A LIFE COURSE APPROACH TO HEALTH IN THE ANCIENT NILE VALLEY

by

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Dedicated to my family

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ABSTRACT

This dissertation employs a multiscalar, life course approach to examine health in the ancient Nile Valley (*c*. 2000- 660 BCE) by analyzing population- and individual-level data of skeletal indicators of stress, health, and pathological conditions. Specifically, this dissertation explores a more detailed reconstruction of health under a life course approach through the inclusion of individuals of all ages, a contextualization of social and biological age categories, the examination of multiple non-specific indicators of general health/stress, and the timing and development of specific conditions. Results of the population-level data are expanded and highlighted through the examination of individual experiences of health, specifically those related to growing old, impairment, and disability. Population-level data examining cribra orbitalia and LEH demonstrated a significant difference between individuals that survived periods of childhood stress (adults) and non-survivors (juveniles) when examining cribra orbitalia. More specifically, there are relatively high frequencies of cribra orbitalia in individuals in the late juvenile social age category (7 – 14 years) and the transition adult social age category (14 - 20 years). A broad examination of old age at Tombos reveals that many individuals were living into their 60s, 70s, and 80s. Individuals at Tombos do not have many indicators of osteoarthritis or entheseal changes, indicating that the inhabitants of Tombos were not subjected to strenuous physical activities throughout their life. Individuals throughout the Tombos cemetery display oral health issues; it is common for members of this community to have significant dental wear, carious lesions, abscesses, and antemortem tooth loss. A case study of an older Tombos adult (U34.B1) investigates the intersection of old age, impairment, and disability through the consideration of the physical changes related to degenerative joint disease and oral health and the impact to U34.B1's mobility, pain level, and daily life. Acute care related to a severe, non-union femoral neck fracture at the end of life is also considered for U34.B1. Finally, impairment and disability are considered in another individual (U35.Sh2.B10) with Léri-Weill dyschondrosteosis by utilizing the bioarchaeology of care approach. Overall, this dissertation demonstrates that population-level and individual-level analysis can incorporate various types of contextual data gathered using a culturally specific lens to create a rich narrative of health in the past.

CHAPTER 1. INTRODUCTION

The purpose of this dissertation is to use a multiscalar, life course approach to examine health in the ancient Nile Valley. This goal is addressed by examining skeletal indicators of stress, health, and pathological conditions through population- and individual-level analyses. In combination, these two levels of analysis provide greater depth to our understanding of Nile Valley health in the past. Population-level analysis provides a general overview of the health of a community. In this dissertation adults and juveniles are compared using social age categories, as well as traditional osteological analyses. In addition to age, patterns related to geographical location and time period are also examined. The individual-level analyses highlight and expand on the population-level results and provide a more intimate narrative of the experience of health in the past. Chapter 1 provides an introduction into the archaeological context of the region. Additionally, Chapter 1 includes an overview of the examination of health in bioarchaeology and the theoretical orientations employed throughout this dissertation, including the life course approach, age identity, impairment, and disability.

1.1 Nile Valley Chronology

The ancient chronology of the Nile Valley is divided into a number of separate chronologies based on region. Table 1 provides a general summary of Egyptian and Nubian chronologies. There is debate among scholars regarding the exact dates of different time periods and the provided dates are all approximates. Ancient Egypt and Nubia had a long-term, dynamic relationship spanning several thousands of years. The complex relationship between these two neighboring groups greatly impacted the movement of resources, goods, and technology (Edwards, 2004), as well as

culture, food, religion, and funerary practices (Buzon and Smith, 2017; Smith, 1995; 2003a; 2003b).

Table 1. General summary of Egyptian and Nubian chronologies. Modified from Hawass (2012). Note that all dates are approximate.

Approximate Dates	**Egypt**	**Lower Nubia**	**Upper Nubia**
Before 3050 BCE	Predynastic Period	Classic A-Group Terminal A-Group	Pre-Kerma
3050-2685 BCE	Archaic Period		
2685- 2150 BCE	Old Kingdom Period	C-Group Ia, Ib	Early Kerma
2150- 2008 BCE	First Intermediate Period		
2008-1685 BCE	Middle Kingdom Period	C-Group IIa, IIb	Middle Kerma
1685-1550 BCE	Second Intermediate Period	C-Group III	Classic Kerma
1550-1077 BCE	New Kingdom Period		
1076-723 BCE	Third Intermediate Period	Independent Nubian cultures	Independent Nubian cultures
722-332 BCE	Late Period	Napatan	Napatan
332-30 BCE	Ptolemaic Period	Meroitic	Meroitic
30 BCE- 641 CE	Roman Period	Meroitic Post Meroitic	Meroitic Post Meroitic

The Bronze Age in Lower Nubia was divided by George Reisner into three phases known as the A-Group, B-Group, and C-Group, although modern scholars do not acknowledge the existence of a B-Group culture (now considered part of A-Group). The Bronze Age in Upper Nubia is divided into the Pre-Kerma, Early Kerma (Kerma Ancien), Middle Kerma (Kerma Moyen), and Classic Kerma (Kerma Classique). The A-Group (*c*. 3700-2800 BCE) culture were hunters, gathers,

and fishers. In addition, the A-Group subsisted on cultivated plants including barley, wheat, and lentils, as well as domesticated animals including goats, sheep, and cattle (Fisher, 2012; O'Connor, 1993). There are Egyptian artifacts found in A-Group funerary contexts, which indicate that the A-Group traded with Egypt. Increasing complexity is noted throughout the A-Group, suggesting a more centralized society (Fisher, 2012; O'Connor, 1993). The A-Group begins to disappear around the time of Egyptian unification. The Pre-Kerma culture (*c*. 3000-2500 BCE) was first identified on the periphery of the site of Kerma by Charles Bonnet, although evidence of the Pre-Kerma culture is found throughout Upper Nubia (Fisher, 2012). There is evidence of settlements, including round houses, hearths, storage pits for food, and cattle pens. The Pre-Kerma graves suggest that there was a hierarchical social structure. The Pre-Kerma culture appears to have developed into the Old Kerma culture. Unlike the A-Group, there is little evidence that the Pre-Kermans were directly interacting with Egypt (Fisher, 2012).

The Egyptian Old Kingdom period (*c*. 2685-2150 BCE) is the beginning of the pharaonic culture and is often considered the pinnacle of prosperity under a unified Egypt. In Lower Nubia, the C-Group appears around 2300 BCE including at many sites occupied by the A-Group. However, scholars debate whether there is a biological continuity between the A-Group and the C-Group cultures (Buzon, 2011; Irish, 2005; Prowse and Lovell, 1995). The C-Group can be divided into three phases with increasing complexity noted in ceramics and settlement archaeology. The C-Group culture is associated with sheep, goats, oxen, and other pastoral animals; ox skulls and leather artifacts are found in cemeteries and stelae, rock art, and pottery include animal iconography (Fisher, 2012). Interactions between Egypt and Nubia were initially relatively peaceful and consisted mainly of trade. However, beginning in the Middle Kingdom Period (*c*. 2040-1650 BCE), this peaceful relationship became increasingly militaristic and violent. During

this period, Egypt began imperialistic expansions into Lower Nubia, culminating in the construction of a series of fortresses at the second cataract (Smith, 2003b).

The Kerma culture is divided between three phases (sometimes four, when the Pre-Kerma culture is included): Early Kerma (*c.* 2500-2050 BCE), Middle Kerma (*c*. 2050-1650 BCE), and Classic Kerma (*c*. 1650-1500 BCE) and is centered around the site of Kerma near the Third Cataract of the Nile River. Kerma was a significant rival to the Egyptian state and had centralized power, economic prosperity, and extensive trade (Fisher, 2012). The First Intermediate Period (*c*. 2150 – 2008 BCE) in Egypt is characterized by the increased regional power of nomarchs and decentralization (Fisher, 2012). While Nubia was unified under the Kerma State, Egypt was disassembled with northern Egypt controlled by Syro-Palestinian Hyksos (Smith, 2003b).

After the reunification of Egypt during the New Kingdom Period, Egypt engaged in several military campaigns to conquer Nubia up to the Fourth Cataract (Morkot, 2001; O'Conner, 1993; Smith, 2003b). One of the most important goals of Egyptian imperial expansions was access to goods and resources. A valued and highly desired material was gold and Nubian gold was an important component of the annual tribute to Egypt (Smith, 1995). Scholars debate the impact the demand for tribute and manufactured goods would have had on the native Nubians. Some suggest that the Egyptian expansion would have resulted in negative outcomes, including harsh manual labor and impoverishment (Trigger, 1976). However, others suggest more positive interactions or little impact on daily life (O'Conner, 1993; Morkot, 2001). Monuments describe overt rebellion by the Nubians to overthrow the Egyptian colonial regime. However, these instances were unsuccessful, in part due to the close geographic proximity of these two societies. A small contingent of Egyptians could attack or respond to Nubian rebellion quite quickly and a larger Egyptian military force could arrive in the Nubian center within a month (Smith, 2013).

Egyptologists have assumed that Nubians assimilated to Egyptian cultural norms in the face of Egyptian dominance, an assertion made in reference to archaeological evidence of assimilative acculturation in northern Nubia. However, the reality is more complex. During the first year of occupation, Nubian culture starts to disappear as a result of Egyptian policy of assimilation (Smith, 2013). Smith (1998; 2013) proposes that the pattern of 'Egyptianization' of burials throughout the colonial New Kingdom Period indicates assimilation was top-down, beginning with the wealthy and the elite. The general lack of specialized grave goods in the New Kingdom Period has led some to argue that the 'Egyptianization' of burials was superficial. However, Smith (2013) argues that this pattern is more reflective of social status than cultural affinity, as these types of specialized grave goods were quite expensive and outside the means of most individuals at the time. Furthermore, there is no archaeological evidence for the widespread adoption of Egyptian-style cultural practices in the Nubian heartland and at some sites there is evidence that Nubian cultural practices were continued long after the Egyptian conquest. Evidence from the sites of Askut and Tombos also suggests women were an integral part of maintaining elements of Nubian culture during these periods (Smith, 2013). Nubians co-opted and reinterpreted Egyptian elite ideology in order to gain power. Furthermore, Nubians were particular in their adoption of Egyptian practices. Specific deities were chosen because of their connection to Nubia and parallel religious ideas. For example, Amun-Re was syncretized with the Nubian god Amani (Smith, 2013).

The Third Intermediate Period (*c*. 1069- 664 BCE) is marked by Egyptian political fragmentation and destabilization; however, relatively little is known about this period (Fisher, 2012). The Kushite rule during the 25th Dynasty (*c*. 760 – 656 BCE) is characterized by the 'restoration' of ancient Egyptian culture by the pharaohs, which included Kashta, Shabaka, and Taharqo. Egyptian style art, clothing, architecture, and other cultural elements were integrated with

Nubian styles. The Kushites continued to prosper in Nubia and several important cities, such as Napata, el Kurru, and Kawa emerged, while Meroë became the seat of centralized power throughout the succeeding Meroitic Period. In Egypt, Assyrian rule marked the beginning of the Late Period (*c*. 664 – 332 BCE; Fisher, 2012).

1.2 General Aspects of Health in Bioarchaeology

The discussion of stress in bioarchaeology is often couched within a larger discussion regarding health and nutrition. Stress and health are inextricably linked in bioarchaeological literature and frequently stress and disease are investigated in order to understand past health. A life course approach to health benefits from cross-disciplinary perspectives regarding human variation and disease. Definitions of what health is (thereby allowing researchers to identify those that are "healthy" and those that are "unhealthy") are difficult when dealing with contemporary individuals and populations. Determining an individual's or population's health in the archaeological record can be even more problematic. The World Health Organization (WHO) defines health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (WHO, 2003), and has continued to use this definition for almost 70 years. Use of this definition has obvious issues when applied to individuals in the archaeological record, where the ability to assess an individual's mental and social well-being is difficult, if not impossible, in most cases. Unfortunately, the individuals bioarchaeologists study are dead, meaning it is often impossible to gauge whether an individual is in a state of mental and social well-being. DeWitte and Stojanowski argue that the only unambiguous assessment bioarchaeologists can make about the individuals they study is "that they are all, at the time of observation, in very poor health, as death is the ultimate state of poor health" (2015:3).

1.2.1 Background on Stress and Health in Bioarchaeology

Temple and Goodman (2014) provide a summary of the term and concept of stress and how it has been used in bioarchaeological literature over the last several decades. The concept of stress was much more restricted in the 1950s and 1960s and was mainly used in relation to mechanics and physics. The authors cite the experimental work by Selye (1936; 1956) as a major driving force in the changing perceptions of the notions of stress, coping, and maladaptation by showing the diversity of intrinsic and extrinsic stressors. The "Selyean" concept of stress is primarily focused on the physiological mechanisms of a stress response, where stress is an individual's response to the demands of the environment (Weston, 2012). In the 1970s, the idea of general stress became more prominent in biological anthropology and focused on stress in relation to adaptive mechanisms and as a response to the "perceived over-emphasis on the possibilities of positive and often no-cost adaptation" (Temple and Goodman, 2014:186). The term 'stress' became part of the field's jargon and an early definition of stress by Armelagos saw it as an "index of biological response" (1969:225).

After this move from the Selyean stress concept, bioarchaeologists begin to focus more on Goodman's ecological model of general stress (Goodman et al., 1984) and the idea of a "stress indicator" upon which much of the future research on stress was based (Weston, 2012). The stress model was developed by Goodman et al. (1984) and further modified by Goodman and Armelagos (1989). It was developed to examine the broader effects of disease and death and to consider the potential insults that may impact individuals (Goodman and Martin, 2002). The model considers the impact of the environment as both a resource (e.g. providing food and water) and as a stressor (e.g. extreme weather). Culture can act as a buffer from stressors (e.g. clothing and shelter) and can also generate significant stressors (availability of resources) (Goodman and Martin, 2002). The model also includes intrinsic factors such as an individual's immune system response.

Individual biological stress impacts the stress on a population, through decreased health, decreased work capacity, decreased reproductive capacity, and social-cultural disruption (Goodman and Martin, 2002). The stress indicator hypothesis uses the concept of stress and the General Adaptation Syndrome (GAS). GAS is manifested physiologically through hormonal responses, originally thought to be related to the increased secretion of adrenocorticotrophic hormone. However, additional research has shown the physiological stress response to be more closely related to the pituitary-adrenal cortical system and the sympathetic-adrenal medullary system (Weston, 2012). This neuroendocrine activity results in the release of growth-inhibiting catabolic hormones (Weston, 2012). Some researchers argue GAS does not describe the body's response to stress sufficiently because it ignores the effect of psychological stress (Armelagos and Goodman, 1991).

While the skeletal stress indicator hypothesis is several decades old, it is still utilized as a framework for the investigation of stress and health in human skeletal remains in more recent studies (e.g. Bennike et al., 2005). However, several authors critique the use of this model because it does not interpret skeletal stress markers in a straightforward manner (Jankauskas and Česnys, 1992) and because it does not create a foundation from which to build biocultural interpretations (Bush, 1991). Weston critiques the incorporation of periostitis into stress models in general and argues "the interpretation of proliferative periosteal reactions as a stress indicator is inherently flawed… stress results in the stimulation of glucocorticoid secretion, which in turn inhibits bone formation, and therefore inhibits periosteal new bone production" (2012:506).

Stress is used to assess several theories and hypotheses including the Barker Hypothesis. The premise of the Barker Hypothesis is simple: stressful events early in life will have negative health consequences in adulthood. Originally concerned with the fetal phase of development, the

Barker Hypothesis was also described as the "fetal programming" or "fetal origins" hypothesis (Armelagos et al., 2009). Research indicating that postnatal stress has consequences in adult health led to the characterization of the Barker Hypothesis as the Developmental Origins of Health and Disease Hypothesis (DOHaD) (Armelagos et al., 2009). Research over the last decade continued to investigate the role of epigenetic effects in producing phenotypic variation through the DOHaD, which builds upon the earlier Barker hypothesis (Barker et al., 2002; Gowland, 2015) and was explicitly utilized by some bioarchaeologists (e.g. Amoroso et al., 2014; Armelagos et al., 2009; Gowland, 2015; Temple, 2014).

