indication that the community valued and respected M9 as an individual so much, that they were willing to forgo their well-established burial procedures to ensure M9 was buried with the same level of attention and care that he received while he was alive, as a huge amount of time and resources were used to prolong M9's survival. Suggesting that he was cared for and valued by other members of the community who they had developed bonds with (Oxenham *et al.*, 2009; Tilley and Oxenham, 2011). The community of Man Bac might have had to change their burial procedures due to M9's physical condition from when he was alive; the ankylosed vertebrae may have prevented from M9's body being positioned in a supine position with his limbs extended i.e., the burial alignment was a practical decision/ based on their knowledge of the person, rather than having a great significance as to whether it was a normative position or not. With regards to the orientation of M9's remains, it is possibly a reflection of the role he had within the community or the result of any special requirements that he made for his passage into the afterlife (Tilley, 2015e).

3.3 Lanhill Burial 7 (LB7)

The Lanhill example is from an early Neolithic (~3800-3400 BC) Long Barrow located in the Cotswolds, England. LB7 was excavated from the North-West corner of the Long Barrow with six other individuals of varying age and sex but was the only individual to remain in articulation (Keiller and Piggott, 1938).

Unlike M9, LB7 would have required less care to ensure they remained healthy and survive. LB7 appeared to have sustained an injury to their elbow. To be precise, there was damage was sustained to the distal epiphysis of the left humerus which caused epicondylar disruption and resulted into a severe deformity of the articular surface that essentially locked the head of the ulna into the olecranon fossa (Tilley, 2015b). This resulted in the left humerus displaying atrophy and arrested development; the left humerus is shorter and substantially more gracile compared to the right humerus (see Figure 4). Despite suffering this injury during their adolescence which resulted in the permanent and total inability to use their left arm (see Figure 5), analysis of the right arm and legs showed they were unaffected in the incident that caused the injury to the left arm, as they were robust with well-delineated muscle attachments, suggesting that LB7 likely lived an active and mobile lifestyle until his death in his 50s (Tilley, 2015b).

As previously mentioned, the provision of care that LB7 would require differed from that of M9; LB7 would not have needed direct care but rather task allocation that would have been

Figure 3.3: LB7, left humerus (top) compared to right humerus (bottom), anterior views, illustrating differences in size (length and diameter) and robusticity (Tilley, 2015a)

Figure 3.4: Representation of the outcomes of injury to LB7's left elbow: permanent flexure, disrupted longitudinal growth, disuse atrophy. Drawing by Lorna Tilley (2015)

assigned tasks that did not rely on the use of both his upper limbs.

To go beyond the physical implications of LB7's injury, emotional and mental wellbeing should also be considered as it is frequent for an individual who loses a limb, or the use of a limb to develop depression as they become socially excluded due to the inability to contribute to the group (Mckechnie and John, 2014; Lindner, Montgomery and Hiyoshi, 2020). Although, this appears to have not been the case with LB7 as they were buried with others in a long barrow. It is just as important to examine how the age of onset impacts the way an individual such as LB7, experiences a life altering injury or disease. For example, we know that LB7 sustained their injury as a juvenile/early adolescence. Losing the use of limb at any age is traumatic but more so on a juvenile as it is unlikely that they would have developed the mental resilience or coping mechanisms for dealing with traumatic events to the capacity of a fully grown adult meaning they would be more at risk of developing severe psychological problems such as depression (Wallander and Varni, 1995). As a result, it probable that LB7 received emotional support during the period of adjustment after his injury in addition to any physical accommodations made to facilitate LB7's reduced mobility of his upper limb. The accommodations that were likely employed by the rest of the group would include assigning tasks that LB7 that he could accomplish and still contribute something of value to the group. In doing so, it would have prevented, or at the very least reduced the level of social isolation LB7 experienced and minimising the risk of developing depression. Role assignment during the Neolithic is not unheard of as Hansen, Jensen and Skovsgaard (2015), argue that modern gender roles are a "Neolithic inheritance". The development of agricultural societies pushed societies on a path to adopt patriarchal norms and beliefs which would consequently impact the job roles among different genders. If job

roles could be decided by gender acceptable to reason that job roles were also allocated in accordance with one's abilities.

What is more, LB7 was buried within a communal burial chamber; a Neolithic long barrow in the Cotswolds (Tilley, 2015b). This implies that LB7 was not ostracised nor stigmatised by the community for their physical disability but actually was able to sustain a strong social cohesion which lasted beyond his death (Tilley, 2015b). Furthermore, the Lanhill site contained several individuals who appear to have suffered from varying severities of diseases and pathologies (Tilley, 2015b). This suggests that the accommodations made for LB7 were not a singular event, rather it appears to be common practice for this community to care for each other. It is likely that other communities also displayed high levels of health-related caregiving as there was a greater need for, which could be contributed to the levels of human-on-human violence during the Neolithic in Europe caused by the increase in population densities from the adoption of sedentism instigating scalar stresses on communities (Friesen, 1999; Wadley and Hayden, 2015). The increased violence can be suggested due to the presence of more mass graves that have been dated to the PPNB (Belfer-Cohen and Goring-Morris, 2011). However, it would be naïve to credit the increased frequency of mass graves to just interpersonal violence and ignoring other significant factors such as the introduction of new microbes and parasites as well as the increased ease of transmission of said microbes and parasites (Armelagos, Goodman and Jacobs, 1991).

3.4 Summary

The relationship between kinship and the provision of care is that of one which is made up of intricate social interactions that can fall outside the biological kinship group such as an individual's status in the social hierarchy (Ensor, 2011).

The Man Bac case study provides a great example of a high demanding and challenging case of an individual needing around the clock care during the Neolithic. Without the presence of their carer/s and the medical knowledge to care for him, M9 would not have lived long after the onset of their disability, which makes the 10-year period of living with quadriplegia even more significant. Due to the fine details of the Man Bac community still being unclear, making it impossible to determine if M9 received care exclusively from his biological kinship group or if the wider community assisted in the caring of M9. We are able to suggest that they were not subject to stigmatisation due to their disability as they was buried within a communal burial site with grave goods (Oxenham, Matsumura and Kim Dung, 2011; Tilley, 2015e).

At the other end of the spectrum with the level of care required by an individual is LB7, they did not require the extent of care that M9 did. Whereas M9 needed 24/7 care and support, LB7's injury was not severe enough to necessitate the need for the same level of care. LB7 required accommodations to their daily life to allow them to be able to remain independent and contribute to the community. Much like M9, LB7 was buried among their peers in a communal burial chamber (Tilley, 2015b) – once again indicating the significance of how disabilities were possibly viewed in Neolithic communities. Likewise, the importance of kinships within communities and the influence it may have on an individual's position in the social hierarchy.

Additionally, the provision of care that is apparent in these case studies indicates towards the presence of specialist knowledge and healers which allows the successful assistance of individuals with varying requirements of care and needs.

Chapter 4: Palaeomedicine of the Neolithic

Prior to the development of modern pharmaceuticals and medical procedures, humans relied heavily on utilising the fauna and flora in their immediate physical environment to attempt to treat and cure illnesses and injuries (see O'Regan, Lamb and Wilkinson, 2016; Hardy, 2018, 2019, 2020; Inoue, Hayashi and E. Craker, 2019). Due to the increased availability of evidence for plant use that accompanied the domestication of plants and animals, this chapter explores how the medicinal use of plants and medical procedures during the Neolithic impacted the provision of care an individual would receive from their caregivers. Where appropriate, the use of archaeological evidence from the Epipalaeolithic and Chalcolithic to support the arguments, but only if it can be inferred that it was also likely to occur during the Neolithic.

4.1 Evidence for the use of plants in a medicinal context

In addition to the production of nutritional food resources, the development of agriculture enables communities to produce larger higher quality crops of psychoactive substances that have medicinal benefits that I will discuss later in this paper (Wadley and Hayden, 2015).The act of self-medication can be seen as a type of adaptive plasticity; humans and non-human animals adapt their behaviour and even their phenotype during their lifetime to environmental change to increase their chance of survival and reproduction (Singer, Mace and Bernays, 2009). Most plants can be both edible and have medicinal properties but it is rare for it to be in equal amounts; plants often have a high nutritional and low medicinal values or vice versa (Hardy, 2019). Clayton and Wolfe (1993) set out three criteria that must be met for a substance to be established as a method of self-medication:

- The substance must be detrimental to one or more species of parasite.
- The detrimental effect the substance has on the parasites must result in increased fitness of the host.
- The substance must be deliberately manipulated with the intent for improving the hosts health.

The disadvantage of using these criteria to classify a substance as an effective form of self-medication is that they do not include any information with regards to the effect the substance may have on the individual when the disease or parasite is no longer present (Abbott, 2014). Therefore, to ensure that the substance being utilised is not part of a healthy diet or lifestyle choice, adaptive plasticity must be considered. If the substance is solely for the purpose of self-medication, a trade-off should be expected; for example, that the substance is only sought and utilised when there is need for it, otherwise it would have a negative impact on the hosts health and fitness (Singer, Mace and Bernays, 2009). The agreement that there should be a trade-off for the use of the medicinal substance resulted in a fourth criterion being added for the substance to be established as a form of self-medication (Singer, Mace and Bernays, 2009):

- The substance must have a detrimental impact on the host in the absence of parasites or disease.

Despite the addition of the fourth criterion, the criteria laid out by Clayton and Wolfe (1993) still assumes that individuals only medicated in response to a parasite or disease and overlooks other reasons people may self-medicate such as to remedy a psychological health impairments like stress or depression (Peoples and Bailey, 2014c).

The largest challenge that archaeologists encounter during their search for the use of medicines is that plant remains rarely appear in the archaeological record due to decomposition (Hardy, 2020). However, archaeologists are able to exploit the chemical biomarkers and the DNA of identified non-nutritive plants that have medicinal properties found in the dental calculus of human remains to gain an insight into plant-based medication (Hardy, 2019).