1.2.2 Interpreting Stress in the Skeleton

The Osteological Paradox: Problems of Inferring Prehistoric Health from Skeletal Samples was published by Wood and colleagues in 1992 and details issues in paleopathological and paleodemographic research. Since its release, Wood and colleagues (1992) has been an integral aspect of the study and interpretation of health research in bioarchaeology. Wood and colleagues (1992) identify and describes three "conceptual issues"- demographic nonstationarity, selective mortality, and hidden heterogeneity in risks, which the authors felt could "render inferences based on various demographic and epidemiological measures meaningless" (344).

Demographic nonstationarity

Demographic nonstationarity refers to a population that is not closed to migration, does not maintain constant age-specific mortality and fertility, experiences zero growth rate, and does not have equilibrium in the age distribution. Demographic nonstationarity has significant consequences for paleodemographic studies. Underlying assumptions of stationary populations permitted the creation of life tables based on the estimated age-at-death distribution in a skeletal

sample (DeWitte and Stojanowski, 2015). Nonstationary populations will experience large effects on age-at-death distributions due to even small shifts in fertility and at the same time large shifts in mortality will exact virtually no effect on age-at-death distributions (Wood et al., 1992). Demographic estimates, such as life expectancy, based on age-at-death distributions may not be accurate if a population is not stationary (DeWitte and Stojanowski, 2015). Wood and colleagues (1992) were not the first to identify or discuss methodological issues related to age-at-death distributions (e.g. Bocquet-Appel and Masset, 1982; Sattenspiel and Harpending, 1983; Van Gerven and Armelagos, 1983), nor were they the last (e.g. White, 2014).

Selective mortality

The issue of selective mortality described by Wood and colleagues (1992) is simple and straightforward: samples used in bioarchaeological research are dead, meaning they do not represent all of the individuals at risk of death or disease at a particular age. Instead, bioarchaeological samples include only those that died at each given age. Wood and colleagues (1992) note that this differs from issues related to an unrepresentative sample, which might result from poor preservation, excavation techniques, or differential burial practices and is an issue in all collections that are not exact random samples of all individuals that died. The inherent nature of skeletal collections, the dead, is highly selective for lesions that increase the risk of death at a given age and can lead to selectivity bias in the estimates of population prevalence rates. In their review of the osteological paradox, DeWitte and Stojanowski (2015) emphasize that the frequencies of skeletal markers cannot be used to estimate the prevalence of disease in a living population because it would tend to produce overestimations of these conditions. Overestimates result from selective mortality acting on heterogeneous frailty, such that high frailty individuals are more likely to die at a given age, be selected out of the population, and become a part of the skeletal sample.

Hidden heterogeneity in risks

Populations are comprised of a multitude of individuals with varying frailty, or susceptibility to disease and death, in an unknown proportion (Wood et al., 1992). The causes of frailty are diverse and include intrinsic factors (e.g. biological and genetic differences, nutritional status) and extrinsic factors (e.g. behavioral and cultural factors, environmental conditions, temporal changes) (Wood et al., 1992; DeWitte and Stojanowski, 2015). The issues described in relation to the osteological paradox have significant impacts on the interpretation of skeletal stress markers.

Selective mortality and heterogeneous frailty in bioarchaeological research require researchers to exercise caution when measuring and interpreting stress (i.e. skeletal lesions or skeletal manifestations of physiological stress). There is no one to one correlation between stress markers and poor health. This is further complicated given the difficulty in defining health. The presence of skeletal stress markers on an individual might indicate the individual was rather healthy because the development of stress markers on the skeleton requires time and thus their presence indicates the individual was healthy enough to survive the sources of the stress markers (trauma, malnutrition, disease) long enough for the markers to form (Wood et al., 1992). Conversely, an individual without any skeletal stress markers might represent a high health individual, free from stress, trauma, disease, etc. or an individual lacking skeletal markers of stress might represent an individual with rather poor health who was unable to survive long enough to develop the skeletal lesion (Wood et al., 1992).

Several issues related to representativeness and bias in archaeological samples exist and impact a bioarchaeologist's ability to make conclusions about the past, both inside and outside of stress and health studies. Researchers are unable to sample skeletal remains; in fact, the sample and the population tend to be the same (Jackes, 2011). Age-at-death distributions are biased

because the probability of dying is not uniform across factors like age and sex. The probability of dying is tied to a number of elements including onset of disease, cultural factors related to conflict, reproductive hazards in females, and degenerative disease, except in extraordinary circumstances such as massacres and catastrophes (Jackes, 2011). Although, evidence suggests that even skeletal samples created as a result of catastrophes may not provide unbiased samples, as age, sex, and health condition can impact susceptibility to disease, conflict, etc. (Milner et al., 1991; DeWitte and Wood, 2008; DeWitte and Stojanowski, 2015).

1.3 Theoretical Framework: Life Course Approach

Foundational to life course approaches is the study of individual lives within their historical and socioeconomic contexts. Life course approaches are "approaches that view the individual at any point in time as the sum of previous life experiences. These include both social and biological experiences, and the individual plastic response to exposures can be viewed as adaptive or not and can be thought of as intergenerational or only affecting the phenotypic expression in the individual" (Agarwal, 2016:S131). Evidence demonstrates that there is an increase in the risk of a number of diseases due to early life factors (Ben-Shlomo and Kuh, 2002; Trostle, 2005). This phenomenon, and aspects of this phenomenon, has been referred to under a number of terms including the "DOHaD", the "Barker Hypothesis", "fetal programming", "fetal origins", among others (Armelagos et al., 2009). Important in these models is the idea of "programming," where these effects happen early in development and become innate in an individual's biology. In other words, the biological system is modified in such a way that it responds differently to subsequent exposures (Hall et al., 2002).

The human body is plastic and the ways in which the body develops are related to the individual's environment, including the actions of others and self (Sofaer, 2006a). Life course

approaches emphasize the biological, social, and psychosocial pathways that operate throughout the life course and between generations, especially in examining the development and manifestations of disease risk (Agarwal and Beauchesne, 2011). Agarwal and Beauchesne (2011) emphasize the need to consider bone plasticity and maintenance at multiple scales by analyzing multiple locations on the skeleton, using multiple methodologies, and considering multiple stages of the life course. Life course approaches align well with other theoretical frameworks used in bioarchaeology, such as embodiment, where the body is conceptualized as a product of both biological and social developmental contexts (e.g. Sofaer, 2006b).

1.3.1 Age Identity, Impairment, and Disability

Age is an integral aspect of social identity and societal organization and is often intertwined with other aspects of social identity including ethnicity, status, sex and gender (Lucy, 2005; Sofaer, 2011). However, within archaeology, cultural experiences of age traditionally were treated uniformly across societies. Age identity remained largely undertheorized in archaeology partly because biological, cultural, and chronological concepts of age are intertwined and difficult to detangle (Gowland, 2006). Despite these challenges, discourse about the study of age as an aspect of social identity within archaeology has increased over the last few decades (Gilchrist, 2000; Lucy, 2005; Sofaer, 2006a). Age can be divided into three interrelated components: physiological/biological age, chronological age, and social age. Physiological/biological age refers to the physical aging of the body through growth, maturity, and senescence. Chronological age refers to the amount of time since birth, usually in months or years. Finally, social age refers to the age-appropriate attitudes and behaviors as constructed culturally (Sofaer, 2011). The life course, and how it is staged, varies cross-culturally.

An issue in age studies in bioarchaeology is that aging is a culture-specific process and not a series of distinct age categories that "say little about the history of the individual and which implicitly separate off different phases of the life course through the labeling of categories such as infant, juvenile, adult, and old age" (Sofaer, 2011:290). Bioarchaeologists use changes in the skeleton during growth and senescence (physiological age) to give estimations of chronological age and these estimations, in turn, are used to create "real" social age categories (Sofaer, 2011).

Within bioarchaeology consideration of the body as a biohistorical phenomenon within the broader social context aids the understanding of age in the past and allows for analysis of diet, health, and activity-related skeletal modifications (Sofaer, 2011). The life course perspective connects the events throughout an individual's lifetime and places these events within a historical context (Prowse, 2011). A life course approach considers the impact of individual agency, in such that life stages and the timing of these life stages can be blurred, deconstructed, and reconstructed through individual choice (Sofaer, 2011). Bioarchaeological studies of age and aging need to consider biology and social/cultural experiences and perspectives within an understanding of human development (Sofaer, 2011). There are limitations in osteological methods in aging human skeletons. Halcrow and Tayles (2008) suggest researchers overcome the difficulties of comparing across cultures and between researchers when social age categories are used by presenting data both within age categories traditionally used in bioarchaeological research as well as those created through an analysis of social age categories.

Bioarchaeological research can utilize a life course approach through multiple scales of analysis. This can be achieved by examining remodeling and modeling on different skeletal elements and by using multiple complementary methods. Use of multiples scales promotes research focused on individual life histories, as well as population-level analysis (Agarwal, 2016).

Most bioarchaeological studies emphasized examination at the population-level. However, others construct osteobiographies to reconstruct individual life histories (e.g. Stodder and Palkovich, 2012). Data from individual-level analysis helps to provide an understanding of population-level variation and the development of larger biosocial questions regarding the community. Agarwal argues "analysis at the individual level is critical if we are to understand fully the range of plasticity of the skeleton over the life course. Analyses of individuals allow the detailed and nuanced exploration of morphology that does not always fall within the normal distribution of the larger community" (2016:138). Larger anthropological questions can be addressed when individual-level analyses are conducted and the use of multiscalar analyses incorporating a comparative approach with both individual and population analyses is of key importance (Agarwal, 2016).

Disability and impairment are not new concepts in archaeology and bioarchaeology. For several decades, researchers have considered these aspects of identity in past peoples (e.g. Dettwyler, 1991; Hawkey, 1998). Impairment and disability are an integral aspect of health over the life course and a revival of interest in impairment and disability in bioarchaeology links bioarchaeological methods with disability theory and provides outlines for modeling impairment (e.g. Hawkey, 1998; Tilley, 2015). Zakrzewski (2014:162) argues that disability is "an age-related and universal phenomenon" and "permits being "disabled" to be viewed as simply a point upon a continuum of ability rather than as a binary opposition to able-bodied". Bioarchaeological studies of disability and impairment are uniquely positioned to access social and clinical aspects of disability while approaching the interaction between multiple threads of identity.

The life course approach emphasizes the distinctiveness of individual biographies and the diversity of life patterns (Alwin et al., 2006). Utilizing the life course approach in studies of age and disability identity better represents the dynamic quality of temporal shits in health, especially

regarding other aspects of social identity (Gilchrist, 2004; Gowland, 2006). Mortuary patterns reflect conceptions of identity and societal perceptions of groups, such as constructions of personhood and adulthood (Gilchrist, 2004). Meskell's (2002) investigation into understanding daily life in the New Kingdom settlement of Deir el-Medina is an example of how the use of a life course approach in archaeology can result in a rich understanding of a population's culture, especially with the incorporation of documentary, textual, and iconographic resources. Archaeological data illuminate individuals sometimes excluded from the documentary record, for example, women, children, the differently-abled, and foreigners (Meskell, 2002). Incorporating multiple source types including, biological, archaeological, documentary, artistic, and textural, allows researchers to draw upon several lines of evidence to arrive at more inclusive and representative interpretations.

1.4 The Present Research

The present project aims to investigate health over the life course in the ancient Nile Valley by examining both population and individual-level data. My goal is to integrate concepts of social age, impairment, and disability with bioarchaeological methods for examining non-specific stress, health, and pathological conditions in the past. This study analyzes excavated material from the site of Tombos and curated material from the Panum Institute in Copenhagen, Denmark. These data are combined with published data from the sites of Tell el-Amarna (Dabbs and Zabecki, 2014; Dabbs et al., 2015; Kemp et al., 2013; Shinder, 2018), Tombos (Buzon, 2006; 2014; Buzon and Bombak, 2010; Schrader, 2012; Schrader and Buzon, 2017), and Al-Widay I (Ingvoldstad, 2009). These sites are located in Nubia and date to periods before, during, and after Egypt's colonization of Nubia during the New Kingdom Period. Specifically, this project incorporates data from

individuals of all ages from the very young to the very old to create a more detailed understanding of health in the past.

1.4.1 Structure of the Dissertation

This dissertation is organized into five chapters. Chapter 1 provides information on a basic chronology of the region. The theoretical orientations applied in this dissertation and the basis for the bioarchaeological methods employed throughout the project are also introduced in Chapter 1. Chapters 2, 3, and 4 are formatted into separate articles and are intended to be read independently of one another. Chapter 2 examines health from skeletal indicators of non-specific stress and infection at the population level. Survivors and non-survivors of childhood stress are compared and juveniles and adults from several Nile Valley collections from diverse periods and regions are compared. Chapter 3 explores old age at the site of Tombos. Chapter 3 utilizes population-level demographic and health data (oral health, osteoarthritis and entheseal changes) in the broader Tombos community. These results are highlighted by a case study that analyzes a Tombos individual in relation to ideas of impairment and disability in old age. Chapter 4 also examines health at the individual level. Chapter 4 uses the bioarchaeology of care model to examine an individual with skeletal dysplasia, specifically Léri-Weill dyschondrosteosis, from an impairment and disability perspective. Chapter 5 concludes the dissertation by providing overarching conclusions from the proceeding chapters.

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CHAPTER 2. HEALTH OVER THE LIFE COURSE DURING THE TRANSITION TO THE NEW KINGDOM PERIOD IN THE ANCIENT NILE VALLEY

A core component of exploring life in the past is the investigation of health. A number of theoretical and methodological orientations are available to bioarchaeologists for such studies. Health data can provide insight into life in the past by comparing groups and examining patterns within populations. This project utilizes a life course perspective to compare differences in non-specific indicators of childhood stress and infection to examine differences between sex, age, social age, time period, and region. Specifically, cribra orbitalia, porotic hyperostosis, linear enamel hypoplasia, and osteoperiostitis are considered from five collections (Al-Widay I, South Tombs Cemetery at Tell el-Amarna, SJE C-Group, SJE Pharaonic, and Tombos) that span from the C-Group through the New Kingdom Periods (*c*. 2000- 1050 BCE).

2.1 Life Course Approach

Bioarchaeological research investigates variation within human populations, as well as at the level of the individual. Studies employing a life course framework are more widely found in fields such as sociology and epidemiology (Ben-Shlomo et al., 2014; Mayer, 2009), but have more recently appeared in bioarchaeological studies. Bioarchaeological studies employing a life course approach have made significant contributions in how researchers consider postnatal plasticity by expanding and building upon biocultural concepts (Agarwal, 2016). Life course approaches in bioarchaeology are used to address many different types of research questions. However, all of these approaches are unified in their perspective that human life is the result of "interrelated and cumulative events over not only the timeframe of the individuals but also over generations at the community level" (Agarwal, 2016:S130).

The foundation of life course approaches is the study of individual lives within historical and socioeconomic contexts. Life course approaches view individuals as a compilation of previous social and biological experiences. The individual's plasticity can be considered adaptive or not and as reflecting an individual's phenotypic expression or intergenerational impacts (Agarwal, 2016). Modern health studies employing a life course framework focus on the role of physical and social exposures, primarily during specific timeframes, such as gestation, childhood, adolescence, and young adulthood and the impact of these on later adult health (Agarwal, 2016). Evidence demonstrates that there is an increase in the risk of several diseases due to early life factors (Ben-Shlomo and Kuh, 2002; Trostle, 2005). This phenomenon, and aspects of this phenomenon, has been referred to under a number of terms including "Developmental Origins of Health and Disease Hypothesis (DOHaD)," the "Barker Hypothesis," "fetal programming," and "fetal origins," among others (Armelagos et al., 2009). The core of these paradigms is simple; stressful events early in life, including postnatal events, will have negative health consequences in adulthood (Armelagos et al., 2009).

Studies that investigated the impact of fetal and childhood environment on later adult health have been particularly influential. The Barker Hypothesis posits that many chronic diseases are established by "programming" during development *in utero* and influenced by nutritional factors during pregnancy and during the mother's childhood and adolescent development (Ben-Shlomo et al., 2014). Similarly, the fetal origins hypothesis argues that "environmental exposures such as undernutrition during critical periods of growth and development *in utero* may have long term effects on adult chronic disease by "programming" the structure or function of organs, tissues, or body systems" (Kuh et al., 2003:778). What is apparent in both models is the idea of "programming," where these effects happen early in development and become innate in an

individual's biology. In other words, the biological system is modified in such a way that it responds differently to subsequent exposures (Hall et al., 2002). These models also emphasize factors that take place during early stages of development, giving less weight to postnatal changes. This sentiment is also found in anthropological realms where studies emphasizing postnatal plasticity in bone morphology are perceived as less important (Lovejoy et al., 2003).

Two key concepts in life course approaches are trajectories and plasticity. Growth and development are viewed as following an arc of trajectory and this trajectory can change direction during the life course. A broad range of influences can alter development over this trajectory and results in varied outcomes (Agarwal, 2016). Plasticity is the "potential for change in intrinsic characteristic in response to environmental stimuli" (Kuh et al., 2003:780) and is conceptually linked to the idea of adaptation (Agarwal, 2016). The consideration of plasticity in a developmental sense gave rise to the developmental systems theory or approach (DST/DSA), which unlike epidemiological approaches, extends plasticity to include infancy, childhood, and adolescence rather than solely fetal development or early infancy. Under this model, developmental influences come from both intrinsic and extrinsic influences, including molecular, cellular, organismal, social, ecological, and biogeographical factors (Agarwal, 2016; Fausto-Sterling, 2005; Lewontin, 2001; Robert et al., 2001). These models align well with other theoretical frameworks used in bioarchaeology, such as embodiment, where the body is conceptualized as a product of both biological and social developmental contexts (e.g. Sofaer, 2006), although they are not widely applied to skeletal data (Agarwal, 2012). However, life course approaches have been used to examine intersecting aspects of identity, such as those that consider gender and aging (Gowland, 2006), aging and senescence (Appleby, 2010; Gowland, 2007), and childhood (Blom and Knudson, 2014; Perry, 2006; Redfern and Gowland, 2012), by emphasizing the importance of the social life

on the skeleton. Sofaer (2006) suggests perceiving the skeleton as material culture in order to blur the division between the biological and social body. Integration of social theory into the study of the skeleton with skeletal indicators of stress enable scholars to recognize the skeleton as a product of lived experience (Agarwal, 2016).

2.1.1 Life Course Approaches in Bioarchaeology: Health and Age

The implementation of a life course approach to the study of social age provides a more accurate representation of the fluid nature of age-related shifts in identity, specifically regarding aspects of health (Gowland, 2006). Individual and community health are fundamental factors in survival and well-being in modern human populations and in the past. In cultural, medical, and biological related fields of the social sciences, researchers are discovering the importance of changes in health over the life course (Becker, 1997; Ben-Shlomo et al., 2014; Gowland, 2015; Hall et al., 2002; Kuh and Ben-Shlomo, 1997; Mayer, 2009; Trostle, 2005; Umberson et al., 2010). Bioanthropological studies incorporate the life course perspective due to its usefulness in examining early life stress and later life morbidity and mortality and bioarchaeological research utilizes a similar model to explore the relationship of malnutrition and later health (Gowland, 2015). The life course approach can enable researchers to identify specific growth disruption patterns and correlate these data to life course social age constructions (Newman and Gowland, 2015). Skeletal lesions in neonates and infants can be used as proxies for past maternal health and to study intergenerational effects (Gowland, 2015). A number of projects integrate social age categories into the analysis of skeletal remains in order to study individuals from both the biological and social perspectives, including developmental age, skeletal indicators of nutritional deficiency and infectious disease, funerary context, material culture, and historical documentation (e.g. Gowland, 2006; Halcrow and Tayles, 2008; Perry, 2006; Wheeler et al., 2013).

Numerous anthropological studies have long utilized a life course approach to answer questions related to health. Anthropologists have examined the impact of childhood stresses, such as malnutrition, psychological stress, infection, and so on, on the slowing or stunting of growth by examining stature (Agarwal, 2016). In 1912, Boas examined changes in stature in migrant children, providing evidence of environmental and social intergenerational impacts on body size. Stature is just one indicator of nonspecific stress and a whole multitude of indicators, reflecting physiological disruptions, can be used by bioarchaeologists to examine health over the life course (Larsen, 2015). By using multiple indicators of stress, researchers can examine stress and health longitudinally at different points along the life course (Agarwal, 2016). For example, linear enamel hypoplasia on the anterior teeth reflects development between one and six years of age (Watts, 2013). Observation of cribra orbitalia on adult frontal bones likely reflects stress before four years of age, and *in utero* through late adolescence/early adulthood growth is reflected in long bone lengths (Watts, 2013).

Examination of skeletal indicators of health and stress in adults and juveniles allows researchers to have a better understanding of health in a community. Investigation of both adults and juveniles is key in approaching health in a holistic and complete way. Skeletal indicators of stress and health observed in juveniles reflects the health of the children that died (non-survivors), while skeletal indicators of stress and health in adults provides insight into the life experiences of survivors of childhood stress and illnesses. To have a full understanding of nutritional deficiencies and infectious disease in past populations it is essential to examine individuals along the entire life course.

2.2 Social Age Categories and Ancient Egypt

Social age provides a more nuanced understanding of life in the past by providing finer detail in age group comparisons. Social age categories are a powerful methodology for understanding how individuals were perceived in their community. Mortuary context, including the type of burial, burial location, position and direction of the body, mortuary architecture, and the inclusion of grave goods can all provide indications of how an individual was perceived by their community, including an individual's social age. In addition, historical texts, art, and other documentation can provide insight to perceptions of different age groups. In combination, these data can be used to construct ideas of social age and social age groups that correspond to age-related patterns in mortuary contexts and historical documentation and texts. This approach differs from traditional osteological age categories and methods (e.g. adults are individuals >18 years at death and juveniles are all individuals <18 years at death) by utilizing evidence of social perceptions of age to create age categories, which attempts to identify patterns of age related to social perceptions. For example, Perry (2006) integrated social age categories into bioarchaeological analysis while examining childhood in the Byzantine Near East. In Perry's (2006) study historical records indicated that individuals were considered "adults" when they married, around the age of 13 to 15 years. Perry (2006) found that this age range corresponded to an observed change in health, with a large number of individuals dying during this period with active lesions. Perry (2006) linked the observed physiological stress with the stress associated with self-sufficiency, starting families, and increased labor demands. If these married, independent adult individuals were put in a juvenile age category, as would be the case in traditional osteological analysis, it would have masked the social, cultural, and environmental factors impacting these skeletal indicators of stress frequencies. Examination of different data types can provide evidence of the perception of age in ancient Egypt.

2.2.1 Mortuary Treatment at Tombos

Few data that provide information about how young individuals were treated in burial are available. Meskell's (2002) investigation of daily life in the New Kingdom Period settlement of Deir el-Medina integrates a life course approach with archaeological, textual, and iconographic sources. This study found that in the cemetery at Deir el-Medina, differential funerary treatment of young individuals is reflected in the spatial organization of cemeteries (Meskell, 2002). However, a few preliminary trends have been identified in the mortuary treatment of newly excavated (field seasons 2015-2017) juvenile individuals from Tombos. Overall, younger individuals at Tombos display greater variability in their treatment after death in comparison to adults at Tombos. This suggests that the more standardized mortuary behaviors seen with adults (e.g. Egyptian-style: extended, supine, head to the west) did not extend to the youngest members of the community. At around five years of age the majority of Tombos individuals were found extended, almost exclusively on their back, with arms extended to their side or over their pelvis. There are notable exceptions of these patterns, including adult women buried in a Nubian-style and a 10 to 12-year-old individual buried face down. However, it is likely that this 10 to 12-year-old individual was not necessarily purposefully placed face down; rather, it is possible that the embalmers lost track during postmortem treatment of the body, an occurrence that has been previously documented (Smith, 2003). Ceramic vessels and jewelry are sometimes included with juvenile burials. In contrast, younger individuals, under four or five years of age at death, were placed in a variety of burial positions, including flexed and extended on their backs. These younger individuals are sometimes interred within a basket or coffin and may be placed with items including jewelry. There are a few exceptions to these trends, which may be related to factors other than age. One four- to six- year -old individual (U36.Sh2.B5) was interred flexed, on the left side, inside of a basket and associated with a ceramic vessel. However, this individual was much smaller

than other four- to six-year-old individuals at Tombos as a result of a type of skeletal dysplasia known as Léri-Weill dyschondrosteosis (Whitmore and Buzon, 2019).

2.2.2 Historical and Artistic Documentation

Egyptian historical texts recognize groups of individuals related to age and provide details of different stages of life, including pre-birth and pregnancy, birth, weaning, training for adulthood, which could include formal apprenticeships, schooling, or domestic activities, adulthood, marriage, and old age (Meskell, 2002). Much less is known about non-Egyptian constructions of age identity in Nubia, although excavations at Classic Kerma Period (*c*. 1750-1500 BC) cemetery at Saï Island, Sudan suggest distinct spatial patterns related to age (Murail et al., 2004). Due to the lack of data regarding social age in ancient Nubian communities, the individuals analyzed in this project are all sorted into Egyptian social age categories. Individuals in this study, where possible, were divided into social age categories using historical documentation and archaeological findings that are intended to reflect Egyptian perspectives of age. Other researchers, (e.g. Shidner, 2018) examining ancient Egyptian populations utilize similar social age categories to the ones outlined below.

Fetal

Pregnancy and having children were extremely important in ancient Egypt. The desire for children can be found in textual sources, such as letters, but also in instructional and medical texts, which often emphasize the importance of successors and progeny (Harrington, 2005). Several medical papyri focus on gynecological and pregnancy issues (Hawass, 2000). Gynecological texts in the Kahun, Berlin 199, Ebers, and Carlsberg papyri include suggestions for determining if a woman is pregnant, as well as determining the sex of the baby (Graves-Brown, 2010). It was

suggested that individuals marry young in order to conceive children while young. Ability to conceive and bear children was extremely important, and pleas were made to deities associated with fertility and childbirth, such as Bes, Taweret, and Hathor. In addition, spells, amulets, and herbal concoctions were used in the hopes of increasing fertility. Adoption seems to be an option if a couple was unable to have children themselves; such cases are known from records at Deir el-Medina (Hawass, 2000). Medical papyri have little to say about the event of birth itself and only a few depictions show labor. However, Isis and her child Horus were often evoked for a safe and quick delivery. Hathor, Bes, and Taweret were also associated with the mother during labor, with Taweret being the protector of pregnant women (Hawass, 2000). Texts from Deir el-Medina also indicate that parents purchased birth amulets. While the exact form of these amulets is unknown, it is possible that they may have been amulets of Taweret which are found in archaeological contexts, who is often depicted as pregnant, carrying a knife, and barring her teeth (Graves-Brown, 2010). Given the importance of children in ancient Egyptian culture, the birth of a child would have been an important life marker. After giving birth, mothers underwent a period of rest and purification to ensure the safety of both mother and child. In fact, there were special areas put aside for these periods of rest (Graves-Brown, 2010). Birth was an important marker of an individual's life and as such, the first age category is termed fetal and includes all remains with an estimated age before birth.

Infancy- birth to one year

The first year of life is perilous and physiologically a time of immense growth for an individual. An infant develops important motor skills and cognitive growth during this period. During much, or all of the infancy, an infant is reliant on breastmilk. In ancient Egypt, infancy was seen as a particularly precarious time and there were several folk ideas about the child's ability to

live. The Ebers Papyrus shows that Egyptians viewed the first years of life as dangerous and employed material culture (e.g. amulets) to protect children (Meskell, 2002). These items often invoke the deities of Bes, Taweret, and Hathor, in order to protect children (Meskell, 2002). The Ebers Papyrus contains instructions for a test to determine whether a newborn or child is going to die on a given day (Graves-Brown, 2010). Spells associated with helping a newborn live might have included aspects of material culture. One such spell involved the use of 41 beads, one of gold, which would then be placed around the child's neck (Hawass, 2000; Meskell, 2002). Tomb scenes from Amarna show that the death of child elicited grief and mourning (Graves-Brown, 2010). In the cemetery at Deir el-Medina, differential funerary treatment of young individuals is reflected in the spatial organization of cemeteries. However, the burial of individuals and similarities in grave goods for all ages indicates even very young individuals were considered full persons (Meskell, 2002).

Young child- one to three years

One to three years are an important period in an individual's life, where individuals develop additional motor skills and cognitive abilities, including language. In most populations, it is during this period that weaning takes place and as such, breastmilk and supplementary foods are important during this period. Children in ancient Egypt would have stayed close to their mother for the first few years of life. In addition, medical papyri discuss the importance of breastfeeding, which was also known to delay timing between births. The *Instruction of Ani* suggests that breastfeeding lasted the first three years of life (Janssen and Janssen, 2007). The *Inscription of Beknekhonsu* is an autobiographical account of the one of Ramesses II's officials, Beknekhonsu. This account provides information on different stages of life that demonstrate similarities to the social age categories described here. For example, one to four years of age are described as "extreme

childhood" (Breasted, 1906:236), which is similar to the young child social age category (one to three years) used here.

Early juvenile-three to seven years

Physiologically, the early juvenile period is marked by continued growth, especially around years six or seven when many individuals experience a growth spurt and the eruption of the first permanent dentition. As children aged, they would be expected to help with household chores or during harvest times. In tomb reliefs and statues, children are usually depicted as naked; however, this would have been impractical year-round and is likely an iconographic convention (Harrington, 2005; Hawass, 2000). Excavated materials suggest that children's clothing was miniatures of adults' (Hawass, 2000). A sidelock of hair, known as the 'sidelock of youth', was grown on the side of the head, especially on girls. At Deir el-Medina young males and females were found with this sidelock (Meskell, 2002). During the New Kingdom Period, the fashion was to shave part of the head, leaving tufts of hair. Adolescent girls are sometimes depicted with several ponytails rather than the full wigs shown on adult women (Hawass, 2000).

Late juvenile- seven to 14 years

During this period, individuals continue to grow and develop, notably in the dentition. The end of this period is marked by continued growth and physiological changes associated with puberty. In ancient Egypt, at around seven years of age males would have begun taking on additional duties and roles, such as apprenticeships and in labor and trade which could include formal education for males (Janssen and Janssen, 2007). Females of this age often did not receive any formal education or training. However, this period would have also been marked by an increase in responsibilities and duties within the household (Janssen and Janssen, 2007). In the

Inscription of Beknekhonsu youth is described as lasting 12 years from around five to 16 years of age, which is similar to the combination of a portion of the early juvenile (three to seven years) social age category and the late juvenile (seven to 14 years) social age category. This period included a position as "chief of the training-stable" (Breasted, 1906:236). However, the inscription is focused on the positions held by Beknekhonsu and might not detail all the important markers in an individual's life.

Transition adult- 14 to 20 years

The beginning of the transition adult category is marked by menarche in females and puberty for all sexes. Growth and development are reduced and reaching completion in the skeleton and dentition. There is little evidence that the timing of adulthood was fixed in ancient Egypt. A passage from the *Instructions of Ani* encourages men to take wives in order to teach them to be human, which suggests to some scholars that women were not considered full adults until they were married. Both marriage and the onset of menarche were possible for individuals as young as 12 years old (Graves-Brown, 2010). Scholars suggest that adulthood was marked by marriage or an individual's first work appointment (Janssen and Janssen, 2007). In the *Inscription of Beknekhonsu*, the author describes their first position as a priest of Amon as a separate stage of their life. This position lasted four years beginning around 17 years of age.