Material culture can be analysed to support the presence of plants with medicinal properties at an archaeological site through the trace residues left behind in storage pots or feeding bottles. Then the results from the analysis of the dental calculus can be used in conjunction with the information obtained from the material culture to form a stronger foundation for an argument supporting the presence of specific plants. Archaeologists can examine material culture such as pottery or tools looking for biological residue that can be analysed to determine the identity of the organic material and it possible uses (Hardy, 2020). If the organic residue that has been found has been determined possess medicinal properties, then it is appropriate for the archaeologists to interpret these finds as a deliberate method to store plants with the intention for them to be used as herbal remedies for members of the community or to produce the herbal remedies for application or consumption.

As mentioned in the last chapter, with the adoption of a sedentary lifestyle alongside agriculture, the risk of an individual becoming victim of a parasitic infection increased (Zammit, 2005). Therefore, the demand for successful treatments that will rid the human body of these parasites was heightened.

In addition to plants being utilised to treat diseases, some plants and fungi have psychoactive qualities that will influence an individual's thought and/or emotional processes through a biochemical action on the nervous system (Wadley and Hayden, 2015). These plants include sugar cane and cereals that can be fermented to produce alcohol (Sherratt, 2005) as well as poppy plants in Spain and the Mediterranean (Zapata *et al.*, 2004) and, cannabis at several sites (Merlin, 2003). The use of psychoactive substances in health-related caregiving can still be seen today in the Yąnomamö as I had previously mentioned (see Chagnon, 2012).

It must be noted that not all medicinal compounds need to be ingested to be effective, depending on their properties, they can also work via topical application, absorption and the proximity of the compound to the individual which can act as a deterrent to harmful fungi or parasites (Clayton and Wolfe, 1993).

Ötzi the Iceman also known as the Tyrolean or Similaun Iceman, is a deceased human male who was found frozen in a glacier pool in the Italian Alps in North-West Italy that dates to ~5300 years old, placing him in the Chalcolithic period n (Keller *et al.*, 2012). Ötzi the Iceman (hereby known as the Iceman), provides a good example of an individual who was in the possession of the necessary knowledge and skills to utilise their environment to harvest resources that have medicinal properties. During the examination of his belongings two objects piqued the interest of the investigating archaeologists - whitish, marshmallow-sized organic objects were threaded onto strips of leather (see Figure 7). These organic materials were originally thought to be *Fomes fomentarius*, a fungus also known as true tinder bracket because of its properties that make it a useful kindling for fires (Peintner, Pöder and Pümpel, 1998; Fowler, 2002). However, after chemical analysis of the fungi by Reinhold

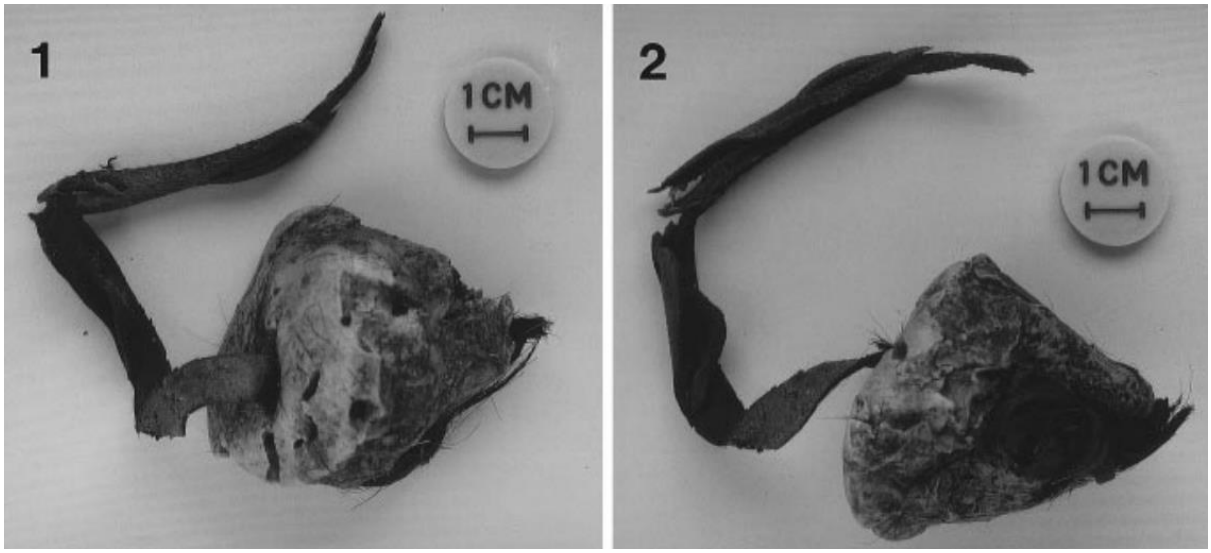

Figure 4.1: The cone-like *Piptoporus betulinus* basidium fragment (91/133a) mounted on a leather thong, in its original, water-saturated condition (Peintner, Pöder and Pümpel, 1998).

Pöder at the University of Innsbruck, it was discovered that the fungi was not *F. fomentarius* but was in fact *Piptoporus betulinus*, a fungus otherwise known as birch polypore or razor-strop fungus and is commonly found on birch trees (Fowler, 2002). The significance of the discovery of this fungus on Ötzi is its antibiotic properties (Peintner, Pöder and Pümpel, 1998). It can be suggested that the Iceman ingested *P. betulinus* for one of two reasons, in an attempt to minimise the bacterial infection of the wounds he sustained peri-mortem or as birch polypore is a vermifuge, it can be used to treat intestinal parasites (O'Regan, Lamb and Wilkinson, 2016); this would have been very beneficial to the Iceman if they were eating insufficiently prepared meat. The ingestion of *P. betulinus* would explain why there is no trace of the fungus at nearby Neolithic settlements. Although, it is also possible that the absence of *P. betulinus* could have been a result of the fungus not being able to survive thousands of years of taphonomic processes with the high level of preservation that the Iceman experienced or it just was not utilised by this community (Fowler, 2002).

It must be noted that even though Ötzi the Iceman is an individual that dates to the Chalcolithic, it is reasonable to infer that the technology and pharmaceutical knowledge he possessed would have been available to individuals in the preceding Neolithic period.

4.2 Possible circumstances that led to the discovery of plants with medicinal properties

The field of zoopharmacognosy focuses on the process in which non-human animals select and use specific plants and other substances with a low nutritional value but have medicinal properties to treat and prevent diseases and parasites (Raman and Kandula, 2008; Álvaro *et al.*, 2019). Humans have been observing non-human animal behaviours to develop their own medicines throughout prehistory (Álvaro *et al.*, 2019). Although there is evidence for the use of plants for medicinal purposes prior to the Neolithic (see Hardy *et al.*, 2015, 2017), the mass implementation of animal and plant domestication that happened over a long period of time, likely acted as a catalyst for the advancements in the pharmaceutical treatment of diseases and parasites. The domestication of wild animals resulted in the opportunity for humans to readily observe what they consumed and if there were any changes in their diet, what the probable cause was. Primatological studies having been conducted where non-human animals have been observed in an attempt to ascertain how and what is ingested or topically applied to treat illness or injury (see Huffman and Seifu, 1989; Spencer Larsen, 1995; Huffman, 2001, 2003; Krief *et al.*, 2006). These studies have primarily involved observing the treatment for internal and external parasites (Raman and Kandula, 2008). A study conducted in the Mahale mountains, Tanzania was the first to document how a sick animal, in this case a chimpanzee (*Pan troglodytes*), utilised Compositae (*Vernonia amygdalina*) to self-medicate and get better (Huffman and Seifu,

1989). It was soon discovered that *V. amygdalina* is a very potent medicine used by the local human population to treat malaria, schistosomiasis, amoebic dysentery and several other intestinal parasites and stomach disorders (Raman and Kandula, 2008). A plausible reason for both humans and chimpanzees in the same environment to exploiting the same natural resource to self-medicate other than independently discovering its uses themselves, is that humans observed (likely on multiple occasions) an ill chimpanzee chew on the *V. amygdalina* leaves and see a noticeable improvement in their health. Thus, motivating the local human populous to experiment and try it themselves to see what symptoms the plant treats and if there are any side effects in using *V. amygdalina*.

4.3 Evidence of dentistry

Although there are only a handful of cases that indicate a strong presence of dental intervention to treat a pathology, there is enough to begin to gain an basic understanding of Neolithic dentistry (Bernardini *et al.*, 2012).

Lonche 1 is a canine found in the mandible from an individual buried in Slovenia (2 sigma range calculations provide a date range of 6655-6400 Cal. BP) shows traces of a beeswax that appears to have been used as a filling on the crown (Bernardini *et al.*, 2012). It is not uncommon to use beeswax as part of a binding agent during the Neolithic as its adhesive and long-lasting properties were well recognised (Luo *et al.*, 2012). For example, the ancient Egyptians used a complex mixture of which beeswax, bitumen, and galbanum[1] were components. This mixture was used to treat the bandages that were to be used in the

[1] Galbanum is a plant. A gum-like material (resin) is obtained from the stems. The resin and roots are used to make medicine. Galbanum is sometimes applied directly to the skin to help wounds heal. The oil and resin that is produced from the galbanum plant are used as fragrance in cosmetics (Wedmd.com, 2021).

mummification process to ensure a the bandages would not un ravel over time (Benson, Hemingway and Leach, 1978).