Given that many of the textual and documentary sources we have were likely written/created by men for a male audience, it is important to recognize there might be potential biases in descriptions of events such as marriage. Some scholars suggest that fathers would want to marry their daughters soon after puberty, around the ages of 12 to 14 years old. However, there does not appear to be any stringent rules about the age of marriage. Men would have likely been married later, perhaps their early 20s, when a household could have been established (Hawass,

2000). Likely, the push for early marriage was related to desire to have many children (Graves-Brown, 2010; Hawass, 2000). Transition into adulthood is illustrated in written "love songs," and coincided with sexual maturation, although appropriate age as related to sexuality appears to be much more fluid (Meskell, 2002). Love and marriage are treated differently in wisdom texts compared to love poetry. The ideal described in love poetry provides insight into the preliminaries to marriage and suggests that young men and women were able to meet and fall in love, speak openly about their feelings, and, with familial approval, had a degree of choice in who they ultimately married (Hawass, 2000). Letters and legal documents show evidence of marriage, as well as divorce (Meskell, 2002). In the New Kingdom Period *Tale of the Doomed Prince*, a daughter can refuse her father's choice in groom (Graves-Brown, 2010).

Prior to the Ptolemaic Period, there is no record of any formal wedding ceremony. However, legal documents clearly show that husbands and wives had well-defined responsibilities to one another (Graves-Brown, 2010; Hawass, 2000). Some translate the word for marriage as "to establish a household," "to live with," or "to found a house," among other translations. This suggests that cohabitation might be the defining act in marriage (Graves-Brown, 2010; Hawass, 2000). Some documents also reference the husband's gift of jewelry or commodities to the wife, which also might have been part of defining a marriage (Hawass, 2000). Contracts defining property rights between husbands and wives are referenced beginning in the New Kingdom Period, in the case of property division during divorce. Wisdom literature emphasizes the importance of respect and harmony in marriage. In *The Instructions of Ptahhotep*, a son is advised to love his wife, provide her with material and emotional support, and to have children with her (Hawass, 2000).

Young adult, middle adult, and old adult- 20+ years

There is limited evidence for different adult social age categories, or their correspondence to chronological age, in ancient Egypt. It is possible that different stages of the life course were not necessarily tied to chronological age, rather to other defining points in life. For example, in the *Inscription of Beknekhonsu* the author divides the ages of their life into sections related to different professional positions:

> "I acted as diving father of Amon, during twelve years,
> I acted as third prophet of Amon during fifteen years,
> I acted as second prophet of Amon during twelve years,
> He favored me, he distinguished me, because of my rare merit. He appointed me to be High Priest of Amon during twenty-seven years." (Breasted, 1906:236).

There are relatively few depictions of older individuals in tombs, which is likely a result of the desirability of youth, beauty, and fertility in Egyptian art. The concepts of youthfulness, fertility, and rebirth are central themes found throughout Egyptian art. For example, these themes are emphasized in banqueting scenes found in New Kingdom Period tombs, where fertility and rebirth are continually symbolized (Manniche, 1987). The way individuals are depicted is not only connected to age, but to other aspects of identify, such as gender and status. For example, men are more frequently depicted as older compared to women. Indications of old age include wrinkles and vertical lines between the eyes, abdominal fat, gauntness, bags beneath their eyes, sagging breasts, and grey or white hair (Graves-Brown, 2010; Janssen and Janssen, 2007). The Ebers Papyrus includes remedies for the process of aging, including those to stop the greying of hair and to counter sagging breasts (Graves-Brown, 2010). Some Egyptologists believe that respect for elders was ubiquitous throughout ancient Egypt. However, Janssen (2006) suggests that treatment and perspectives on the aging are considerably variable and tied to factors such as gender, wealth, and status. For example, there are few representations of older women in ancient Egyptian art and

those that do appear are usually from the lower class (Janssen and Janssen, 2007). In the *Teaching of Ptahhotep*, old age is depicted as a period of wisdom and authority, and as a time when parents needed the care and support of their children (Frood, 2010). In fact, there were social consequences for a child failing in their duty to care for their parent. In one example, the woman Naunakhte disinherited some of her children for failing to care for her (McDowell, 1999; Meskell, 2002). Due to the limited evidence of different social age categories in adults, the adult social age categories used here followed those outlined in *Standards* (Buikstra and Ubelaker, 1994) to increase comparability between collections. The young adult category corresponds to 20-35 years, the middle adult category corresponds to 25-50 years, and the old adult category corresponds to 50+ years.

2.3 Materials and Methods

This project investigated approximately 866 Egyptian and Nubian individuals from pre-Egyptian colonialization of Nubia (Scandinavian Joint Expedition to Sudanese Nubia (SJE) C-Group and Al-Widay I) sites and sites dating to the Egyptian colonization of Nubia (Tombos, SJE Pharaonic, and South Tombs Cemetery). Juvenile (n = 47; data collected by author) and adult (n = 179, data published in Buzon and Smith, 2017; Buzon, personal communication; Gibbon and Buzon, 2018) skeletal remains were used from the site of Tombos at the Third Cataract in Sudan. Tombos was occupied continuously from the New Kingdom Period (*c*. 1450 – 1050 BCE), through the Third Intermediate and into the Napatan Period (*c*. 750 – 660 BCE). Individuals at Tombos are buried in several different structures, including underground chambers, pyramid/chapel complexes, tumuli, and pit/subsidiary graves. All the different burial structures include dates for the New Kingdom Period; however, some of the structures date to the Third Intermediate/Napatan Periods. Individuals buried at Tombos represent a hybrid community of Egyptian colonists and local

Nubians (Buzon et al., 2016). Excavations were conducted at Tombos in 2000, 2002, 2005, 2010, 2011, 2013, and 2015-2017 and are currently ongoing. Skeletal remains from Tombos are housed at the Bioarchaeology Laboratory at Purdue University.

Juvenile (n = 80) and adult (n = 71) skeletal remains were examined by the author from the SJE C-Group collection, which encompasses sites in the Nile Valley of northern Sudan. The individuals from this collection are from sites that date to *c*. 2000 – 1600 BCE and are housed in the Panum Institute at the University of Copenhagen, Denmark. Juvenile (n = 16) and adult (n = 82) individuals from the SJE Pharaonic collection were also examined at the Panum Institute. These individuals likely represent a mixed population of Egyptian colonists and Egyptianized Nubians from sites located in Lower Nubia during the New Kingdom Period (Vagn Nielsen, 1970).

Individuals from Al-Widay I were excavated by the Oriental Institute Nubian Expedition (OINE) as part of a larger salvage project related to the Merowe Dam during the winters of 2007-2008. Data for these individuals are found in Ingvoldstad (2009). Al-Widay I is located in the Fourth Cataract region and dates to the Middle and Classic Kerma Periods (*c*. 2000 – 1500 BCE). Both juveniles (n = 43) and adults (n = 71) were recovered and investigated from Al- Widay I (Ingvoldstad, 2009). Individuals from Al- Widay I are currently housed at the Department of Anthropology at New York University.

Individuals from the South Tombs Cemetery (STC), one of four cemeteries at Akhetaten in Tell el-Amarna, Egypt, were excavated by members of the Amarna Project from 2006 to 2014. Akhetaten was occupied for a short period of time beginning around *c*. 1346 BCE during the New Kingdom Period reign of the pharaoh Akhenaten. Akhetaten was abandoned shortly after the pharaoh's death (*c*. 1331 BCE). The population that moved to Akhetaten originated from areas throughout Egypt (Dabbs and Zakrzewski, 2011). Juveniles (n = 102; data published in Shidner,

2018) and adults (n = 175; data published in: Dabbs and Zabecki, 2014; Dabbs et al., 2015; Kemp et al., 2013) were excavated and investigated from the STC, although in total 432 individual have been recovered from the cemetery.

Several traits were recorded for each individual including, maximum femur length, cribra orbitalia, porotic hyperostosis, linear enamel hypoplasia (LEH), and osteoperiostitis. Individuals examined by the author were recorded using the standards provided by the Global History of Health Project's *Data Collection Codebook* (Steckel et al., 2011). Estimation of demographic variables was conducted using standard protocols (Baker et al., 2005; Buikstra and Ubelaker, 1994; Schaefer et al., 2009; Steckel et al., 2011). Individuals were assigned to the above described social age categories.

Defects caused by LEH are disturbances in dental development that are indicative of body-wide, metabolic insults. LEH is associated with infectious disease, malnutrition, and a myriad of other social, psychological, and physical stressors (Aufderheide and Rodríguez-Martín, 1998; Goodman and Martin, 2002; Ortner, 2003; Steckel et al., 2011). LEH forms during early development, from prenatal to approximately seven years of age. Due to the nature of enamel formation, LEH remains on dentition throughout an individual's life, although LEH reflects periods of childhood stress. LEH presents as transverse deficiencies in enamel thickness, singularly or in multiples, and is considered present when the indentation can be felt with a fingernail (Steckel et al., 2011). Due to the differences in recording schemes in the utilized published data, LEH is reported here as present or absent and individuals were included for observation if at least one anterior tooth was present.

Cribra orbitalia is manifested as cranial porosities on the orbital roof of the frontal bone and have been linked to anemia (including iron- deficiency anemia), parasitic infection, and

nutritional deficiencies (vitamin B_{12}, vitamin D, and vitamin C), although there is debate regarding the etiology of cribra orbitalia (Cole and Waldron, 2019; Rivera and Lahr, 2017; Walker et al., 2009). Cribra orbitalia forms during childhood but remodels and can be observed in adult individuals as well. The widespread presence of cribra orbitalia in the Nile Valley has been linked to endemic malaria (Smith-Guzmán, 2015). Individuals were scored for cribra orbitalia if at least one orbit was observable. Due to differences in reporting between collections, both active and remodeled cribra orbitalia were considered present and are not differentiated between in this project. Like cribra orbitalia, porotic hyperostosis is linked to anemia, nutritional deficiencies, and infection, although the exact etiology is debated (Walker et al., 2009). Individuals were scored for porotic hyperostosis if at least one parietal was present for observation.

Osteoperiostitis (periosteal lesions) is the result of reactive periosteal bone deposition that can result from trauma, inflammation, and infection (Steckel et al., 2002; Weston, 2012). Certain patterns of osteoperiostitis are associated with a specific disease, such as tuberculosis, but most periosteal lesions cannot be associated with a specific disease process (Ortner, 2003). Bilateral lesions likely indicate hematogenous infection, where the blood distributes the infection throughout the body. Conversely, localized, unilateral lesions or lesions associated with a fracture are likely the result of traumatic injury. Individuals were scored for osteoperiostitis if more than 50% of the long bone was present. Osteoperiostitis was scored present when lesions were distributed bilaterally. Due to differences in reporting between published data, only osteoperiostitis recorded on tibiae are included here.

Human growth is complex and affected by multiple factors including, genetics, environment, nutrition, and infection. Growth stunting during childhood impacts the long bones more than other regions of the body and stature is a powerful indicator of childhood nutritional

status. (Goodman and Martin, 2002; Zakrzewski, 2003). Adult stature primarily reflects health during childhood; here, the maximum femur length is used as a proxy for stature.

Associations between age category or collection (for the Tombos, SJE C-Group, SJE Pharaonic, and STC collections) and presence or absence of skeletal markers of non-specific stress and illness (cribra orbitalia, porotic hyperostosis, LEH, osteoperiostitis) were made using Fisher's Exact tests. Associations between estimated sex and collections (for the SJE C-Group, SJE Pharaonic, and Al-Widay I collections) and maximum femur length were made using Mann Whitney U-tests, while comparisons of maximum femur length with the Tombos and STC collections (males and females) and the SJE C-Group, SJE Pharaonic, and Al-Widay I collections were made using one sample t-tests. Statistical tests were chosen based on the type of available data (e.g. frequency, lesion count, number of individuals observed, separated information for males and females or age categories, etc.). Statistical analyses were carried out using IBM SPSS Statistics version 26.

2.4 Results

2.4.1 Adults

Examining available demographic information for the adults from the each of the collections reveal that in the SJE Pharaonic collection 46.3% (38/82) of individuals are estimated to be male, 36.3% (30/82) are estimated to be female, and 17.1% (14/82) are adults with indeterminate sex. In the SJE C-Group collection 50.7% (36/71) of individuals are estimated to be male, 47.9% (34/71) are estimated to be female, and 1.4% (1/71) are adults with indeterminate sex. In the Al-Widay collection 46.0% (35/71) are estimated to be male, 36.0% (28/71) are estimated to be female, and 18.0% (14/71) are adults with indeterminate sex (Ingvoldstad, 2009).

Mean maximum femur length by sex in each collection are presented in Table 2. Mann Whitney *U*-tests and one sample t-tests were used to compare the maximum femur length in the Al-Widay I, SJE C-Group, Tombos, STC, and SJE Pharaonic collections. There was a significant difference in femur length between males and females in the Al-Widay I ($p = 0.007$), Tombos ($p = 0.026$), and SJE C-Group ($p < 0.001$) collections. Males had higher mean femur lengths compared to females for these collections. Femur lengths were significantly higher for females from Al-Widay I and compared to females from the Tombos ($p < 0.001$) and STC ($p = 0.004$) collections. Femur lengths from females from Tombos were significantly lower than SJE Pharaonic females for femur length ($p < 0.001$). Femur lengths of males from the SJE C-Group collection were significantly higher compared to males from the SJE Pharaonic ($p = 0.022$) collection. Femur lengths of males from the Al-Widay I collection are significantly lower compared to males from the SJE C-Group ($p = 0.024$), SJE Pharaonic ($p < 0.001$), and Tombos ($p = 0.014$) collections. Additionally, femur lengths of males from the STC collection were statistically lower compared to males from the SJE C-Group ($p < 0.001$), SJE Pharaonic ($p = 0.041$), and Al-Widay I ($p < 0.001$) collections.

Table 2. Mean maximum femur length by sex in each collection

Collection	Females (n)	Female Mean	Males (n)	Male Mean
Tombos*	13	409.4	9	440.4
SJE Pharaonic	11	434.3	12	440.5
STC	50	411.0	37	429.0
SJE C-Group	12	420.6	11	459.3
Al-Widay I**	7	443.7	13	475.9

*New Kingdom individuals from Gibbon and Buzon (2018)
**From Ingvoldstad (2009)

Frequency of osteoperiostitis in adult individuals from Tombos, SJE Pharaonic, SJE C-Group, and STC collections are presented in Table 3. Twenty-eight percent of adults (20+ years; n = 82) from the Tombos collection had bilateral osteoperiostitis on the tibiae compared to 0% of adults from the SJE C-Group, 0% of adults from the SJE Pharaonic, and 19% of females and 12% of males (Dabbs and Zabecki, 2014) from the STC collections. Examining the results from the Tombos and SJE Pharaonic collections demonstrates a statistical difference ($p = 0.020$) between these two collections, with the Tombos collection demonstrating a higher frequency of osteoperiostitis. The results for cribra orbitalia and LEH in adults by collection are presented in Tables 4 and 5 respectively. Approximately 3% of SJE C-Group, 8% of SJE Pharaonic, 11% or Tombos, and 13% of STC adults had cribra orbitalia. Approximately 3% of SJE C-Group, 6% of SJE Pharaonic, and 20% of Tombos adults had LEH. No adults from any of the collections had porotic hyperostosis.

Table 3. Frequency of osteoperiostitis in adult individuals (young adult through old adult age categories) by collection.

Collection	n	#	%
Tombos*	82	23	28.0%
SJE Pharaonic	16	0	0.0%
SJE C-Group	1	0	0.0%
STC**	-	-	-

*Buzon, personal communication
**Dabbs and Zabecki (2014) report a frequency of osteoperiostitis of 19% for females and 12% for males, but do not provide information for the number of adults observed or the counts for the presence of osteoperiostitis.

Table 4. Frequency of cribra orbitalia in adult individuals >20 years (young adult through old adult age categories) by collection

Collection	n	#	%
Tombos*	179	20	11.2%
SJE Pharaonic	61	5	8.2%
STC	-	-	12.7%**
SJE C-Group	67	2	3.0%

*Buzon, personal communication
**the number of individuals observable for cribra orbitalia and the number of individuals with cribra orbitalia are not presented; from Dabbs et al. (2015).

Table 5. Frequency of LEH in adult individuals >20 years (young adult through old adult age categories) by collection

Collection	n	#	%
Tombos*	77	15	19.5%
SJE Pharaonic	48	3	6.3%
SJE C-Group	60	2	3.3%

*Buzon, personal communication

2.4.2 Juveniles

Age was estimated for juvenile individuals <20 years of age at death from Tombos, SJE-Pharaonic, and SJE C-Group and were compared to juvenile individuals <20 years of age at death from STC (Shidner, 2018) and Al-Widay I (Ingvoldstad, 2009). Each juvenile was assigned to a social age category and the results are presented in Table 6. Note that the transition adult social age category (14 – 20 years) from the Al-Widay I collection includes individuals estimated to be under 25 years old (Ingvoldstad, 2009). The results for cribra orbitalia, porotic hyperostosis, and linear enamel hypoplasia for individuals <20 years of age at death are presented in Tables 7, 8, and 9. Juveniles from the STC cemetery at Akhetaten had the highest frequency of cribra orbitalia and linear enamel hypoplasia. The only recorded cases of porotic hyperostosis come from STC.

Fisher's exact tests were used to compare the frequency of non-specific stress markers between juveniles (<20 years) for the Tombos, SJE Pharaonic, SJE C-Group, and STC collections. There was a statistically significant higher frequency of cribra orbitalia in the STC collection compared to the Tombos ($p = 0.013$), SJE Pharaonic ($p = 0.016$), and SJE C-Group ($p < 0.001$) collections. There was also a statistically significant higher frequency of LEH in the STC collection compared to the Tombos ($p = 0.006$), SJE Pharaonic ($p < 0.001$), and SJE C-Group ($p < 0.001$) collections. When social juveniles (<14 years, see Table 10) from the Tombos, SJE Pharaonic, SJE C-Group, and STC collections were compared, cribra orbitalia was significantly higher in the STC social juveniles compared to the Tombos ($p = 0.026$) and SJE C-Group ($p < 0.000$) social juveniles. When social juveniles (<14 years, see Table 11) from the Tombos, SJE Pharaonic, SJE C-Group, and STC collections were compared, LEH was significantly higher in the STC social juveniles compared to the Tombos ($p = 0.007$), SJE Pharaonic ($p = 0.006$), and SJE C-Group ($p < 0.000$) social juveniles.

Table 6. Number of juvenile individuals <20 years in each social age category by collection

	Fetal <birth		Infancy Birth - 1 year		Young child 1 - 3 years		Early juvenile 3 - 7 years		Late juvenile 7 - 14 years		Transition adult 14 - 20 years	
Collection	n	%	n	%	n	%	n	%	n	%	n	%
Tombos	0	0.0	8	17.4	8	17.4	15	32.6	12	26.1	3	6.5
SJE Pharaonic	0	0.0	2	12.5	1	6.3	5	31.3	3	18.8	5	31.3
STC	-	-	12	11.8	22	21.6	30	29.4	31	30.4	7	6.9
SJE C-Group	3	3.8	17	21.3	6	7.5	18	22.5	17	21.3	19	23.8
Al-Widay I	2	4.7	3	7.0	7	16.3	10	23.3	11	25.6	10*	23.3

*juveniles in this range include individuals under 25 years old.

Table 7. Frequency of cribra orbitalia in juvenile individuals <20 years (fetal through transition adult age categories) by collection

Collection	n	#	%
Tombos	33	15	45.5%
SJE Pharaonic	12	4	33.3%
STC	63	46	73.0%
SJE C-Group	37	11	29.7%

Table 8. Frequency of porotic hyperostosis in juvenile individuals <20 years (fetal through transition adult age categories) by collection

Collection	n	#	%
Tombos	33	0	0.0%
SJE Pharaonic	10	0	0.0%
STC	66	3	4.5%
SJE C-Group	33	0	0.0%

Table 9. Frequency of LEH in juvenile individuals <20 years (fetal through transition adult age categories) by collection

Collection	n	#	%
Tombos	21	6	28.6%
SJE Pharaonic	9	0	0.0%
STC	38	26	68.4%
SJE C-Group	38	7	18.4%

Table 10. Frequency of cribra orbitalia by social age category and collection

	Fetal <birth			Infancy Birth - 1 year			Young child 1 - 3 years			Early juvenile 3 - 7 years			Late juvenile 7 - 14 years			Transition adult 14 - 20 years			Young adult 20- 35 years			Middle adult 35-50 years			Old adult 50+ years		
Collection	n	#	%	n	#	%	n	#	%	n	#	%	n	#	%	n	#	%	n	#	%	n	#	%	n	#	%
Tombos*	0	0	0.0	6	0	0.0	4	2	50.0	9	4	44.4	11	7	63.6	3	2	66.7	24	2	8.3	16	0	0.0	11	1	9.1
SJE Pharaonic	0	-	-	0	-	-	1	1	100.0	5	2	40.0	1	0	0.0	5	1	20.0	10	1	10.0	18	0	0.0	20	1	5.0
STC	-	-	-	9	6	66.7	17	13	76.0	16	12	75.0	21	12	71.4	-	-	-									
SJE C-Group	1	0	0.0	10	1	10.0	1	0	0.0	8	2	25.0	8	4	50.0	9	4	44.4	20	2	10.0	23	0	0.0	5	0	0.0

*From Buzon (2014), note that the in Buzon (2014) young adult refers to individuals 18-29 years old, middle adult refers to individuals 30-45 years old, and old adult are individuals 46+ years old.

Table 11. Frequency of LEH by social age category and collection

	Fetal <birth			Infancy Birth - 1 year			Young child 1 - 3 years			Early juvenile 3 - 7 years			Late juvenile 7 - 14 years			Transition adult 14 - 20 years			Young adult 20- 35 years			Middle adult 35-50 years			Old adult 50+ years		
Collection	n	#	%	n	#	%	n	#	%	n	#	%	n	#	%	n	#	%	n	#	%	n	#	%	n	#	%
Tombos*	0	-	-	1	0	0.0	4	0	0.0	7	1	14.3	8	5	62.5	1	0	0.0	20	8	40.0	14	2	14.3	7	2	28.6
SJE Pharaonic	0	-	-	0	-	-	1	0	0.0	2	0	0.0	2	0	0.0	4	0	0.0	12	1	8.3	14	1	7.1	11	0	0.0
STC	-	-	-	-	-	-	-	-	-	10	3	30.0	28	23	82.1	-	-	-									
SJE C-Group	0	-	-	0	-	-	0	-	-	7	1	14.3	15	2	13.3	16	4	25.0	19	1	5.3	21	0	0.0	4	0	0.0

*From Buzon (2014), note that the in Buzon (2014) young adult refers to individuals 18-29 years old, middle adult refers to individuals 30-45 years old, and old adult are individuals 46+ years old.

2.4.3 Survivors vs. Non-survivors

Comparisons using Fisher's Exact test of non-specific stress markers in juveniles and adults allows for the investigation into differences between survivors and non-survivors of childhood stress in the Tombos, SJE C-Group, and SJE Pharaonic collections. Adults and juveniles were compared in these collections using the social age categories described above (see Tables 10 and 11), as well as using traditional age categories for juveniles (<20 years, see Tables 6, 7, and 9) and adults (20+ years, see Tables 4 and 5) to increase comparability between studies and highlight the utility of social age categories. There were no significant differences for LEH between juveniles and adults in the Tombos and SJE Pharaonic collections. There is a significantly higher frequency of LEH in juveniles (< 20 years) compared to adults (20+ years) for the SJE C-Group collection (p<0.001). However, there was no statistically significant difference for LEH between social juveniles (< 14 years) and social adults (14+ years) for the SJE C-Group collection. There was a statistically significant higher frequency of cribra orbitalia in juveniles (< 20 years) compared to adults (20+ years) in the Tombos (p< 0.001), SJE C-Group (p< 0.001), and SJE Pharaonic (p = 0.035) collections. This pattern of significance was also found for cribra orbitalia between social juveniles (<14 years) and social adults (14+ years) in the Tombos (p<0.001), SJE C-Group (p = 0.039), and SJE Pharaonic (p = 0.036) collections, with higher frequencies of cribra orbitalia in social juveniles (<14 years) (Tables 10 and 11).

The social age category with the highest frequency of cribra orbitalia in the Tombos collection is the transition adult category (14-20 years; 66.7%), followed by the late juvenile age category (7-14 years; 63.6%). For LEH, the age category with the highest frequency is the late juvenile age category (7-14 years; 62.5%). In the SJE C-Group collection, the highest frequency of cribra orbitalia is found in the late juvenile age category (7-14 years; 50%), followed by the

transition adult category (14-20 years; 44.4%). The age category with the highest frequency of LEH is the transition adult category (14-20 years; 25%). The age category with the highest frequency of cribra orbitalia (with more than one observable individual) in the SJE Pharaonic collection is the early juvenile category (three to seven years; 40%), followed by the transition adult category (14-20 years; 20%). The age category with the highest frequency of LEH is the young adult category (20-30 years; 8.3%). However, the LEH results from the SJE Pharaonic collection are limited by the small number of individuals that are able to be observed for this condition and are estimated to be under 20 years of age.

2.5 Discussion

There was a significant difference between individuals that survived periods of childhood stress (adults) and non-survivors (juveniles) when examining cribra orbitalia. Cribra orbitalia was significantly different between juveniles and adults (as determined by traditional osteological indicators) and social juvenile and social adults (as indicated by archaeological and historical evidence) in all collections where juveniles and adults could be compared (Tombos, SJE C-Group, and SJE Pharaonic). There are high frequencies of individuals with cribra orbitalia in the late juvenile social age category (7 – 14 years) and the transition adult social age category (14 - 20 years). These two social age categories correspond to periods of transition, where individuals underwent significant changes in cultural norms and expectations. During the late juvenile social age category individuals would begin to participate in adult labor and apprenticeships and during the transition adult social age category individuals could be engaging in adult labor, marriage, and childbirth. The individuals (adults) that survived these periods were more likely to have no skeletal indicators of stress (cribra orbitalia, and LEH). The results from the comparisons between maximum femur length demonstrate that with female individuals, the Al-Widay I females have

significantly longer femoral lengths than the Tombos and STC females and the Pharaonic females significantly longer femoral lengths compared to the Tombos females. These data suggest that the individuals at Al- Widay I may have been experiencing differences due to social or environmental conditions. Additionally, the Al-Widay I collections originates from the 4th Cataract region, whereas the other collections originate from further north, and it is possible that the differences are related to genetic components and potential femur length, a pattern suggested in other Nile Valley studies (e.g. Buzon, 2006). This conclusion is supported when analyzing maximum femur length in male individuals. The Al-Widay I males are significantly taller than males in all of the other collections. However, in combination with the very few instances of cribra orbitalia (2/68), porotic hyperostosis (0/69), LEH (2/60), and osteoperiostitis (0/1) in the same sample, the larger femur length in the C-Group collection is likely related to differences in stress and health between collections.

The STC collection demonstrated large differences from the other collections examined in this project for skeletal indicators of cribra orbitalia, porotic hyperostosis, LEH, and maximum femur length. The cribra orbitalia and LEH data from the STC collection indicates that the STC juveniles with stress markers were dying with a higher frequency than those individuals without cribra orbitalia or LEH in the same collection in all the social age categories except for LEH in the early juvenile social age category. Comparisons between juveniles in the Tombos, STC, SJE Pharaonic, and SJE C-Group collections demonstrate differences in cribra orbitalia and LEH in the STC collection, with the STC juveniles having a higher frequency of these indicators. The only cases of porotic hyperostosis come from juveniles in the STC collection. Additionally, the STC adult males are significantly shorter than the males from the SJE C-Group, SJE Pharaonic, and Al-Widay I males. In conjunction with the higher frequency of skeletal indicators of non-specific

stress and infection this result suggests that individuals from STC were experiencing greater health-related stress. Other studies have suggested that Nile Valley males demonstrate higher levels of stress compared to females which might be attributed to a greater negative response to environment-related stress (Buzon, 2006; Zakrzewski, 2003) and this trend is reflected in the results from the STC males. Following this same trend, the adults from the STC collection had high frequencies of LEH (61% for males, 58 % for females; Dabbs and Zabecki, 2014) compared to adults from Tombos (19.5%), SJE Pharaonic (6.3%), and SJE C-Group (3.3%) collections. A higher frequency of individuals with cribra orbitalia were dying during their juvenile years rather than their adult years. However, this same pattern does not hold true for LEH, where both juveniles (68.4%), adult males (58%), and adult females (61%) have high frequencies of this indicator.

The historical context of the STC collection provides insight into the pattern of skeletal indicators of stress observed. Under the pharaoh Akhenaten, Egypt underwent immense cultural, religious, and political changes. This period is often referred to as the Amarna Period. At this time the pharaoh moved the capital of Egypt to Akhetaten, which was situated between Memphis and Thebes in Middle Egypt. Akhenaten also proclaimed Aten, who is represented as a sun disc, to be the only god of Egypt. This period also corresponded with changes in the artistic canon of ancient Egypt, especially in the depictions of human body shape (Van de Mieroop, 2011). The building of the new capital city Akhetaten in an area that was previously uninhabited required immense construction efforts. Construction was facilitated with technological advances, especially within construction techniques that increased the efficiency of building, such as the *talatat* block (Dabbs et al., 2015). Previous studies of the individuals from STC demonstrate that the quick and intense building projects directly impacted the individuals residing in the new capital. Dabbs and colleagues (2015) found a high rate of trauma in the STC collection (66.7% of adults and 10.5%

of juveniles), including those that are associated with work. Osteophytic growth in the spine of 47.4% of the STC sample, including in younger individuals, indicates a strenuous workload (Dabbs et al., 2015). These patterns are reflected, albeit with even higher frequencies, in the preliminary results from the North Tombs Cemetery at Tell el-Amarna, where high frequencies of spinal trauma and degenerative joint disease in the skeleton were also found. Interestingly examples of degenerative joint disease were found in individuals as young as six to seven years old at death (Dabbs, forthcoming). Both the STC and NTC are unique cemetery contexts not often found in the archaeological record due to the short occupation period of Akhetaten. The NTC in particular, demonstrates interesting demographics with the majority of the individuals excavated so far under 25 years of age. Additionally, the majority of adults interred in the NTC are female. The NTC represents a demographically restricted subset of the larger urban population of Akhetaten that were engaging in heavy workloads, perhaps related to limestone quarrying (Dabbs, forthcoming). The STC is also an cemetery of non-elite individuals. In addition to heavy workloads, individuals in the North Tombs Cemetery also had a high frequency of LEH (73.2%), suggesting that this pattern at Akhetaten is not isolated to the STC. Dabbs and colleagues (2015) suggest the possibility of an endemic disease affecting the individuals living at Akhetaten, citing the unusual demographic makeup of the STC and historical texts from the time, including the Amarna Letters, documenting a 'plague' or 'pestilence'. Overall, it appears that the individuals who were living at Akhetaten were experiencing high levels of stress associated with the major economic, cultural, environmental, and religious upheavals of the time. A comparison of childhood stress between sites dating to pre-Egyptian colonization of Nubia (SJE C-Group and Al-Widay I) and sites dating to post-Egyptian colonization of Nubia (Tombos, SJE Pharaonic, and STC) demonstrates that Egyptians were not buffered during the Egyptian colonial periods and were still susceptible to

conditions that result in skeletal indicators of stress and infection. The results from STC highlights the negative health conditions that impacted native Egyptians during this period.

Previous studies of health at Tombos did not benefit from the examination across the life course, now possible with the addition of a newly excavated juvenile sample. For both cribra orbitalia and LEH, juveniles from Tombos had higher frequencies compared to adults from the same site, especially for cribra orbitalia. Additionally, the use of social age categories revealed important patterns in the non-specific stress indicator data. Individuals in the late juvenile social age category had high frequencies of cribra orbitalia and LEH, indicating that this transitional period was particularly precarious at Tombos. The inclusion of juvenile data in the study of Tombos expands the understanding of health at this site, revealing higher frequencies in non-specific indicators of stress in juveniles and high frequencies in individuals in the late juvenile social age category.