Given that it was not uncommon for fillings to be applied to teeth post-mortem during the burial practices (Bernardini *et al.*, 2012), archaeologists must be able to distinguish with a degree of reliability between if the teeth were altered ante-, peri- or post-mortem. In response to this problem Hughes and White (2009) conducted a pilot study and proposed a method that would potentially make it possible for archaeologists to differentiate between ante- and peri-mortem filling application and post mortem application. The method revolves around analysing how the dentin and enamel tissues behave during the dehydration process that occurs after death. Cracks will form in the dentin due to the stress imposed upon the dentin from dehydration and consequent shrinking through the dental-enamel junction

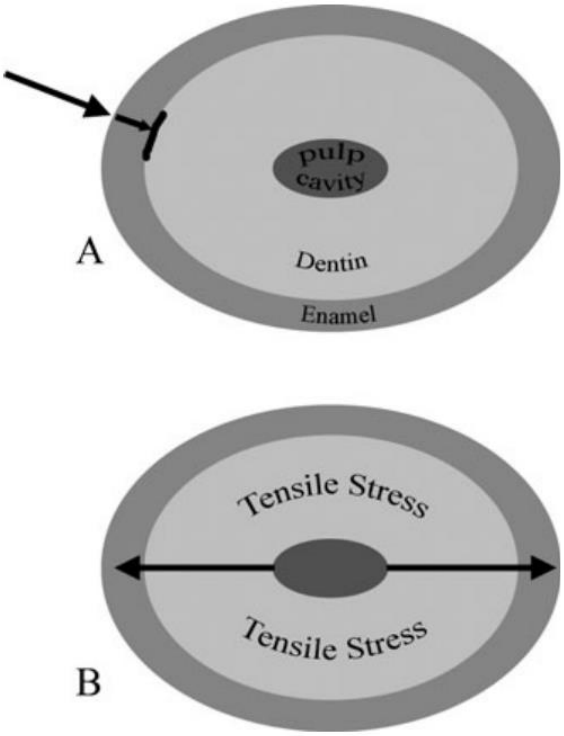

Figure 4.2: Models of crack propagation patterns in peri-mortem/ante-mortem trauma (A) and post-mortem heat-related damage (B). Black arrows indicate initial direction of stress and subsequent crack propagation (Hughes and White, 2009).

(DEJ) and out toward the enamel itself (see figure 8) as that contains less water and would therefore, shrink less during the dehydration process (Hughes and White, 2009).

Therefore, cracks in archaeological teeth can be analysed to determine when the cracks occurred; ante-mortem crack are often characterised by a stress being applied to the exterior of the tooth and a crack develops in the enamel to the DEJ. Whereas post-mortem cracking can be seen originating in the dentin and directs towards the DEJ (Imbeni *et al.*, 2005; Hughes and White, 2009). However, clinical reports have shown that is it possible for the ante-mortem cracks to penetrate the dentin (see Loomba *et al.*, 2010).

Once the nature of the crack has been determined, the application of the beeswax filling must be analysed. Markers to be mindful of if the beeswax was applied ante-mortem are signs of chipping along the fracture line that have been filled by the beeswax and if there are other teeth that have cracks with exposed dentin. It would seem illogical to only apply beeswax post-mortem to some of the teeth and not others (Bernardini *et al.*, 2012).

Additionally, the case of a beeswax dental filling is not an isolated case of a product sourced from bees being used as a dental aid. In the Papyrus Ebers which originated in 9th Century BC Egypt, a mixture of honey and minerals was applied externally to loose teeth to either hold them in place or to reduce the pain from infection (Leek, 1967).

Ante mortem tooth loss can be attributed to several causes such as dental pathologies and trauma, there is evidence that suggests that teeth were intentionally removed for medical as well as cosmetic purposes (Robb, 1997; Pietrusewsky *et al.*, 2017). To determine if the intentions behind the removal of teeth was deliberate during the Neolithic, archaeologists must examine the wider environment to identify if there is repetitive pattern of ante-mortem tooth loss in the community despite the presence of good dental health

(Pietrusewsky *et al.*, 2017). To distinguish if the tooth ablation was due to a dental disease or if it was a result of an aesthetic cultural modification, several indicators must be identified. For example, the presence of a dental disease will often manifest lesions which will leave a permanent trace on the mandibular and maxillary bones (Robb, 1997). There is also a pattern to which humans in the Neolithic lost their teeth if it was due to a dental disease; the first teeth to fall out is nearly always the molars and the teeth will then proceed to fall out from the rear of the mouth to the front (Robb, 1997).

To assist in the differentiation between tooth ablation and tooth loss with no deliberate human intervention, Domett *et al.* (2013) produced criteria used to identify tooth ablation in humans. The criteria consist of:

- The spacing of teeth
- The symmetry and non-randomness of the tooth loss
- The absence of a significant dental pathology
- Presence of roots in the tooth socket
- Fractures of the labial portion of the alveolus can be identified
- Ethnographic accounts of the community the individual belonged to

The modification of teeth is a prevalent phenomenon during the Neolithic and can be found in the form of altering the shape of the teeth or the complete removal of teeth (Robb, 1997; Pietrusewsky *et al.*, 2017). The explanations for such modifications will vary from culture to culture for example, there are several Neolithic sites in Italy such as Passo di Corvo and Continenza in which women were found to have undergone tooth removal (Robb, 1997). However, as tooth ablation was not prevalent in all the woman, it can be suggested that this

process was not necessarily a rite of passage but was a choice for the women to make. It is possible that the reasoning behind why all the women did not have teeth removed was due to a combination of social distinctions such as adult female status and an initiation into a particular group or social status (Geniola and Mallegni, 1975). On the other hand, the woman who had their teeth removed (likely in early adulthood), lived longer than those who kept their teeth (Robb, 1997). Although the reason for this is still unknown, research into Italian Neolithic communities has shown that dental pathologies were common among societies (Robb, 2002).

4.4 Evidence for the use of trepanation

In addition to the developments in the herbal aspects of palaeomedicine, there were substantial advancements in the surgical procedures available too, such as the introduction of trepanation on individuals with head injuries. The act of trepanation involves the burring of hole the cranium via several methods discussed below. Trepanation provides the earliest evidence in the archaeological record for humans performing a surgical procedure (Weber and Wahl, 2006). The earliest evidence for trepanation can be found in human skeletons from the Neolithic period, and it is most commonly a single opening but in some cases there are multiple openings that can vary in size (Prioreschi, 1991; Faria, 2015). It is reasonable to assume that such a procedure performed during the Neolithic would commonly result in the death of the patient due to poor standards of hygiene and the lack of modern surgical equipment. Plus, as with any surgical procedure, complications can arise that will endanger the individual's life. With regards to trepanation, the two major risks are infection and direct injury to the brain during the procedure due poor technique or complication (Ortner, 2003).

Until the introduction of sedation and the technology to reduce blood loss, trepanning was a very time sensitive procedure that needed to be completed as rapidly as possible to maximise the success rate of the procedure as it would reduce the amount of blood loss and prevent any unnecessary damage to the individual's head, particularly the brain (Weber and Wahl, 2006). However, there are several examples of Neolithic skulls that appear to have undergone trepanation and the process of healing had begun (Weber and Wahl, 2006; Faria, 2015). Therefore, the survival rate of Neolithic trepanation must not have been as low as one might expect given the resources available and the probably unsanitary conditions in which the procedures took place, as patients were surviving for an extended period of time after the procedure.

When attempting to associate a hole in a skull with trepanation, it is also imperative for the pathology to undergo a differential diagnosis to eliminate the possibility that the hole was caused by a cranial defect that resulted from a developmental disorder, trauma, disease or a taphonomic process (Verano, 2016). Once that has been established, further analysis of the type of trepanation can be undertaken. The osteological record shows that there were four methods of trepanation that were used more often than other methods: scraping, grooving, intersecting linear cuts and a combination of boring and cutting (see Figure 9) (Weber and Wahl, 2006; Verano, 2016).

The presence of unhealed holes in the skulls from Neolithic sites has produced speculation to intentions behind trepanation such as it being a result of post-mortem experimentation or a ritual practice, particularly in regions where there are isolated cases of trepanation being performed (Ortner, 2003; Nicklisch *et al.*, 2018). Therefore, when conducting an investigation to identify the cause of a hole in a skull, certain considerations must be made.

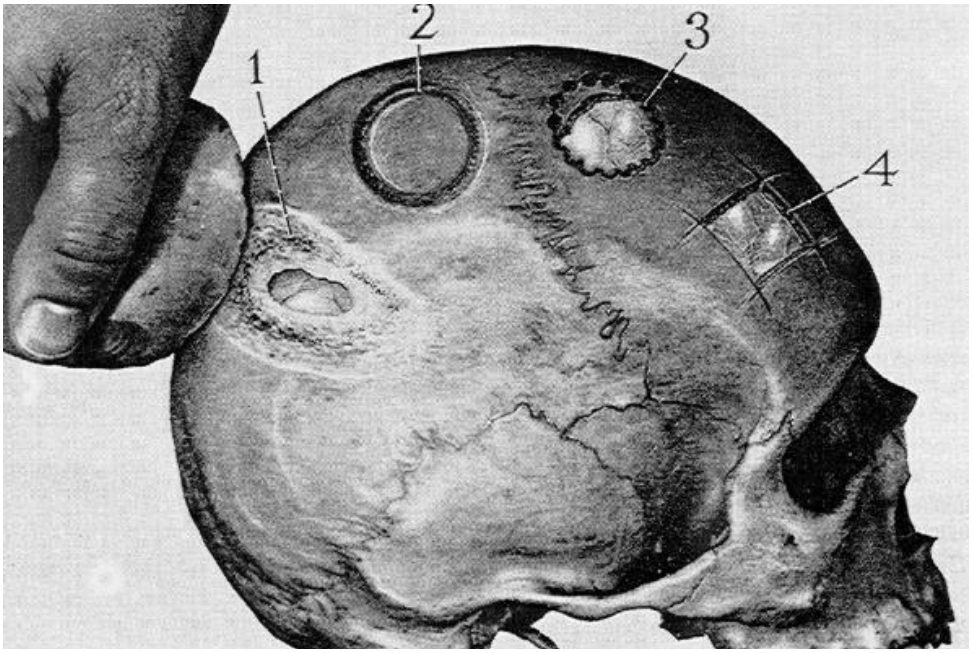

Figure 4.3: Illustration of trepanation methods: (1) scraping, (2) circular grooving, (3) drilling and cutting, and (4) linear cutting with angular intersections. From Lisowski, 1967

Firstly, one must ascertain if the hole was caused by natural causes or if there was a mechanical intervention which can be detected from any evidence of cutting or scrapping around the hole even if the healing process has already begun (Ortner, 2003). Once it has been determined that trepanation has taken place, the next obstacle is to establish if the hole occurred ante-, peri- or post-mortem. The presence of inflammation or healing will strongly indicate that trepanation occurred while the individual was alive and lived for a period post-surgery. In contrast, if the individual died during the surgical procedure or soon after, then no anatomical reaction to the procedure would occur, leaving it impossible for the examiner to distinguish if the trepanation was performed while the individual was alive or already deceased (Ortner, 2003). Subsequently, it becomes our responsibility as archaeologists to research the geographical area to ascertain if trepanation was a commonly performed surgical procedure or the individual in question was an isolated case. If the individual was an isolated case, archaeologists must conduct further investigation to the

geographic environment, the burial site and the material culture found to suggest if the trepanation was a product of surgical intervention or a post mortem experimentation or ritual (Ortner, 2003).