Social age categories are important components when investigating health in the past. The efficacy of using social age categories and the comparison of social age categories with traditional age categories separating juveniles and adults is demonstrated when examining the results of LEH in the SJE C-Group collection. There was no statistical difference between adults and juveniles when social age categories were used, but there was a significant difference between the traditional age categories of adults (20+ years) and juveniles (<20 years). This difference in significance reflects that the age category with the highest frequency of LEH in the SJE C-Group collection is the transition adult (14-20 years). Without comparing social age categories, the importance of this period of the life course might have been overlooked in a traditional assessment of health. Combining an understanding of the social meaning and experience associated with the transition adult social age category reveals this transition as a particularly precarious period for individuals,

especially for those with skeletal markers of childhood stress. Social age categories reveal the precarious nature of these transition periods in the ancient Nile Valley, reflecting changing cultural and social demands.

2.6 Conclusion

The life course approach is a beneficial avenue for bioarchaeological research into health in the past. An important component to a life course approach is the integration of social age categories, which help to elucidate patterns of health related to the wider cultural milieu. An examination of juveniles and adults from the ancient Nile Valley demonstrates the importance of including juvenile individuals in the examination of health. Cribra orbitalia is an important indicator when comparing survivors (adults) and non-survivors (juveniles) for skeletal markers of childhood stress. The use of traditional age categories (e.g. individuals >20 years compared to individuals 20+ years) can mask important patterns in health data. In the Nile Valley, transitionary periods of the life course are especially precarious for individuals with skeletal markers of childhood stress, specifically for those in the late juvenile (7- 14 years) and the transition adult (14 – 20 years) social age categories. Changing cultural and social demands associated with individuals of this age may have negatively impacted health. The use of social age categories can aid researchers in identifying contexts that impact health. Individuals from STC are experiencing high levels of stress, which is reflected in the frequencies of cribra orbitalia and LEH in juveniles and adults and the short femur length of adults, especially males. These results likely reflect the social, political, environmental, and religious upheavals associated with the pharaoh Akhenaten and the construction of a new capital on a group of non-elites.

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CHAPTER 3. OLD AGE AND IMPAIRMENT IN NUBIA: INVESTIGATING OLDER INDIVIDUALS FROM TOMBOS

3.1 Introduction

Age identity was traditionally overlooked in archaeological and bioarchaeological spaces. Undertheorization of age identity results from the entangled nature of the biological, cultural, and chronological concepts of age (Gowland, 2006). Over the last several decades, theory and research into the concept of social age have increased significantly, although much of this research has focused on the first several decades of life (e.g. Halcrow and Tayles, 2008; Perry, 2006). The increased focus on a life course approach in bioarchaeology has begun to fill these gaps, as have methodological developments, such as Transition Analysis, that target a more nuanced picture of older age. Life course approaches have been used to examine intersecting aspects of identity, including gender and aging (Gowland, 2006), aging and growing old (Appleby, 2010; Gowland, 2007), childhood (Blom and Knudson, 2014; Perry, 2006; Redfern and Gowland, 2012), and aging and disability (Lovell, 2016; Welinder, 2001) by emphasizing the importance of the social life of the skeleton. Different aspects of identity do not exist in a vacuum; rather, aspects of identity overlap and entwine one another. As such, age identity is related to other identities, including gender, kinship, social status, marital and reproductive status, ethnicity, and religious affiliation among others (Appleby, 2010).

There are several terms fundamentally important to disability studies; unfortunately, there is no clear consensus on the definitions for these terms, and they are often used interchangeably in scholarly work. It is important to distinguish between disease, impairment, and disability. Disease is a temporary or permanent pathological condition (Knudson and Stojanowski, 2008). Impairment and disability are related to one another but conceptually distinct. Impairment is defined by Roberts

as “a functional limitation within the individual caused by physical, mental or sensory impairment” (1999:83). The World Health Organization defines impairment as “any loss or abnormality of psychological, physiological, or anatomical structure or function” (WHO, 1980:47). Impairment is viewed as a biological “fact,” and therefore without any social connotations, either positive or negative (Metzler, 2006). Disability is “the loss or limitation of opportunity to take part in the normal life of the community on an equal level with others, due to physical or social barriers” (Roberts, 1999:83). The World Health Organization refers to disability as the “restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for a human being” (WHO, 1980:143). Metzler (2006) uses disability to refer to the “social constructedness of the relationship between the impaired body and the culture and society that body’s owner inhabits” (Metzler, 2006:20).

Integration of social theory into the study of the skeleton enables scholars to recognize the skeleton as a product of lived experience (Agarwal, 2016). A life course approach is particularly well suited to explore the intersection of old age, impairment, and disability. Here, the intersection of old age, impairment, and disability is explored at the site of Tombos in Sudan by combining population- and individual-level data to more fully understand what life was like for older individuals.

3.1.1 Old Age and Elders

Old age is underexamined in archaeological and bioarchaeological contexts. Often, old age is mentioned tangential to other discussions of age and the difficulties in examining old age are attributed solely to difficulties in osteological aging techniques (Appleby, 2010). However, the aging process can provide valuable information to the understanding of past peoples within archaeology and bioarchaeology. Initial investigations into age in past societies likely focused on

early life due to the more detailed methods available for age estimation in juveniles. Modern Western perspectives of old age, the negative connotations associated with aging, and the social invisibility/marginalization of elders in Western contexts may also contribute to the lack of focus on old age (Appleby, 2010; Gowland, 2007).

The view of 'old age' or 'elders' as a category is culturally constructed and aging as a process or experience is not universal or fixed. This begs the question: when does an individual become old and does this directly relate to a chronological age (Gowland, 2007)? In modern Western society, great emphasis is placed on chronological age and chronological age is often the basis for categorizing individuals into different groups, participation in certain activities, and legal status (e.g. legal adult, habitation in senior communities, voting in elections). This way of thinking may not hold true for past societies. Individuals are deemed 'old' at different points during their life course and factors such as appearance, bodily ability, and appropriate social roles influence the perceptions of old age (Appleby, 2010). Visible appearance might have been a more important factor in how age is perceived. Some skeletal markers of age, such as cranial suture closure, result in no changes to appearance. Others, such as dental attrition and antemortem tooth loss, result in changes to appearance. These more visible characteristics could be better indicators of how old age was perceived in the past (Appleby, 2010). Additionally, there are issues with directly relating chronological age with social age when examining archaeological populations and chronological age may not have held as great of importance in the past as it does today (Appleby, 2010; 2017). The lack of focus on old age and aging is likely also a result of methodological restrictions related to age estimation of individuals over approximately 45 years (Appleby, 2010). Estimation of age from skeletal remains attempts to examine physiological/biological age to reconstruct chronological age. For example, some standard methods for estimating old age only provide a

broad age range (e.g. 20 to 55 years). These methods may combine individuals in dissimilar stages of the life course into one age category and mask variability. The life experiences and associated skeletal markers of an individual who is 45 years old may be quite different from an individual of the same community who is 80 years old. Additionally, there are issues with many age estimation methods. Not only is age strongly influenced by environmental factors (whereas early development during childhood is strongly tied to genetics), but Mays (2015) found that around 60% of the variation in the features used for age estimation in skeletal remains were not actually related to age.

There is a strong tie between disability and age, especially old age. Zakrzewski argues that disability is "an age-related and universal phenomenon" and "permits being 'disabled' to be viewed as simply a point upon a continuum of ability rather than as a binary opposition to able-bodied" (2014:162). As individuals age, the body undergoes degenerative changes which impact a person physically and as individuals age, each are more likely to experiences degenerative changes (Appleby, 2010). Individuals experience increased disease risk as they age and in fact, the accumulation of risk increases not only over a single lifetime but over generations (Gowland, 2015). Bioarchaeological studies of disability and impairment are uniquely positioned to access both the social and medical models of disability while approaching the interaction between multiple threads of identity. The life course approach is an ideal framework for the consideration of old age and changing ability. However, care should be taken to avoid placing Western paradigms onto past communities. Contemporary ideas of accommodation and impairment in old age may not accurately reflect perspectives of past populations, communities, and individuals. The idea that old age and aging requires accommodation from community members necessitates that

the able-bodied adult (but not the old adult) is the basis for what is 'normal' and that all other statuses are deviations from the 'normal' (Appleby, 2017).

Less is known about how old age was perceived by ancient Egyptians in comparison to other age categories. However, artistic depictions and textual documentation provide clues to how older adults were viewed in Egyptian society. There are varying accounts of the average lifespan of individuals in ancient Egypt. Estimations vary between regions and time period, with some suggesting that women in their thirties would have been considered old (Graves-Brown, 2010). However, this perception is perhaps influenced by misunderstandings related to life expectancy estimations. Average life expectancy estimations for past populations are influenced by all members of the community, including those who die at younger ages. Some of the Egyptian life expectancy estimations are influenced by the death of young individuals (especially infants who commonly succumbed to infection), which pulls the average age at death to a much younger age. Additionally, the risks associated with childbirth meant that some women died during their reproductive years, again pulling the average life expectancy younger. However, bioarchaeological evidence indicates that there were many individuals, both male and female, living well into older age categories and young life expectancy estimations do not mean that individuals were not living into old age (Buzon, 2004). The *Inscription of Beknekhonsu* describes the number of years spent in different professional positions and provides an age estimation of retirement, or perhaps death, for Beknekhonsu at around 86 years (Breasted, 1906). Egyptians aspired to live into old age, even over the age of 100 (Graves-Brown, 2010). Generally, scholars are unable to determine exactly how hold pharaohs lived, although the approximate number of years a pharaoh ruled can be determined (Janssen and Janssen, 2007). Additionally, an indication that a pharaoh reigned for a number of years is a *sed* festival, where the pharaoh would be renewed, and often occurred during

the 30th regnal year. The New Kingdom Period pharaoh Ramesses II was likely the longest living pharaoh and celebrated more *sed* festivals (14 in total) than any other pharaoh. This information provides an estimation that Ramesses II lived to be over 90 years old (Janssen and Janssen, 2007). Yet, associations with old age were not always cast in a positive light. In the *Instruction of Ptahhotep*, the depiction of old age is associated with physical and mental weakness:

> "O King, my Lord!
> Old age is here, high age has arrived,
> Feebleness came, weakness grows,
> Childlike one sleeps all day.
> Eyes are dim, ears are deaf,
> Strength is waning, one is weary,
> The mouth, silenced, speaks not,
> The heart, void, recalls not the past,
> The bones ache throughout.
> Good has become evil, all taste is gone,
> What age does to people is bad in every respect.
> The nose, clogged, cannot breathe,
> Painful are standing and sitting." (Janssen and Janssen, 2007:142).

While Egyptians aspired to live into old age, youth, beauty, and fertility are core themes in artistic depictions. Artistic conventions related to age, gender, and status contribute to the relatively few depictions of older individuals in tombs. In some contexts, older age is depicted as desirable, especially among elite individuals. Indications of old age include wrinkles and vertical lines between the eyes, abdominal fat, gauntness, bags beneath their eyes, sagging breasts, and grey or white hair (Graves-Brown, 2010; Janssen and Janssen, 2007). Graves-Brown (2010) also suggests that these signs change from time period to time period; in the Old Kingdom Period, gauntness is used to denote aging, while white hair is more common in the New Kingdom Period. The treatment and perspectives on aging are variable and tied to factors such as time period, gender, wealth, and status (Janssen, 2006). For example, there are few representations of older women in ancient Egyptian art and those that do appear are usually from the lower class (Janssen and Janssen, 2007).

The Ebers Papyrus includes remedies for the process of aging, including those to stop the greying of hair and to counter sagging breasts (Graves-Brown, 2010). In the *Instruction of Ptahhotep*, old age is depicted as a period of wisdom and authority and as a time when parents needed the care and support of their children (Frood, 2010). In fact, there were social consequences for a child failing in their duty to care for their parent. In a will from Deir el-Medina, the woman Naunakhte disinherited some of her children for failing to care for her (McDowell, 1999; Meskell, 2002).

Finding and understanding disability in the past

There are several issues that should be considered when investigating disability in the past, especially in ancient populations. Roberts (1999) outlines several principles including that ancient ideas of disability may not be the same as modern conceptions and that it is difficult to assess what would be considered a disability to the individual and to the individual's society in the skeletal record. In addition, art and documentary sources can be problematic for the interpretation of disability. Finally, direct evidence in the archaeological record of whether past societies provided health-related care for individuals with disabilities is difficult to ascertain as many acts of health care provisioning would not leave archaeological evidence. In addition, many health conditions do not leave skeletal marks. Many diseases do not exhibit external manifestations and therefore may not be perceived as impairments or disabilities by a given society. Diseases also might not influence a person's mortality but may have had an impact on work capabilities and reproduction. These, in turn, can influence social and economic status. The economy of a community impacts the way all individuals contribute to the community and it can be difficult to determine the impact of the disabling condition on the community (Dettwyler, 1991; Roberts, 1999; 2000). Assessing disability in the past stems from assumptions of what constitutes a disabling condition. In contrast, identifying what constitutes "normal" participation in an activity in the past also stems from

assumptions. Researchers should strive to be cognizant of their personal cultural presumptions in the development of disability models.

Minor bone damage can cause extreme pain, while a physically severe impairment might not impact an individual's ability to "normally" function. In modern communities, individuals with leprosy who have lost their fingers are still capable of performing activities that require high dexterity, such as needlework (Roberts,1999; 2000). Similarly, what might be considered a deformity in Western society today may not have been viewed as such in the past or in other societies.

Impairment and ability fluctuate and change throughout the life course and are contextual. All individuals require health-related care or support at some point during their life. For example, infants require the care of others for survival, including basic daily activities like acquiring water, feeding, and hygiene. Impairment and disability may be sporadic, rather than chronic. During pregnancy, especially the days or weeks around birth, women's mobility may be limited and recovery from birth likely would require care provisioning from others, including acquiring food and water and assistance with hygiene and mobility. Additionally, the special status of pregnant women and new mothers might include additional accommodations and support.

3.2 Tombos and Old Age

Tombos is a site located on the Third Cataract of the Nile River in the northern part of modern-day Sudan. The cemetery at Tombos was used continuously from the New Kingdom Period (*c*. 1450 BCE) through the Third Intermediate Period and into the Napatan Period (*c*. 750 – 660 BCE). The cemetery is comprised of a number of different structure styles, including pyramid and chapel complexes, underground chamber tombs, tumuli, and pit and subsidiary graves. Some of all of these types of structures first appear in the New Kingdom Period and continue to

appear through to the Third Intermediate and Napatan Periods. Some of the New Kingdom Period structures were reused during later periods as well. Tombos likely served as an administrative center concerned with the tribute from Kush (Nubia) to Egypt and at least one high-level administrator, Siamun the "Scribe Reckoner of the Gold of Kush", was buried at Tombos. Recent excavations at the Tombos settlement, which is associated with the cemetery, indicate that Tombos may have in fact been the Egyptian fortress of Taroy (Smith and Buzon, 2018).

Old age at Tombos can be investigated utilizing a variety of data including demographic patterns, osteoarthritis, entheseal changes, and oral health. The utility of Transition Analysis in bioarchaeology is well established within bioarchaeological and forensic anthropology settings (Boldsen et al., 2002; Milner and Boldsen, 2012). The availability of easy to use software has increased the prevalence of this method in bioarchaeological literature and is particularly useful in bioarchaeological contexts because it accommodates incomplete and fragmentary remains. In the Tombos sample, there are a number of older individuals and these individuals are found throughout the Tombos cemetery in the different types of funerary structures. Transition Analysis in the Tombos collection is ongoing; however, preliminary results indicate that within the group of adults estimated to be 45+ years there is a high frequency of individuals that are over 65 years of age. Additionally, there is evidence that some individuals at Tombos were living into their 80s.

Osteoarthritis refers to lesions that result from primary inflammatory processes. Most commonly lesions present as marginal (osteophytic) lipping, and in more severe forms as eburnation (articular surface is pitted and/or polished). Degenerative joint disease is related to several factors including mechanical stress, genetic predisposition, and variation in age (Steckel et al., 2011). Factors such as sex, repetitive activities, and weight all can influence osteoarthritis. However, the largest influence, both in terms of onset and severity, on osteoarthritis is age (Weiss

and Jurmain, 2007). While osteoarthritis is not a certain part of growing old, the greatest risk factor for osteoarthritis is older age (Anderson and Loeser, 2010). Recently some scholars have begun examining osteoarthritis from impairment and disability perspectives to understand the individual and potential community-level impacts (e.g. Domett et al., 2017). Entheseal changes are at stress sites were tendons and ligaments attach to bone and are a result of repeated muscle use. Entheses can be used broadly to examine physical activity levels over an individual's lifetime (Havelková et al., 2011; 2013; Lieverse et al., 2012; Palmer et al., 2016; Villotte et al., 2010; Villotte and Knüsel, 2013). Genetics, age, body size, and many other factors impact entheseal changes (Milella et al., 2012; Weiss, 2003; 2004; Wilczak, 1998).