4.5 Evidence for the presence of an assigned healer within a community

It is plausible that some communities in the Neolithic had access to an individual whose role within the community was to heal and care for others. For example, investigations into the Neolithic site at Hambledon Hill in Dorset, UK (see Figure 6) has provided evidence of shamanism being practiced, thus there would be an individual whose role was to provide a standard of care for the community through a combination of performance and the use of materials such skeletal remains (Reynolds, 2014). According to Chagnon (2012), the word *shaman* can be "used to describe men and women in any tribal society who manipulate the spirit world; cure the sick with magic, sucking, singing, or massaging; diagnose illness and prescribe a magical remedy; and generally intercede between humans and spirits in the context of health versus sickness".

So, within the context of Hambledon Hill, being the assigned healer may have been one of the roles that the community's shaman undertook as they was often involved in the healing of individuals as well as the spiritual ceremonies (Winkelman, 2002; Peoples and Bailey, 2014b). The presence of a shaman at Hambledon Hill has been inferred from the excavation and analysis of human skulls. A series of human skulls that have been separated from the body were found deposited in a row during phase II of segment 3 (Mercer and Healy, 2014).

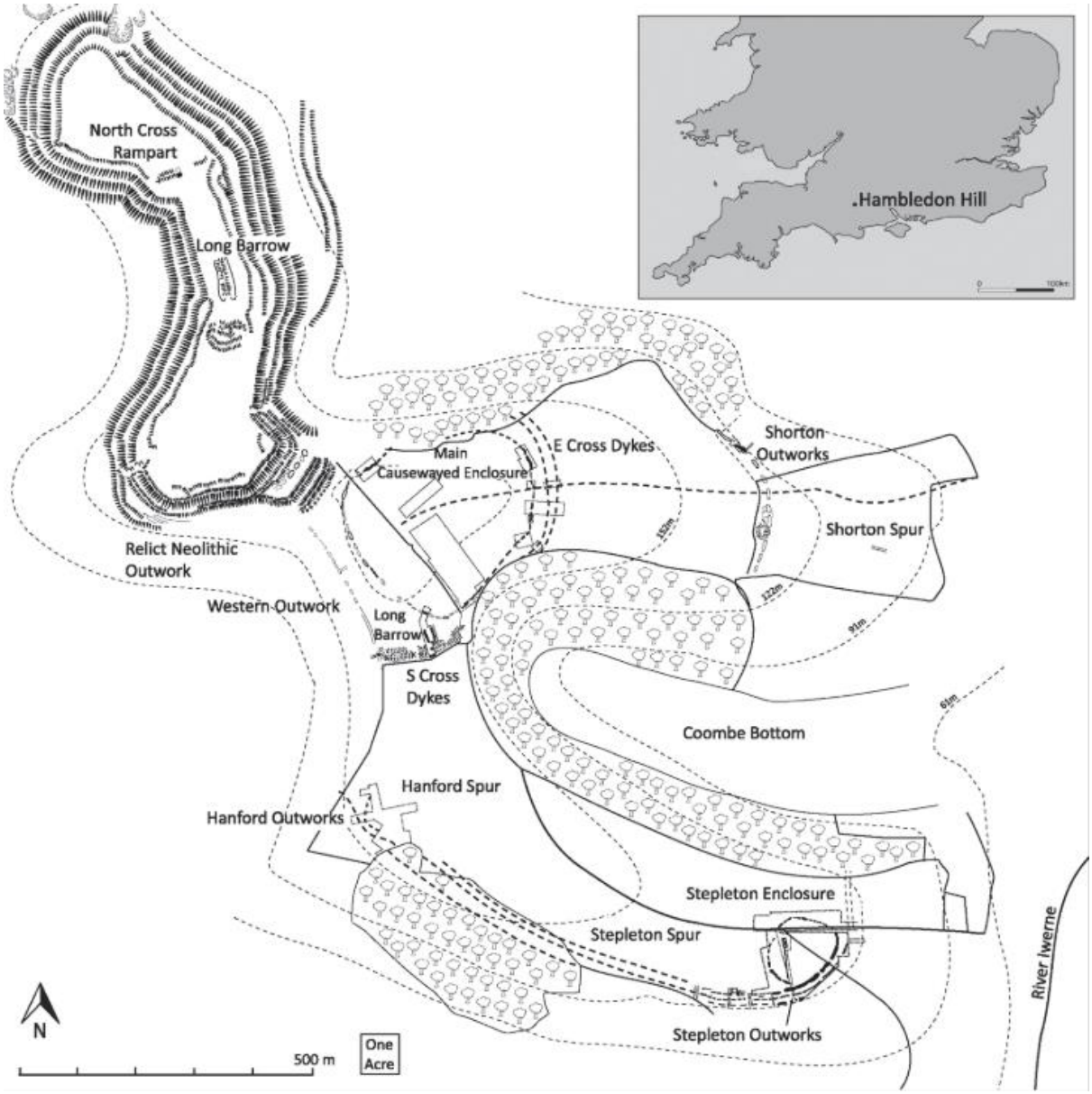

Figure 4.4: Hambledon Hill (redrawn by Reynolds, after Mercer and Healy 2008) (Reynolds, 2014)

The significance of this find has been contributed to the community at Hambledon Hill using human skulls as a way to directly contact deceased relatives through the help of a shaman as the skulls themselves acted as a 'vessel' in which an animistic essence was deemed to reside (Reynolds, 2014). The use of a shaman at Hambledon Hill as a healer can be further supported by the analysis of the topography and the identification of a structure that was likely used by the shaman. Once the site has been located, further analysis of any archaeological evidence that was recovered at that site will be needed. Soil analysis in particular can provide the necessary information which would allow archaeologists to more accurately infer if the shaman acted as a healer for the community. Likewise, investigation of the other structures at Hambledon Hill may show that medicine was practiced elsewhere on site and that it was not necessarily the role of the shaman to heal ailed members of the community. However, it is near impossible to say with certainty who was the healer as archaeologists can only infer what has happened from the evidence that has been presented in front of them.

A contemporary group that makes use of shamanism like it has been suggested in Neolithic societies are the Yąnomamö. By examining the shamanistic practices Yąnomamö, we can hope to gain an insight as to the relationship between the role of caregiving and shamanism. In Yąnomamö society, almost any person within the community can aspire and train to be a shaman. The only requirement is that you are male (Chagnon, 2012). As a connection to the spiritual world is essential in shaman practices, hallucinogens are often taken. Yąnomamö shamans inhale hallucinogenic snuff called *ebene*[2] (Chagnon, 2012). They believe this will

[2] *Ebene* refers to any prepared snuff powder in which its composition includes bark, seeds, leaves and resin from several different plants. In terms of the Yąnomamö, *ebene* consists of bast bark and its resin of feral species of tree belonging to the *Virola* genus (Chagnon, Le Quesne and Cook, 1971).

allow them to contact the spirits to assist them in their duties which include healing ailed members of the community (Chagnon, 2012).

Although discussing shamanism in archaeological literature is often avoided due the fringe nature of the topic, clinical research has been conducted into the effects of an individual relying on a religion or some form of spirituality as a coping mechanism to help cope with chronic pain (Wachholtz and Pearce, 2009).

One of the theories that has been proposed in an attempt to explain this phenomenon is the Neuromatrix Theory of Pain (Melzack, 1999), which was developed off an early Gate Control Theory of Pain (Melzack and Wall, 1965). These theories provide a conceptual basis for how spiritual and religious beliefs and practices may make it possible for an individual to have more control over their pain management. For example, the Neuromatrix Theory of Pain suggests that experiencing pain is multidimensional and is associated with a specific series of nerve impulses produced by an extensive neural network that is initially determined by genetics but is then sculpted by peripheral sensory input (Melzack, 1999; Romanenko and Romanenko, 2017). Additionally, Romanenko and Romanenko (2017) believe pain is subjective and that an individual's perception of pain will stem from the transduction, transmission and modulation of sensory stimulation that has been sorted through a filter of genetic characteristics and the unique previous experiences of the individual. So, if a person is able to utilise their previous life experiences in such a that it helps them with pain management, they will be in a better state of mind and able to communicate this technique to others and allow them to care for themselves more effectively via more efficient pain management.

Even if the shamanistic practices at Hambledon Hill did not prove to be an effective method of treatment for a physical illness or injury. It is highly likely that the pain individuals may be in can be lessened because pain is perceptual and pain signals can be influenced by several cognitive, social and emotional factors (Wachholtz and Pearce, 2009). The intensity that an individual would experience in real time does not solely depend on the degree of tissue damage or dysfunction of the body (Wachholtz and Pearce, 2009; Romanenko and Romanenko, 2017). Therefore, if modern studies into the use of religion and spirituality are anything to go by, then the belief of an individual who was seriously ill or dying, who thought that they were getting better or that there was something better waiting for them when they died would at the very least have a healthier state of mind and facilitate them to be able come to terms with their ailments and possibly allow that individual to cope better with any pain they were in. As a result, it is highly probable that individuals who incorporate the use of religious and spiritual coping strategies into their treatment and/or recovery will have a more favourable mental and physical health outcome in the long-term (Wachholtz and Pearce, 2009).

4.6 Summary

This chapter debates the evidence for medicine in the Neolithic period through the use case studies that examine the use of plants as well as evidence for dentistry and trepanation. The study of plants and the access to nutritional food resources during the Neolithic period has facilitated the analysis of the medicinal practices utilised by Neolithic communities as well as the potential origins to how they acquired the knowledge of which flora is safe to use and is effective at treating specific pathologies. That being said, it is not without its challenges due to the rate at which the plants decompose, almost completely removing them from the archaeological record (Hardy, 2020). Thankfully, due to modern technology being able to

exploit the chemical biomarkers and the DNA of plants found in the dental calculus of human remains that have medicinal properties, we have been able to gain an insight into plant-based medication of the Neolithic period (Hardy, 2019).

Although there are only a few cases of Neolithic dentistry, those cases display strong evidence for dental intervention to treat a pathology. Lonche 1 provides a great example of an ante-mortem application of beeswax as a filling on the crown of a canine. One of the biggest challenges faced when examining tooth fillings is the ability to differentiate between ante and post-mortem application as it was not uncommon for fillings to be applied to teeth post-mortem during the burial practices (Bernardini *et al.*, 2012). Another strong case for dental intervention is the use of tooth ablation and much like with the analysis of determining the nature of tooth fillings, the analysis of missing teeth involves the identification of patterns that fit a pre-determined criteria (Domett et al., 2013).

It is extremely difficult to conclusively identify trepanation in the archaeological record due to many, if not most, trepanations occurring alongside skull fractures which makes for a very difficult differential diagnosis as a number of lesions may closely resemble a lesion (Bennike, 2003). What is more, as there appears to be no clear distinction at sites where trepanation has taken place, it could suggest that there is a single individual who may appear in the form of a shaman, is conducting these surgical procedures and/or providing the necessary mentorship to their peers so they will also be able to complete the procedures if they are not available to do so.

Chapter 5: Index of Care

Now the background to health and medicines in the Neolithic has been established, we return to the Index of Care to apply this knowledge to three case studies from Western Europe.

The Index of Care comprises of a four-stage process that takes the researcher through a series of steps to determine the severity of the pathology and the subsequent care the individual received, that is if they did receive any form of care (Tilley and Cameron, 2014). The below stages are taken from Tilley and Cameron's 2014 publication which introduced the world to the Index of Care

5.1 Stage 1: Describe, diagnose, document

The first stage of the process is to describe the remains. This should include the presence of any pathologies and the size and condition of the bones. This will allow for a diagnosis to formed of what disease and/or injury ailed the individual as well as an identity (approximate age, sex, and stature). Afterwards, the researcher must attempt to document the lifeways of the individual, making sure to provide as much detail regarding the cultural, social, environmental, economic and mortuary context; it is crucial for the later steps that as much context for the individual as possible is provided here if an accurate assessment is to be completed.

5.2 Stage 2: Assess the disability

Stage 2 will determine if the individual required health-related care and if so, to what extent they received it. To make this stage user friendly, it is split into three sub-sections: clinical features, functional impacts and need for care (Figure 10).

- Clinical features
    - Consider the probable pathological impact on body systems and function and assign a percentage score for the likely severity and duration of each symptom.
- Functional impacts
    - Using the lifeway parameters outlined in Stage 1, the researcher should assess the likely functional impact caused by the symptoms on the essential activities of day-to-day life and the instrumental activities of daily like such as interpersonal relationships.

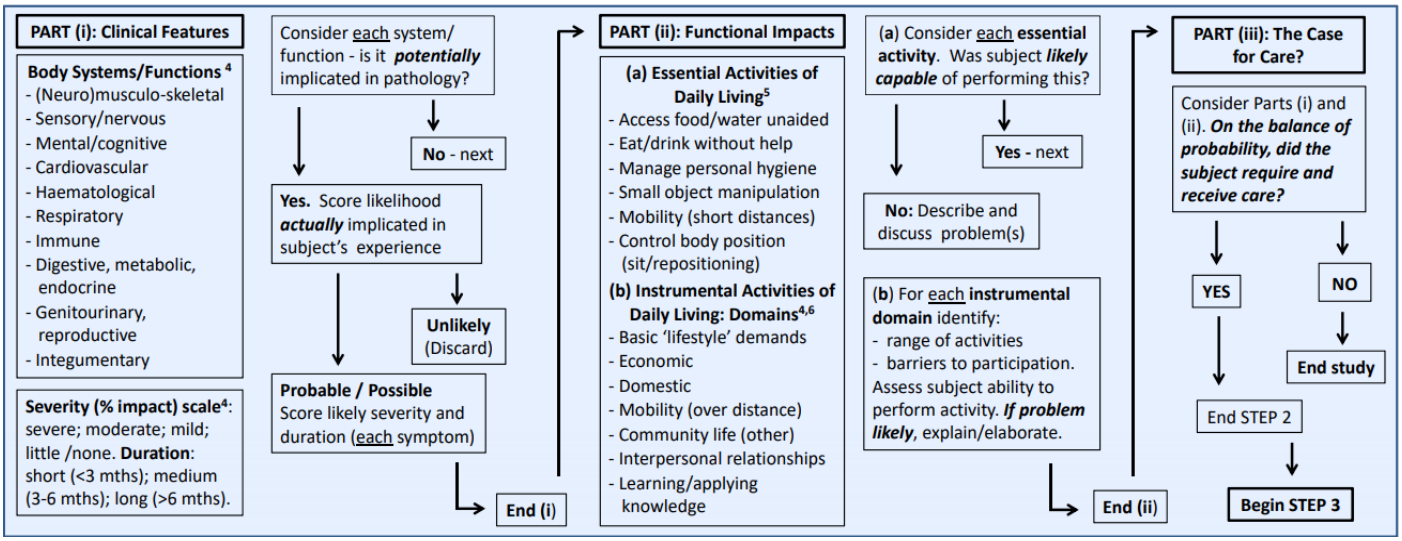

Figure 5.1: A flow chart showing the process of Stage 2 (Tilley and Cameron, 2014)

- Need for care
    - Finally, the previous two sections of Stage 2 are collated and used to assess whether the impact on functioning in daily life would require a level of care from others to ensure the individual survived. If it is considered that the individual did not require any form of health-related care or accommodation, then the study is stopped at this stage, otherwise the researcher will continue to Stage 3.

5.3 Stage 3: Construct a model of care

Once it has been ascertained that the individual would require care, it is now prudent to understand the level of care that they would require. Firstly, the researcher must identify the characteristics of care that would likely have been required to treat the symptoms, e.g., the estimated length of the period of care and resource requirements needed to meet the basic elements of care such as nutrition and hygiene. Then it is decided if the individual would need direct support in the form of 'hands-on' caring or simply an accommodation for their disability like a role they can fulfil without assistance.

5.4 Stage 4: Interpret the implications of care

The final stage requires the researcher to explore the possible implications of providing the care outlined in Stage 3 on the individual and the wider community's agency, which can provide an insight into the social relations, practices, and organisation of the community as well as the individual and group identities.

The application of the Index of Care provides a standardised methodology that can be widely utilised by archaeologists to more easily identify instances of health-related caregiving in human remains. Although the Index of Care cannot provide precise answers to the complex questions of healthcare provision due to ambiguities in the data and the potential for contention in the interpretation of the results, it encourages archaeologists to consider the questions that are being asked about an individual and the healthcare provisions that they may have received more constructively, even if that was not the main aim of their research (Tilley and Cameron, 2014; Schrenk and Tilley, 2018).

5.5 Applying the Index of Care

The Index of Care can almost be universally applied to human remains regardless of their geographic location and culture; the condition and abundance of the human remains holds a larger influence on the successful application of the Index of Care. I will be applying the Index of Care to three case studies of varying pathologies and number of identifiable skeletal remains in an attempt to demonstrate the strengths and pitfalls of the Index of Care. The choice of these case studies is to show the benefits of using the Index of Care on individuals who require direct care for the long term and those who were able to transition from direct care to just needing lifestyle and environmental changes to accommodate their new disability. Plus, I will show how the Index of Care struggles to produce an informative report of the provision of care when applied to a case study in which there is few identifiable remains.

5.5.1 Buthiers-Boulancourt, France (Burial 416)

The human remains in Burial 416 were found at the Neolithic site of Buthiers-Boulancourt (Seine-et-Marie), France and have been 14C dated to 4900-4710 Cal. BC. Multiple seasons of excavation have uncovered two dwelling areas, both which date to the Neolithic (Buquet-Marcon, Philippe and Anaick, 2007). The individual studied here was found in an individual pit in one of the two tombs discovered (a total of five individuals have been recovered so far); the tomb that Burial 416 was found in, was located in the smaller of the two dwellings and the use of an individual pit was characteristic for this period (Jeunesse, 1997; Buquet-Marcon, Philippe and Anaick, 2007).

Step 1: Describe

The individual in question was a robust-bodied male who died in his 40s. The remains showed signs of osteoarthritis and complete ante-mortem tooth loss as well as an amputation of the lower left arm from the distal end of the left humerus. The individual was buried in a large oblong grave, 1.6m wide, 2.5m long and 1.5m deep; the decedent was placed on their left side in a crouched position and orientated East-West with the face

Figure 5.2: Burial 416 of the old Neolithic site of Buthiers-Boulancourt (Seine-et-Marne) was that of a privileged individual who was amputee of the lower left arm. (Beyneix, 2015). 1) Polished slate axe blade measuring 20.5cm long; 2) Flint pick that measures 30cm long (Annotations by author)

directed South (Buquet-Marcon, Philippe and Anaick, 2007; Beyneix, 2015). Removal of the remains revealed a sprinkling of ochre underneath the deceased's head. Additionally, the individual was buried with large, polished slate axe blade measuring 20.5cm long, which was placed behind the individual's skull; the handle likely decomposed due to taphonomic processes. As well as the axe blade, a flint pick that measures 30cm long was found placed on the left arm. Finally, the remains of a young animal (a lamb or a kid) were found at the feet of the deceased (Beyneix, 2015). Buthiers-Boulancourt was a small pastoral-agricultural community that consisted of seven buildings and four other burial sites have been linked to the hamlet.