Schrader (2012) examined indicators of osteoarthritis from a sample of individuals at Tombos. Within the discrete burials, there were no instances of eburnation. Lipping was the most common indicator observed, while the frequency of porosity was limited. The Tombos sample has comparatively lower frequencies of indicators of osteoarthritis compared to other Nile Valley collections. Schrader and Buzon (2017) examined 17 fibrocartilaginous entheses, reflecting the major muscle/ligament attachment sites in the upper and lower body. The authors examined a total of 50 adult individuals from the Third Intermediate and Napatan Periods. In comparison to the New Kingdom Period sample (n = 97), Schrader and Buzon (2017) found significantly higher scores for those related to shoulder movement, elbow movement, wrist/hand movement, and all entheses of the lower body, excluding the left popliteus. Overall, these data demonstrate an increased level of physical activity from the New Kingdom into the Third Intermediate/Napatan Periods.

Oral health has important implications for an individual's health status and can provide insight into diet, episodes of stress, and the rate of oral infection in a population. Antemortem tooth

loss can result from carious lesions, as well as severe dental attrition and periodontal disease (Steckel et al., 2011). Dental health, especially antemortem tooth loss and periodontal disease, are age-related. In addition, these are more visible characteristic of aging compared to other characteristics such as osteoarthritis, as other individuals would easily be able to see antemortem tooth loss and the distinctive recession of gums associated with periodontal disease. Abscesses can also be a result of carious lesions or of rapid tooth wear which exceeds the ability of dentin to fill the pulp chamber. Subsequently, abscesses can affect the surrounding bone, resulting in openings in the maxilla or mandible. They are considered to be painful and potentially life-threatening. In addition, they reduce an individual's resistance to disease and affect an individual's ability to eat (Steckel et al., 2002; Steckel et al., 2011). Buzon and Bombak (2010) examined 85 individuals from Tombos for frequencies of carious lesions, abscesses, antemortem tooth loss, and dental attrition. The Tombos individuals have a high frequency of abscesses (48%) and antemortem tooth loss (72%); however, they demonstrated a low rate of carious lesions (24%). Tombos individuals also had a high frequency of tooth wear in comparison to other Nile Valley collections. Furtner and Buzon (2019) also examined individuals from all Tombos tomb types for dental disease and found a difference in dental disease between the type of funerary structure. There is a difference in antemortem tooth loss between tumuli (16.59%), pyramid (19.74%), and underground chamber (26.5%) tomb types. A similar frequency pattern was noted for tumuli (2.57%), pyramid (6.31%), and underground chamber tombs (9.99%) for abscesses. A different pattern was noted for the carious lesions with individuals buried in pyramids having the highest frequency (10.00%), followed by underground chamber (6.46%) and tumuli (2.22%) tomb types. Additionally, individuals buried in pyramids had significantly higher rates of wear compared to those from tumuli. The authors suggest that these results are related to social class and potentially differing

diets related to class and cultural variation between Nubians and Egyptians (Furtner and Buzon, 2019).

Individuals buried in the Tombos cemetery include a number of older individuals, including those that lived into their 80s. Overall, older individuals displayed limited indicators of osteoarthritis. These data combined with entheseal change data indicate that individuals at Tombos were not participating in strenuous physical activities. However, individuals throughout the Tombos cemetery displayed oral health issues, including significant dental attrition, carious lesions, abscesses, and antemortem tooth loss. As individuals at Tombos aged, these dental health issues would have worsened and likely impacted daily life in negative ways. These data provide information regarding the health of older individuals generally at Tombos, and a foundation for a more detailed examination of old age. However, individual-level data provide further insight into life for older adults. To highlight the experience of old age at Tombos, one individual (U34.B1) will be analyzed in greater detail to examine the intersection of impairment, disability, and old age.

3.3 Case Study: U34.B1

U34.B1 was excavated from a Nubian style tumulus at the Tombos cemetery in 2011 and is an older adult female. Transition Analysis indicates that U34.B1 was over 70 years old at the time of death and possibly closer to 80 years old. Currently, U34.B1 is housed at the Bioarchaeology Laboratory at Purdue University. U34.B1 was found extended and supine, with head to the west. This individual was buried in an Egyptian-style coffin on top of a Nubian-style bed and a large ceramic vessel was included with the burial. Results of radiocarbon dating combined with the associated ceramic vessel indicates that the burial dates to the late Third Intermediate Period, circa 885-843 BCE (Figure 1). The skeletal remains of this individual were fairly well preserved; however, due to the fragile and light nature of the bones there was some fragmentation as a result

of the burial context and removal of the remains. U34.B1 was analyzed following standard procedures (Buikstra and Ubelaker, 1994; Boldsen et al., 2002) and a differential diagnosis was conducted following Ortner (2003).

Figure 1. U34.B1 *in situ*. Photo credit: Stuart Tyson Smith

Radiogrammetry of U34.B1's second metacarpal indicates that based on cortical thickness this individual has osteoporosis (Sanders, personal communication). Additionally, U24.B1 displays evidence of degenerative joint disease in the spine and oral health issues. Due to the fragile nature of the bones, some of the vertebrae were damaged postmortem and were not able to be observed for all characteristics. Osteophytic growth was observed on at least 11 vertebrae. Additionally, at least three vertebrae had compression fractures and three vertebrae displayed Schmorl's nodes. Like the postcrania, the fragile nature of the bones of the skull, especially the alveolar bone of the maxilla, was damaged postmortem. However, U34.B1 had significant dental

attrition, periodontal disease, at least three small abscesses, and at least two teeth were lost antemortem. In addition, pathological changes were observed in the proximal portion of the right hip joint, where the majority of the femoral head, greater trochanter, lesser trochanter, and femoral neck was resorbed (Figures 2, 3, and 4). The bone at the proximal portion of the femur and the femoral head was actively remodeling, with woven bone. Due to the preservation and fragmentation of the right os coxa in the location of the acetabulum, potential pathological changes were not observable on this element. Radiographs show a small amount of reactive compact bone formation (sclerosis) in the affected areas of the femoral head and proximal shaft (Figure 5). A differential diagnosis was performed on U34.B1 and considered several conditions including Legg-Calvé-Perthes disease, a slipped femoral capital epiphysis, and neoplasm. It was determined that the most likely cause of the changes observed in the proximal femur were related to a severe, non-union fracture on the femoral neck.

Figure 2. Close-up of the proximal right femur. From left to right: medial, posterior, lateral, and anterior views

Figure 3. U34.B1's right and left femora. Note the extensive resorption of the proximal femur, including greater and lesser trochanters, femoral neck, and femoral head

Figure 4. Detail of the right femoral head. Note the extensive resorption of the femoral head.

Femoral neck or “hip” fractures have a high correlation with age (older adults) and sex (female). Prior to advances in surgery (such as surgical nails and pins), it was not uncommon for patients to die. Osteoporosis-related hip fractures account for the highest morbidity and mortality among older age groups (Curate et al., 2010; Dequeker et al., 1997; Ortner, 2003). Accounts from

Figure 5. Radiograph of U34.B1's right femur. Radiograph was taken at Purdue University Student Health Service

the early 1900s suggest that most patients died within the first eight weeks and those that survived were left severely impaired (Ridlon, 1901:61 in Byrnes, 2015). Hip fractures, especially subcapital or transcervical fractures of the neck, can subsequently lead to avascular necrosis (Ortner and Putschar, 1985). In older adults, the most common cause of a fracture is indirect trauma like osteoporosis, which is increased by the risk of falling (Curate et al., 2010; Djuric et al., 2006). In modern clinical settings, hip fractures associated with osteoporosis account for the large proportion of morbidity and mortality in older adults and hip fractures are related to the highest public health costs of osteoporosis (Dequeker et al., 1997). Avascular necrosis can arise subsequent to trauma when the blood supply is disrupted leading to the death of tissue and osteolysis (Ortner and Putschar, 1985). The proximal femur is a common site for post-traumatic osteolysis and subcapital or transcervical fracture of the femoral neck is frequently complicated by avascular necrosis on part or all of the femoral head (Dequeker et al., 1997; Ortner and Putschar, 1985). The pathological condition observed in U34.B1's right hip joint is most consistent with an injury resulting in a severe non-union fracture of the femoral neck associated with osteoporosis, with subsequent avascular necrosis. The significant resorption and remodeling observed at the femoral neck and head indicate that U34.B1 survived after the initial onset of the condition. Analysis of U34.B1's conditions can provide insight into the type and nature of potential health-related care provisioning provided by the community (Tilley, 2015).

3.3.1 Care Provisioning

Accommodation

U34.B1 displays evidence of degenerative joint disease in the spine. Individuals with degenerative joint disease in the spine can experience a range of symptoms from mild to severe.

Some people with degenerative joint disease of the spine experience little interference with activities in their daily lives, while others may find it difficult to participate in normal activities. Symptoms include pain, stiffness, tenderness, loss of flexibility, grating sensation, and swelling. Additionally, the formation of osteophytes may place pressure on the nerves of the spine causing weakness and/or pain in the arms and legs. Discomfort in the back can be relieved by laying down. However, discomfort can also produce sleep disturbances from the symptoms. In clinical settings, patients where the symptoms of degenerative joint disease impacted daily life also reported feelings of isolation due to decreased mobility and depression (Mayo Clinic, 2019b). It is not possible to tell from U34.B1's skeletal remains the degree of symptoms that would have been experienced related to degenerative joint disease as studies have demonstrated a discordance between what is observed skeletally (i.e. via radiographs) and pain level (Hannan et al., 2000).

Antemortem tooth loss would have made consuming certain types of food, such as meat, more difficult. Soft foods, such as gruel and well-cooked items would have been easier to consume. Additionally, the small abscesses and periodontal disease are associated with pain during chewing, bleeding of the gums, bone loss, and tooth loss (Mayo, 2019a). Worsening dental health for U34.B1 would have likely necessitated the modification of the types of consumed food. The temperature of consumed food and drink might have also been modified as a result of temperature sensitivity to hot and cold. As U34.B1 increased in age, health-related care provisioning from others, in the form of accommodation due to decreased ability to engage in certain activities, may have been provided.

Direct care

U34.B1 displays a severe, non-union femoral neck fracture, likely related to osteoporosis, with subsequent avascular necrosis. The degree of remodeling and bone resorption indicates that

U34.B1 lived for a period after the onset of the condition, perhaps several weeks. During this period, U34.B1 would have required direct care provisioning from individuals in the community. The onset of this condition would have been sudden, requiring new, acute care that was likely not previously necessary. U34.B1 would have likely felt severe pain on the onset of the injury. However, it has been suggested that if the fracture impacts nerves in the proximal femur appropriate pain might not be felt and an individual could cause further damage by continuing to walk (Ortner and Putschar, 1985). However, in most cases, a femoral neck fracture of this severity would be associated with high levels of pain, especially with movement. U34.B1 would likely have been unable to walk and mobility would have been greatly reduced. In fact, in the days following the injury U34.B1 would probably have had limited mobility and maintained a posture where the right leg and pelvis was immobilized. Other individuals in the household or community would have needed to provide direct care provisioning for hygiene and obtaining food and water. It is likely that others would have also needed to assist U34.B1 with eating and drinking.

3.4 Discussion and Conclusion

Older age, impairment, and disability are important components of the life course but have been mostly overlooked in Egyptian and Nubian bioarchaeology. One possible reason for this phenomenon is that old age, impairment, and disability as categories are difficult to define and operationalize. In many archaeological settings, evidence for what was considered to be ‘old’, ‘impaired’, or ‘disabled’ by a community is limited or difficult to evaluate. Even with extensive documentation from ancient Egypt, determining who would have been considered old, and the relationship between old age and chronological age, is difficult to cement. These issues are further complicated by methodological limitations in age estimation. Many traditional bioarchaeological methods for estimating age are not able to provide detailed age at death estimations for older

individuals. The use of Transition Analysis will hopefully contribute to increased investigations into old age in the past.

A broad examination of old age at Tombos reveals that many individuals were living into their 60s and 70s, and even into their 80s. Individuals here do not have many indicators of osteoarthritis or entheseal changes, indicating that the inhabitants of Tombos were not subjected to strenuous physical activities throughout their life. In addition, adults from Tombos show relatively few non-specific stress indicators associated with infection and nutritional deficiency (Buzon, 2014). These results correspond to evidence that suggests Tombos was an administrative center with a community of middle-class and elite individuals involved in the coordination of the tribute from Kush to Egypt (Buzon et al., 2016). Individuals throughout the Tombos cemetery display oral health issues and it would be common for members of this community to have significant dental wear, carious lesions, abscesses, and antemortem tooth loss. Dental health would have worsened as individuals aged and may have impacted day to day life through difficulties with chewing and pain.

Older age is often not considered from an impairment or disability perspective. However, impairment and disability studies can help inform research investigating the later decades of life in the past. Use of a life course approach enables researchers to integrate disability and impairment models into the investigation into older age. An especially fruitful avenue for the incorporation of disability perspectives into old age studies is through analysis at the individual level. The case study of U34.B1 highlights the experience of old age suggested by the community-level data, by providing a narrative from a single individual's experience of daily life as an older member of the Tombos community.

Some fundamental questions can be addressed in U34.B1's case. Was U34.B1 perceived as old by the Tombos community? Transition Analysis indicates that U34.B1's chronological age was over 70 years and possibly closer to 80 years. Historical documentation from Egypt indicates that old age was often associated with physical changes and U34.B1 would have experienced several physical changes while aging. U34.B1's physical changes related to degenerative joint disease may have impacted U34.B1's mobility, pain level, and daily life. In addition, visible changes in U34.B1's dentition, such as significant dental wear and antemortem tooth loss, may have been associated with older adults at Tombos. These age-related changes observed in U34.B1 correspond to the patterns observed in the broader Tombos community.

Another question that can be considered is whether U34.B1 was impaired or disabled. Excluding the traumatic injury sustained near the end of life, it is difficult to evaluate whether U34.B1 was considered impaired or disabled within the Tombos community. Degenerative changes are associated with stiffness, a decrease in mobility, discomfort, and even pain. However, it is unclear if U34.B1 would have experienced these symptoms, and if so what the severity of these symptoms would have been. However, it is possible that U34.B1 would have experienced limitations in mobility, stiffness, or even pain due to the degenerative changes observed in the spine. U34.B1 also had dental health issues including periodontal disease, abscesses, dental wear, and antemortem tooth loss. These conditions can greatly impact individual health through discomfort, bleeding, and difficulty chewing, which in turn impacts the type and quantity of food that can be consumed. It is possible that the Tombos community provided accommodation to meet with U34.B1's changing abilities and health during the older years. However, when compared to the wider Tombos community, the changes U34.B1 experienced would not have been unique

among older adults, and these 'accommodations' might have been considered a normal part of the ancient Egyptian life course and therefore not disabling.

However, it is clear from the skeletal evidence that U34.B1 would have required direct support for a significant impairment near the end of life. U34.B1 suffered from a severe non-union femoral neck fracture with subsequent avascular necrosis. This injury would have very suddenly changed U34.B1's daily life. Femoral neck fractures are often accompanied by high levels of pain and would have required U34.B1 to immobilize the right leg and hip joint. During this period, U34.B1 would have relied on others for daily necessities, including obtaining food, water, and basic hygiene. It is likely that U34.B1 would have also needed assistance with eating and drinking. This acute condition would have required direct care by other members of the Tombos community and would have likely been considered a disability. The combination of population-level and individual-level data provides a more nuanced picture of old age at Tombos. Furthermore, the use of a life course approach allows for the integration of impairment and disability models into the study of old age in the past.