Step 2: Assess the need for care

Clinical

Certain: amputation of the left arm from the distal end of the left humerus (see Figure 12), ante-mortem tooth loss

Figure 5.3: Detail of the distal part of the humerus of the man of Buthiers-Boulancourt (Seine-et-Marne). The bone carries the brands of a cutting and the signs of a cicatrisation (Beyneix, 2015)

Probable: debilitating osteoarthritic backaches

Possible: depression; pain; phantom limb

Functional

The amputation would have been a hinderance in daily activities in the long-term with the individual would having limited upper body functionality, restricting the array of activities they could complete. Nevertheless, the individual would be able to maintain independence in all 'Essential activities of daily living' but would have been restricted in 'Instrumental activities in daily living'. The limited functionality of one of his upper limbs would likely have prevented the individual partaking in primary economic activities such as construction and food preparation. However, as the individual was able to retain their mobility after their injury, they would have been able to assist in the collection of resources and travel across difficult terrain.

Care needed: Yes

Step 3: Model of Care

Direct support: the individual would likely only need direct support for a short period immediately after the amputation.

Accommodation: the acceptance of the injury and the following accommodations by the community to prevent social isolation and maintain an optimum level of psychological health; burial evidence indicates that the individual was socially included and held a privileged social status among the community. Alternative occupations were likely assigned

to the individual that did not require the use of two hands and allow the individual to contribute to the community despite their injury, such as tending to crops.

Step 4: Interpret implications of care

Community: Buthiers-Boulancourt was a small hamlet that contained a small pastoral-agricultural community so the importance for members of the community to equally contribute to the hamlet was accentuated. Therefore, the survival of this individual suggests that there was a strong social internal cohesion and a willingness to assign task allocation with consideration to this individual's injury. Moreover, the remains show no sign of infection following the amputation which suggests that the wound was kept clean and the application of an antiseptic herb such as a sage was applied post-surgery (Abu-Darwish *et al.*, 2013). It is likely that a herb with analgesic properties was also utilised during surgery to reduce the amount of pain the individual was in and minimise the risk of the patient going into shock from the pain of the procedure (the use of these specific herbs is pure speculation however) (Beyneix, 2015). The acceptance of his injury also indicates that the community valued communal identity over the differences of the individual identities of members.

Individual: living with the loss of a limb suggests psychological resilience and the ability to adapt their behaviour to account for their injury.

Someone must have performed the procedure to amputate this individual's arm

5.5.2 Schweizersbild Burial 9, Switzerland (S9)

The Neolithic site of Schweizersbild consists of a skeletal sample of 31 individuals, four of which have been radiocarbon dated to 4905-4785 years BP (Höneisen and Peyer, 1994). But, the skeletal remains of S9 has been radiocarbon dated to 5155±45 Cal. BP at the Laboratory for Ion Beam Physics, ETH Zurich, placing her in the Late Neolithic period (Milella, Zollikofer and Ponce de León, 2015).

Step 1: Describe

We know that remains of S9 belongs to an adolescent aged around 12 years old due to the degree of dental formation and calcification of their teeth (Milella, Zollikofer and Ponce de León, 2015), see Figure 13. They were interred in a communal burial site at the site of Schweizersbild (Canton of Schaffhausen, Northern Switzerland); S9 was the only set of remains to display developmental anomalies. Schweizersbild is comprised of a rock shelter

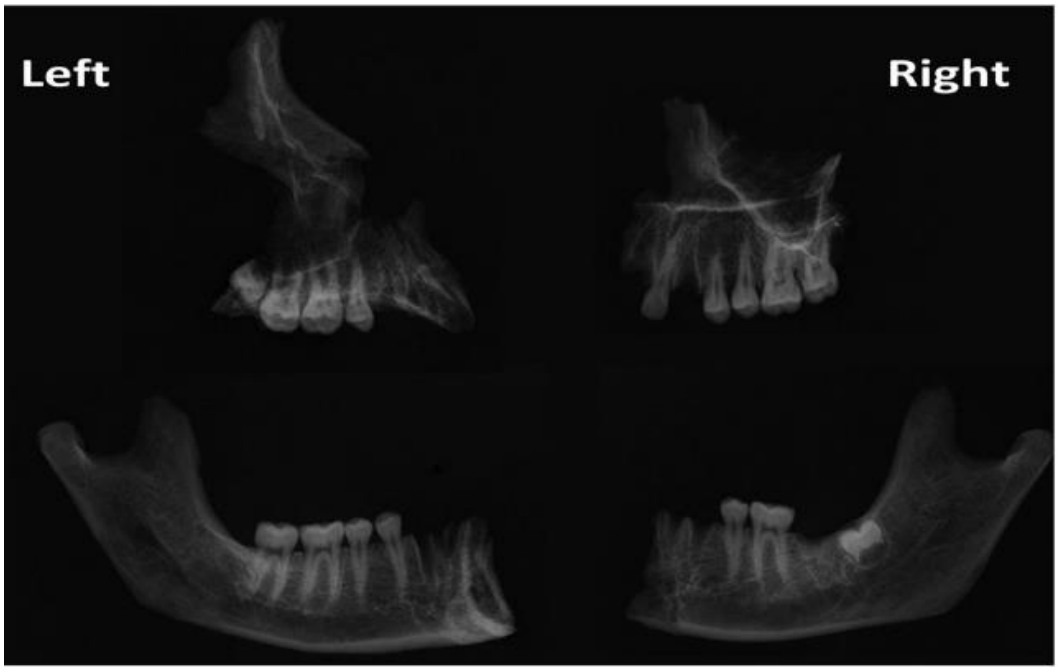

Figure 5.4: Schweizersbild 9 (S9): Plain radiography of the upper and lower dentition pointing to an age at death of ca. 12 years (Milella, Zollikofer and Ponce de Leon, 2015)

and examination of the archaeological layers show that the site was intermittently occupied from the Upper Palaeolithic to the Medieval period (Höneisen and Peyer, 1994). The preservation of the skeletal remains was relatively poor, and parts of the skeleton were found to be missing during the excavation. The missing parts include the cervical vertebrae, almost all ribs, the left radius, both fibulae, all the bones of the feet and hands, plus all unfused epiphyses (Milella, Zollikofer and Ponce de León, 2015). S9's remains display indicators of mesomelic dysplasia in all limb bones whereas the rest of the skeleton appears unaffected. A differential diagnosis produced three possible causes of the bilateral mesomelic dysplasia[3]: Léri Weill dyschondrosteosis (LWD), Langer Mesomelic Dysplasia (LMD) and Acromesomelic Dysplasia Maroteaux type (AMDM). Due to the degree of skeletal changes and the relative incidence characterising each disorder, LWD was considered to be the most plausible diagnosis (Milella, Zollikofer and Ponce de León, 2015). The pathological shortening of the limbs likely caused by LWD made it difficult to produce an estimation of the stature of the individual. This is due to the stature calculations being reliant on the measurements of the long limbs to determine the individual's stature.

Step 2: Assess the need for care

Clinical

Certain: dwarfism; limited forearm extension; restricted forearm pronation; dorso-lateral bowing

[3] A growth disorder that results in the severe shortening of the metaphyses in the long bones (Kaitila, Leisti and Rimoin, 1976; GARD, 2020)

Probable: poor mobility and endurance; limited mobility of the wrists; developmental delays during infancy

Possible: reduced grip/manipulation skills; neuropathic pain; endocrine, respiratory and cardiovascular complications; hand and foot bone deformities

Functional

S9 would have been able to maintain a degree of independence in most 'Essential activities of daily living' but would have been restricted in 'Instrumental activities in daily living'. The limited mobility and manipulation skills of S9 would have meant they were not able to participate in primary economic activities such as hunting and would struggle to manoeuvre over difficult terrain. This level of limited mobility and manipulation skills that can be contributed to having short limbs can be seen in the Late Pleistocene/Early Mesolithic case of Romito 2 who suffered from chondrodystrophic dwarfism (see Tilley, 2015a). However, it is possible that they might have been able to assist in the working of bone, stone, and wood, depending on the presence of any deformities in S9's hands.

Step 3: Model of Care

Direct Support: S9 would have likely required a provision of food and water for their lifespan, assistance in mobility during periods of neuropathic pain and protection to ensure their physical safety.

Accommodation: S9 would have received extended nurturing in early childhood to compensate for developmental delays. Successively, the acceptance of/adjustment to S9's

physical appearance and functional ability by the community at Schweizersbild; burial evidence indicates that S9 had full social inclusion.

Step 4: Interpret implications of care

Community: given that S9 was able to survive until about 12 years old, it is reasonable to suggest the community actively contributed to the direct care and accommodation for S9's disabilities.

Individual: S9 would have been living with physical challenges their whole life which suggests an aspect of resilience in the personality of S9.

5.5.3 Eira Pedrinha, Portugal

Eira Pedrinha is a Late Neolithic site with a skeletal assemblage comprised of at least 144 individuals found in a funerary monument that measures 5 m high, 10 m depth and 6 m wide (Corrêa and Teixeira, 1949; Gama *et al.*, 2003). The site was uncovered during excavations of the Covão de Almeida cave located in Condexia (modern day Coimbra) on the western coast of Portugal (Gama *et al.*, 2003).

Step 1: Describe

The individual who displays strong indications of surgical trepanation is an adult male who died in his late fifties (Ferembach, Schwidetzky and Stoukal, 1980; Masset, 1982). He was found during excavations in the Covão de Almeida cave, found in Eira Pedrinha, Portugal. This limestone cave was used as a funerary space in the Late Neolithic and radiocarbon

dating confirms the human remains date to 3360 - 2925 Cal. BC (5310 - 4875 Cal BP) (Gama *et al.*, 2003). There is an ovoid/elliptical shaped lesion located on the middle portion of the left frontal bone; the lesion has been attributed to trepanation and bone remodelling is present (see Figure 14). The individual was found in an ossuary, so it is not possible to be able to associate any of the postcranial remains to the calvaria belonging to this individual.

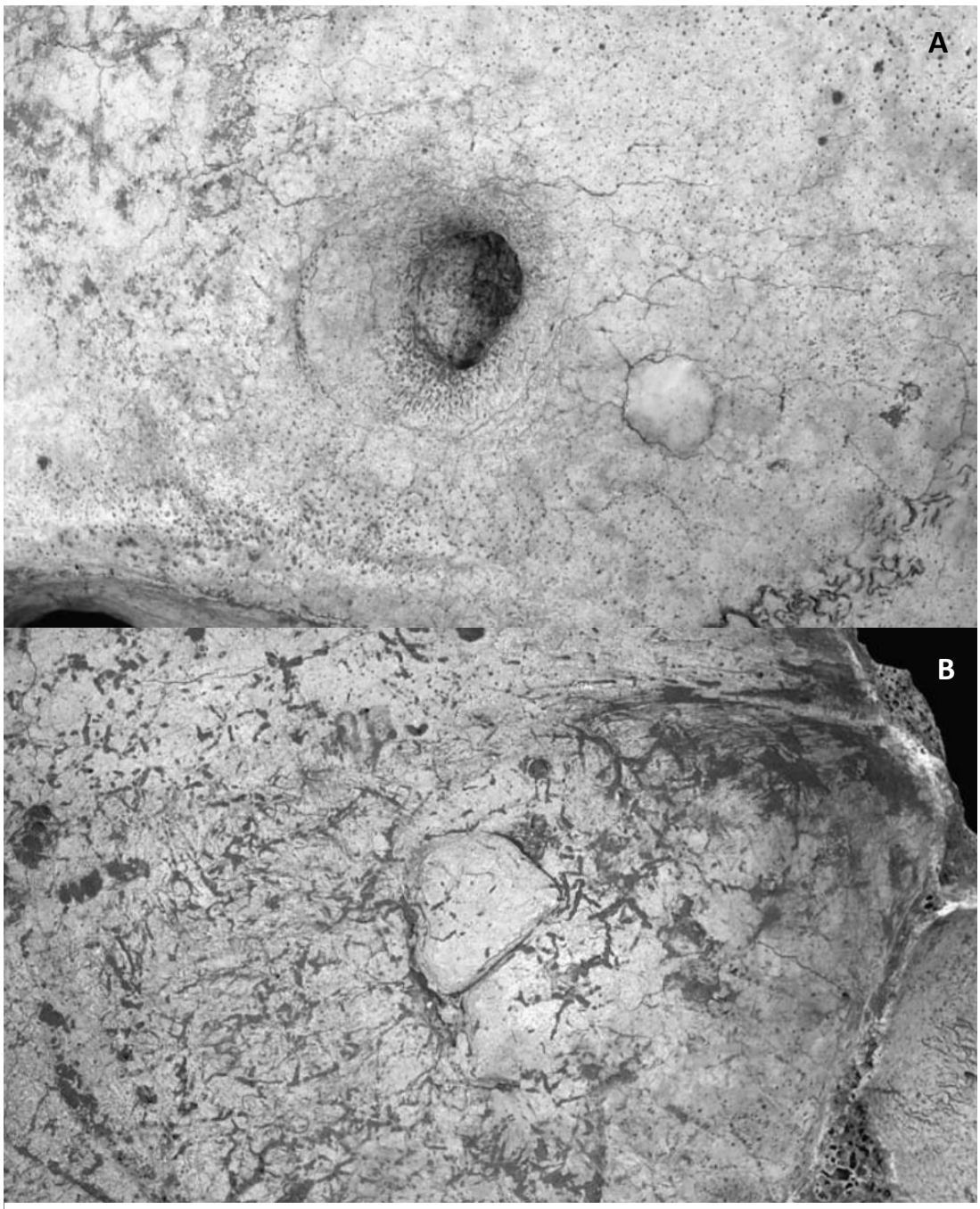

Figure 5.5: a) A close-up of the exocranial aspect of the trepanation. b) The endocranial aspect of the trepanation (Gama *et al*., 2003).

Step 2: Assess the need for care

Clinical

Certain: Cranial trauma

Probable: Unknown

Possible: Unknown

Functional

Certain: Unknown

Probable: Unknown

Possible: Unknown

Step 3: Model of Care

Direct support: The individual received surgical intervention to treat a cranial pathology (origin and identity of which is unknown). As the individual survived the surgical procedure, it is probable that the individual's health status was monitored post-operation to ensure any complications are prevented or treated.

Accommodation: Not likely needed.

Step 4: Interpret implications of care

Community: As this case of Neolithic trepanation shows indications of bone remodelling, the individual survived the procedure long enough for the healing process to begin. The individual likely received care and rudimentary medical advice from a specialised individual and members of the community such as their kin, actively contributed to the support that the individual required.

Individual: For this individual to undergo such an invasive and risky procedure suggests they had a mental resilience and had an element of trust for their community, particularly the individual who performed the trepanation.

Chapter 6: Discussion

6.1 Significance of the burials at Buthiers-Boulancourt, Schweizersbild and Eira Pedrinha

There has been reluctance within many palaeopathological interpretations to consider the question of disability in sociocultural terms (Southwell-Wright, 2013) but the burials of the lower arm amputee, the trepanned individual and S9 can be utilised to provide an insight to Neolithic societies' perception of disability. Firstly, the lower arm amputee will be discussed, followed by S9 and the trepanation case study, then a comparison of the three burials. The use of terminology in this comparison is vital and there is a difference between an impairment and a disability. For example, I specifically use the terms hands rather than arms when discussing the functional capability of in the individual in Burial 416 as they could potentially steady objects with their stump while they manipulate it with their other hand.

The burial at Buthiers-Boulancourt is the earliest recorded example of amputation and displays the characteristics of a high-status Neolithic burial which suggests that the amputee possessed a high social status among the community at his time of death; the burial contained rich grave goods and was buried with animal remains that only a member of a community that is ranked highly in the social hierarchy would be interred with (Buquet-Marcon, Philippe and Anaick, 2007). The origin of this individual's high social status could have been a result of the family he was born/married into, achievements accomplished during their lifespan or as a result of the amputation itself.

The placement of the flint pick in place of the missing lower left arm could be symbolic of the occupation that the deceased lived; he could have been a craftsman, a warrior or a miner and that pick could have been an extension of his arm prior to the injury that resulted

in the amputation. In contrast, the placement of the pick could be interpreted as an indicator of the incident that caused his life altering injury and became part of his identity. Another possibility is that this individual may well have used the flint pick as a rudimentary prosthetic arm during their lifespan post-amputation. However, no leather straps or harness has been uncovered that would indicate that the flint pick was attachable to his arm (although the leather straps would have unlikely been able to withstand the taphonomic processes and preserve). As a result, the flint pick may have been placed in the grave for religious or spiritual reasons, as the placement of the flint pick where his lower arm would have been provided an alternative limb for the deceased to use in the afterlife.

The complexity and success of the surgical amputation of the injured limb (origin of the original injury has not yet been determined) shows that at least one individual within the nearby area possessed an advanced level of medical knowledge. The practitioner had the knowledge to cauterise the wound to prevent further blood loss and control infection (Buquet-Marcon, Philippe and Anaick, 2007; Beyneix, 2015). Buquet-Marcon, Philippe and Anaick (2007) suggested that sage was used as an antiseptic during the aftercare stage due to medicinal properties (Abu-Darwish *et al.*, 2013). This could also be interpreted as the small hamlet that the amputee belonged to being in the possession of an individual or had access to a local specialist who has devoted their career to focus on the healing and caring of others. This would not be the first instance of a community from the Neolithic to display indicators of an assigned healer as there is evidence for the presence of an individual at Hambledon Hill in Dorset as discussed above (Reynolds, 2014). Furthermore, the ante-mortem tooth loss in the individual from Burial 416 was possibly a result of tooth evulsion so, further warrants the notion that there was a an individual or possibly multiple

individuals and there is no way to prove that the same person who completed the amputation was the same person who removed his teeth.

With regards to the death of S9 whom was 12 years old at the time, their burial also suggests that they too were not ostracised by their community for their disability; S9 was buried among individuals from the same community. This inclusion implies that the community at Schweizersbild had a strong social cohesion likely due to the large network of kinships that can be made in such small communities (Ensor, 2011).

A key similarity between the case studies from Buthiers-Boulancourt and Eira Pedrinha is the presence of an individual who specialises in the performance of surgical procedures and the caring for others. This does raise the question of how these techniques were developed and how the knowledge was passed on.

Overall, the fact that all of these individuals survived for long periods of time in their communities confirms that there must have been some form of mutual aid and solidarity towards people with disabilities (Buquet-Marcon, Philippe and Anaick, 2007; Milella, Zollikofer and Ponce de León, 2015). When these individuals eventually died, they were buried or underwent an established interment process which further shows that they were not subject to stigmatisation and held some form of social status as the process of burying an individual is a deliberate act of respect (Southwell-Wright, 2013). Plus, the method in which they was buried will then provide the necessary information to form a conclusion of their social ranking in their respective communities (Southwell-Wright, 2013). Moreover, their disabilities did not appear to lessen their social ranking within their societies, in fact, in the case of the amputee he appears to have held a high-ranking social position that could have been aided by the occurrence of his injury.

To further my point with regards to these individuals receiving ongoing care after experiencing significant events in their life that required medical attention, the existence of kinship groups would have largely contributed to the decision to care for a sick or injured individual. Kinship plays a crucial role in the provision of health-related care via the formation and maintenance of social bonds with members of an individual's community who may not necessarily be of blood relation (Joyce and Gillespie, 2000; Souvatzi, 2017).

Not only does the case study from Eira Pedrinha provide an all be it small insight into an uncommon example of trepanation during the Neolithic in Portugal but, it supports my point of one of the prominent limitations of using the Index of Care on disarticulated remains. I was unable to complete an in-depth analysis of the remains to determine a credible conclusion to the provision of care that this individual received and how any other pathologies they may have had impacted their life in conjunction with the trepanation is they had any.

Although archaeological evidence is very useful and can provide insight into the studies of disabilities and care, the evidence is not comprehensive; we as archaeologists, can only recognize those impairments that have left permanent signatures on the human skeleton such as those caused by physical trauma, disease, or congenital impairment. Many impairments that only affect the soft tissues of the body will never be recognizable, for example, it is very rare to be able to make a verifiable diagnosis of mental or sensory impairment from skeletal material alone (Roberts, 2000).

The documentation for the surgical amputation of limbs in the Neolithic period is very limited (Buquet-Marcon, Philippe and Anaick, 2007). As a result, the case of Burial 416 at Buthiers-Boulancourt is very significant as it shows us that an individual received a surgical

amputation of the lower left arm, presumably due to an injury that necessitated the amputation. We also know that the amputation was a success and the individual lived for a long period after the procedure due to signs of bone remodelling on the distal end of the left humerus. What is more, the amputation and the reduced upper body functionality did not appear to have impacted the individuals social standing as they received a burial that would often be associated to person of high social ranking. Although we do not know if this individual was left or right handed, we can assume the likelihood of them being right handed was high as most of the human population is right-handed and has been for at least 5,000 years (McManus, 2019). If this individual was right-handed, it would have probably not impacted his ability to complete tasks as much as if he was left-handed. However, it is possible they if they were, they adapted to the situation and learned to use their right hand to complete tasks.

The use of the Index of Care is an invaluable tool in the investigative process to understand what kind of care an individual likely received which can produce the necessary information to further our insights into the sociocultural aspects on Neolithic communities. Despite the Index of Care providing an almost universal program for archaeologists to use when investigating the bioarchaeology of care, it does have its limitations. The Index of Care is unable to fill the gap in an archaeologist's toolkit to investigate and interpret partial or disarticulated remains. Moreover, the Index of Care is not a program that is designed to be used by someone who does not possess a reasonable amount of medical knowledge on diseases and injuries. If said person does not have that knowledge, it is very easy for them to unintentionally miss out on symptoms that the deceased may have suffered from, which would impact the outcome of their conclusion when investigating the provision of care that the deceased may have received.

6.2 Limitations of using the Index of Care

The development of the Index of Care (Tilley and Cameron, 2014) has been an invaluable resource for archaeologists during the assessment of articulated human remains. Although it does not provide the answers for the more complex questions surrounding the bioarchaeology of care, it does provide a universal vocabulary and process for determining the provision of care an individual did or did not receive. However, the Index of Care does have its shortcomings. The Index of Care cannot be applied to disarticulated human remains as effectively as with articulated human remains. As a result, a profound gap in the archaeological record is being created with regards to the assessment of human remains from periods and regions where disarticulation is the norm. More effort needs to be made into the researching of disarticulated human remains as the information collected from the analysis and interpretation of the remains would provide a larger sample and could prove to be just as valuable in the attempt to resolve the ambiguities surrounding the provision of care in human prehistory.

The social structures in the Neolithic period that have been theorised from the archaeological record indicate that houses, households, and community are extremely important themes in social analysis, especially with regards to health-related caregiving in which kinship plays a critical role. However, the social foundations cannot be fully understood if they are separated from the institutions and the set of social issues that are associated with the role of kinship. As kinship provides an opportunity for archaeologists to observe individual relationships in archaeological assemblages that reflect larger social relationships and therefore to bridge the gap between institutions and actions such as health-related caregiving (Souvatzi, 2017). This need to study and understand kinship

further reinforces the necessity for incorporating anthropological research that priorities the social and cultural aspects of society. By using anthropological research in the study of kinship it allows for archaeologists to observe how concepts of relatedness are formed and maintained through the application of what we understand about modern pre-industrial societies to the societies in the Neolithic. What is more, kinship is ultimately a way for individuals to both integrate and differentiate themselves socially (Peoples and Bailey, 2014a).

The notion that if an individual is already suffering from a weakened immune system due to a pre-existing illness or strenuous living conditions, then the case of M9 at Man Bac becomes even more remarkable. The fact that this individual spent around a decade of their life completely immobilised raises the question of how they survived so long if risk of additional infections was so high for someone who was both immobile and had a weakened immune system due to a pre-existing condition. It is possible that the Neolithic site of Man Bac had a more advanced pharmaceutical knowledge and access to a wider range of flora that had medicinal properties than the Neolithic sites in Europe such as Derenburg in the TB case study that I previously discussed (Oelze *et al.*, 2011; Nicklisch *et al.*, 2012). If this were to be true, it could provide an explanation as to why M9 was able to live so much longer than S9 even though the severity of M9's disease was arguably more serious than that of S9. Though, this is just speculation as we do not know for certain what the cause of death was for these individuals as it is possible that the result of their deaths was not related to the identified diseases that they suffered from.

The need for developments in health-related caregiving during the Neolithic period can be partly credited to the interpersonal violence, especially in regions where population

densities were high (Friesen, 1999). The violent conflicts were likely caused over disagreements on land boundaries, accessibility and availability of resources as well as personal disputes and predominately occurred between males (Darvill, 2010; Fibiger *et al.*, 2013; Meyer *et al.*, 2015). The presence of interpersonal violence meant that there was an was a demand to manage and heal trauma-related injuries to reduce the number of fatalities caused from conflicts (Wadley and Hayden, 2015). Due to the high footfall in population dense regions from travellers, it is plausible that there were specialised individuals who conveyed their medical knowledge on surgeries and medicines to those who wanted it for something of value in return (Darvill, 2010).

Chapter 7: Conclusion

The bioarchaeology of care is still a relatively new field of research that has so much to offer archaeologists. With the proper application of the Index of Care, archaeologists are able to reconstruct the lifeways of individuals who required some form of health-related caregiving.

Therefore, more focus needs to be placed into the role of kinship in the analysis of caregiving behaviours and the social bonds among individuals as from a purely economic perspective, it could provide a more conclusive explanation as to why someone would invest a lot of time and energy to care for an individual who is consuming a larger portion of the valuable resources of a community that has a subsistence economy, than they are generating into the community.

The advancements in palaeomedicine have without a doubt provided the necessary opportunity for humans to enhance their ability to care for one another and become more competent in the treatment of diseases and injuries. The ability to successfully treat injuries is required in the Neolithic as it has been suggested that there was a substantial increase in the frequency of human-on-human violence(Friesen, 1999; Belfer-Cohen and Goring-Morris, 2011; Wadley and Hayden, 2015) but further research will be needed for me to determine if there was an increase in violence or if it is just more evident in the archaeological record during the Neolithic than in the Mesolithic. The supposed increase of human-on-human violence could also be the reasoning behind the advancements of palaeomedicine as the requirement to treat injured individuals had never been so high, thus forcing people in the Neolithic to find ways to overcome these new challenges. For example, either or both injuries detailed in the Lanhill Burial or Burial 416 at Buthiers-Boulancourt

could have been a result of human-on-human violence. We know that both of these individuals experienced some form of trauma at the time of their respective injuries and given the high levels of violence during the Neolithic period, it is plausible that they sustained their injuries at the hand of another person rather than by accident (Meyer *et al.*, 2015; Wadley and Hayden, 2015). The individual's injury at Buthiers-Boulancourt was so severe, they underwent an amputation of the lower right arm; a surgical procedure that was the first of its kind according to the archaeological record and raises the question as to what influenced the person who performed the amputation to do it in the first place.

As for the investigation of human remains, the Index of Care is an indispensable tool for archaeologists and is in a constant process of development to refine the program and allow it to be used by archaeologists on sets of human remains from various geographic locations, cultures, and time periods. Although the Index of Care is only truly beneficial in the examination of articulated remains, as the Index of Care is updated and refined, archaeologists will hopefully be able to apply the Index of Care to disarticulated human remains. On the other hand, this small gap in the field of studying disarticulated remains provides the opportunity for the development of a whole new program that can be used to interpret the disarticulated human remains to infer the provision of care the deceased individual received. Yet, the challenges associated with examining disarticulated human remains to determine a provision of care will be extremely hard to overcome and we may be waiting many years before the technology becomes available for us to do so.

With regards to the future of the research into the bioarchaeology of care. I believe that the metaphorical barrier between archaeology and anthropology is diminishing as it becomes

more common over recent years for archaeological research to encompass anthropological techniques and theories to gain a better insight into archaeological material. As a result,

the role of kinship as one of the determining factors in the provision of care is becoming prominent among the other factors that have been contributed to the provision of care in the Neolithic. Therefore, I believe progress will be made in the development of models that can better explain the social and cognitive processes involved in the caring of sick and injured individuals. Particularly in environments where resources are scarce. Furthermore, in an attempt to answer if caregiving behaviour is an innate response to seeing someone sick or injured, research must be conducted beyond the *Homo sapiens* lineage and determine at which point in hominin evolution did individuals begin to provide health-related care to each other. Once that point has been determined, research can be conducted into what environmental factors instigated this behaviour. This research can include the use of extant non-human primate analogues to produce a model for early hominin behaviour as well as further analysis of the archaeological materials we have at our disposal once we are in possession of the technology that can provide more detailed answers to what we already have.

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