The examination of old age provides a broader understanding of health at the site of Tombos and a more detailed understanding of age-related health changes. The use of a life course approach allows for the examination of the intersection of old age, impairment, and disability by using multiple levels of analysis to explore broad changes in health throughout the Tombos community and the more detailed examination of individual-level changes experienced by U34.B1. A more detailed understanding of the experience of old age at Tombos is possible through the combination of diverse types of data.

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CHAPTER 4. DWARFISM IN ANCIENT EGYPT: UTILIZING THE BIOARCHAEOLOGY OF CARE APPROACH TO INVESTIGATE LÉRI-WEILL DYSCHONDROSTEOSIS AND DISABILITY IN ANCIENT NUBIA

4.1 Introduction

The cemetery of Tombos is located at the Third Cataract of the Nile River in modern-day Sudan. The Tombos cemetery was in use beginning in the New Kingdom Period (*c*. 1450 to 1050 BCE). During this period Egypt colonized portions of Nubia, including Tombos, which likely served as an administrative center related to the annual tribute from Kush to Egypt. The large size of the fortification system in the settlement at Tombos, as well as the high rank of individuals buried at the Tombos cemetery, suggests that Tombos may be the fortress of Taroy (Smith and Buzon, 2018). Nubians and Egyptians cohabitated at Tombos and there is evidence that over time individuals at Tombos formed a mixed and entangled community. Isotopic analysis demonstrates that Egyptian colonists came to Tombos even late into the New Kingdom Period (Buzon et al. 2016). Egyptian mortuary practices, including monumental pyramid complexes and Egyptian-style artifacts, are prevalent in the New Kingdom Period structures of the cemetery. Within one of these Egyptian-style elite pyramid structures an individual (U36.Sh2.B10) with Léri-Weill dyschondrosteosis (LWD), a form of disproportionate dwarfism, was discovered and is the focus of this investigation.

Disability and impairment studies have increased in bioarchaeological research recently and over the last several years increasing attention has been placed on the bioarchaeology of care methodology and associated Index of Care (Tilley, 2015b; Tilley and Cameron, 2014; Tilley and Oxenham, 2011; Tilley and Schrenk, 2017). U36.Sh2.B10 provides an interesting case to utilize the bioarchaeology of care perspective to examine health-related care provisioning in New

Kingdom Period Egypt, given the number of publications discussing dwarfism in ancient Egypt. Additionally, many case studies utilizing the bioarchaeology of care methodology focus on individuals with severely physically and socially limiting conditions. U36.Sh2.B10 highlights how the bioarchaeology of care methodology can be used to examine conditions that are less severely physically limiting in the past. Furthermore, the case of U36.Sh2.B10 is a compelling comparison to the case of Romito 2, another individual with disproportionate dwarfism from a site in southern Italy dating to around 11,000 BP, which has received attention in the bioarchaeology of care literature.

4.1.1 Disability and Bioarchaeology

Disability and impairment have been discussed within archaeological and bioarchaeological contexts for several decades (e.g. Dettwyler, 1991; Frayer et al., 1987; 1988; Hawkey, 1998). However, impairment and disability identity have not entered into the archaeological canon with the same attention as other aspects of identity, such as sex and gender (Díaz-Andreu, 2005; Wylie, 2007), ethnicity (Emberling, 1997; Jones, 1997; Lucy, 2005a), and age (Gowland, 2006; Joyce, 2007; Lucy, 2005b; Sofaer, 2007). There are several contributing factors to the lack of integration of disability studies into archaeology, including undertheorization and a perceived or real inability to investigate disability and impairment outside of case studies (Byrnes and Muller, 2017; Tilley, 2015b). Recently, attention to theory and methods to investigate disability in the past have increased dramatically, with a number of works being produced (e.g. Byrnes and Muller, 2017; Powell et al., 2017; Tilley, 2015b; Tilley and Schrenk, 2017).

Defining impairment and disability

Several terms are fundamentally important to disability studies. However, there is no clear consensus on the definitions for these terms in the paleopathological and bioarchaeological literature and the terms are often used interchangeably. Impairment and disability are related to one another but conceptually distinct. Impairment is defined by Roberts (1999:) as "a functional limitation within the individual caused by physical, mental or sensory impairment". The World Health Organization defines impairment as "any loss or abnormality of psychological, physiological, or anatomical structure or function" (WHO, 1980:47). Under the social model of disability, impairment is viewed as a biological "fact," and therefore without any social connotations, whether positive or negative (Metzler, 2006). In contrast, disability is "the loss or limitation of opportunity to take part in the normal life of the community on an equal level with others, due to physical or social barriers" (Roberts, 1999:83). The World Health Organization refers to disability as the "restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for a human being" (WHO, 1980:143). Metzler (2006) uses disability to refer to the "social constructedness of the relationship between the impaired body and the culture and society that body's owner inhabits" (Metzler, 2006:20).

While there is variability in the acceptance of these terms, unless otherwise noted, when the term 'impairment' is used here it will refer to the loss of function or functional limitation, for example, the inability to fully extend or bend the leg. The term 'disability' on the other hand will be used to refer to a cultural construct, in which the impairment restricts the ability to participate fully in the life of a community in the manner considered culturally appropriate. These definitions are influenced by modern Western constructions and perspectives. Disability and impairment should not be universalized and cross-culturally these terms have varied definitions and

experiences (Finlay, 1999; Roberts, 2000). However, some methods for considering impairment and disability can provide outlines for the investigation of impairment (e.g. Tilley, 2015b). Disability studies of past populations are influenced by modern, Western perspectives of disability, which often emphasize the relative degree of need, health care provisioning, and dependency (Zakrzewski, 2014b). The perspective of an impairment as a disability is culture-specific and can be related to the prevalence of the impairment within a community (Metzler, 2006). For example, in places where the impairment is especially prevalent, the impairment may not be viewed as abnormal, such as among the congenitally deaf in Martha's Vineyard (Dettwyler, 1991). Conversely, an impairment that is especially rare might also not be viewed as a disability, rather as an example of divine touch, gift, or special ability. For example, ancient Egyptians venerated the dwarf god Bes, who is associated with fertility and pregnancy. Female dwarves were considered to be particularly good midwives and were associated with this profession (Kozma, 2006; 2010).

Bioarchaeology of Care

Since the bioarchaeology of care approach was introduced an increasing number of publications have been dedicated to utilizing the method. Tilley and Schrenk (2017) bring together a number of case studies that have developed since the approach was first introduced and are emblematic of the diversity of cases utilizing the bioarchaeology of care methodology, including those from Precontact Southwest United States (Willett and Harrod, 2017), Medieval Poland (Matczak and Kozłowski, 2017), Prehistoric Peru (Jolly and Kurin, 2017), and Bronze Age United Arab Emirates (Schrenk and Martin, 2017). Additionally, a number of other publications utilize the bioarchaeology of care methodology including those investigating health-related caregiving in 19th century Kentucky (Worne, 2017), Metal Period Philippines (Vlok et al., 2017), Late Archaic

northeastern North America (Vairamuthu and Pfeiffer, 2018), Neolithic Sweden (Tornberg and Jacobsson, 2018), late medieval Ireland (Tesorieri, 2016), Late Intermediate Period Peru (Palma Málaga and Makowski, 2019), and in Neanderthals (Spikins et al., 2018). However, the majority of these publications focus on individuals with physically severe impairments. In comparison, there are relatively few case studies of individuals with more minor functional impairments.

Limitations to finding disability in the past

There are several limitations to the investigation of disability in the past, especially within ancient populations. The visibility of impairment can have a profound impact on how individuals are perceived in their community (Appleby, 2010). Many conditions associated with health problems do not leave skeletal marks but still greatly impact daily life (Zakrzewski, 2014b). In addition, many diseases do not exhibit external manifestations, such as anemia, and therefore may not be perceived as impairments or disabilities by a given society. Conditions such as these are rarely considered a disability within paleopathology, despite the potential for these conditions to impact how individuals are perceived within their community and an individual's ability to participate in daily activities. Further, some diseases may not influence a person's mortality but may have had an impact on an individual's ability to work and reproduce, which in turn could influence one's social and economic status (Metzler, 1999). The economy of a community influences the diverse ways individuals contribute and may impact what is considered a disabling condition within a community (Dettwyler, 1991; Roberts, 1999; 2000). All individuals will experience periods where health-related care is necessary, such as during infancy, the hours/days surrounding childbirth, acute illnesses, and so on. Disability and ability are fluid and relate to a society's or community's ideas of "normalcy" (Zakrzewski, 2014a). Assessing disability in the past stems from assumptions of what constitutes a disabling condition. Minor bone damage can

cause extreme pain, while a severe impairment might not impact an individual's ability to normally function. For example, it has been documented in modern communities that individuals with leprosy who have lost fingers are capable of performing activities that require high dexterity, such as needlework (Roberts 1999; 2000).

4.1.2 Impairment and Disability in Egypt

Impairment and disability have been considered in ancient Egypt on a general level, as well as within the context of paleopathology and bioarchaeology (e.g. Jeffreys and Tait, 2000; Zakrzewski, 2014a; 2014b). Additionally, several case studies investigate specific conditions, such as dwarfism and related them to impairment and disability in ancient Egypt (e.g. Kozma, 2006; 2008; 2010; Kozma et al., 2011; Molto and Kirkpatrick, 2018). There are a variety of sources from which researchers can investigate themes of impairment and disability in ancient Egypt, including skeletal remains (Kozma et al., 2011), mummified remains (Nerlich et al., 2010), artistic depictions (Dasen, 1993; Hawass, 1991; Kozma, 2008; Kozma, 2010), and texts (Baines, 1992; Dasen, 1993). Many publications regarding disability in ancient Egypt include discussions of dwarfism, usually ascribed to achondroplasia if a specific type of dwarfism is mentioned. However, other types of disproportionate dwarfism are found in ancient Egypt (e.g. Whitmore and Buzon, 2019) and diagnoses of a specific type of dwarfism from artistic depictions, texts, etc. are problematic. It is likely that some cases that have been diagnosed solely as achondroplasia may actually represent different types of dwarfism, as has been found in other revisited cases of dwarfism in other regions (e.g. Cormier et al., 2017).

Individuals with dwarfism have been documented in all parts of Egyptian society, from personal attendants, to jewelers, to entertainers, to high-ranking officials in the Egyptian hierarchy. Three words have been identified as relating to individuals with short stature (*dng*, *nmw*, *and ḫw*ʿ)

and are often associated with determinatives of disproportionate dwarves with short limbs (Dasen, 1993). While many of the documented high-ranking dwarfs lived during the Old Kingdom Period (*c*. 2600-2150 BCE), evidence of the importance of dwarves are found throughout the whole of ancient Egyptian history (Kozma, 2006). Perhaps one of the most well-known examples is Seneb and his family from the 4th Dynasty. Seneb and his family are depicted in a statue that was excavated in the 1920s at the Giza necropolis. The statue of Seneb shows him in the seated position of a scribe with his wife and two children (Figure 6). Seneb appears to have disproportionate dwarfism, perhaps achondroplasia (Kozma, 2006). Another example is the statue of the dwarf Perniankhu who was approximately 40 years old at death and had a form of disproportionate dwarfism. The statue of this individual mimics the skeletal remains found in association with the statue, both in terms of proportions and measurements (Kozma, 2006). Perniankhu also lived during the Old Kingdom Period and was a court official during the 5th or 6th Dynasty. The statue includes the inscription 'the King's acquaintance, (the dwarf) of the Great Palace, Pr-n(j)-'nḫ(w)' (Hawass, 1991). However, some translations of the description include references to 'the dancing dwarf' (Hawass, 1991; Kozma, 2006). The dwarf Djeho lived during the 30th Dynasty and his sarcophagus includes a life-sized side profile/figure of Djeho and displays the characteristics associated with disproportionate dwarfism, perhaps achondroplasia (Baines, 1992; Kozma, 2006). There are several other cases of dwarfism that are attributed to individuals who did not hold high ranking positions, such as the female worker found with fetal bones from an Old Kingdom Period cemetery near the pyramids at Giza (Kozma et al., 2011) and an adult female with proportionate dwarfism from the Third Intermediate Period cemetery in the Dakhleh Oasis, Egypt (Molto and Kirkpatrick, 2018). Medical papyri do not reference dwarfism, perhaps because ancient Egyptians do not consider this type of condition as a disorder or disease (Kozma, 2006).

Figure 6. Seneb, a dwarf with his family. Reproduction, 1934, of a photograph of a statue. Photo Credit: Wellcome Collection

New Kingdom Period magical spells invoke the protection and assistance of both dwarves and dwarf gods against a myriad of dangers, including snakes and fire (Dasen, 1988). For example, "*O you dwarf of heaven! You whose face is big, whose back is long, and whose legs are short*" is part of a New Kingdom Period magical spell beseeching the intervention of a divine dwarf (Dasen, 1988:258). New Kingdom Period wisdom texts also reference dwarves and indicate a level of tolerance for impaired individuals, including dwarves. For example, the *Instruction of Amenemope* advises readers, "*Do not laugh at a blind man, Nor tease a dwarf, Nor cause hardship for the lame.*

Don't tease a man who is in the hand of the god [meaning one who is ill or insane]*, Nor be angry with him for his failings.*" (Lichtheim, 2006:165). The examples of the New Kingdom Period magical spell and the passage from the *Instructions of Amenemope* suggest very different social implications for dwarves in ancient Egypt. However, both demonstrate that dwarves were marked as different in some way.

There are several ancient Egyptian gods who are depicted with dwarfism, although the best known are probably Bes and Ptah. Bes was a popular god in ancient Egypt, especially during the New Kingdom Period (Dasen, 1993). Bes is often depicted with a combination of animal and human features. In addition, Bes is presented with a form of disproportionate dwarfism and is often displayed in objects, including amulets (Figure 7) and figurines (Figure 8), but is also found in reliefs and paintings associated with childbirth in the New Kingdom Period (Dasen, 1993). Bes is a household protector and is often associated with fertility, pregnancy, childbirth, infants, and mothers and is often connected with Taweret the goddess of pregnancy and childbirth as a protector (Dasen; 1993; Kozma, 2006). Furthermore, papyri from the New Kingdom Period describe magical spells to protect the mother and child during birth, appealing to dwarves, probably specifically Bes, for their assistance (Kozma, 2008). Ptah is associated with regeneration and rejuvenation. Ptah is sometimes depicted with disproportionate dwarfism, perhaps achondroplasia, and frequently as a dwarf in amulets during the New Kingdom Period (Dasen, 1988; 1993). Ptah is the patron god of craftspeople and was particularly revered at Deir el-Medina, the New Kingdom Period village associated with the building of the tombs in the Valley of the Kings (Kozma, 2006). It is not surprising that dwarves in ancient Egypt were associated with certain crafts, such as the dwarves shown making jewelry in tomb scenes from the tomb of Mereruka (vizier to the Titi of

the 6th Dynasty) and with nursing and midwifery (Kozma, 2006), given the close association with Bes and Ptah.

Figure 7. Amulet of Bes from Tombos. Figure of Bes is shown in a crouched position with a fine detailed feathered headdress. Photo credit: Stuart Tyson Smith.

Figure 8. Four figures of Bes on a faience cosmetic vessel from Tombos. Photo credit: Stuart Tyson Smith

4.2 Materials and Methods

The focus of this study is the individual identified as U.36.Sh2.B10, an older adult female who displays a form of disproportionate dwarfism, most likely LWD (Figure 9). This individual was excavated during the 2017 field season of the Tombos Archaeological Project (Directors: Drs. Stuart Tyson Smith and Michele Buzon). The skeletal remains from this project are housed at the Purdue University Bioarchaeology Laboratory. A complete differential diagnosis for U36.Sh2.B10 can be found in Whitmore and Buzon (2019). U36.Sh2.B10 displays several characteristics associated with LWD including short stature, mesomelia, and characteristics of the arm and wrist known as Madelung's deformity.

Figure 9. U36.Sh2.B10 *in situ*. Photo credit: Michele R. Buzon

4.2.1 Bioarchaeology of Care Approach and the Index of Care

The bioarchaeology of care approach (Tilley, 2015b; Tilley and Oxenham, 2011) and the Index of Care (Tilley, 2015b; Tilley and Cameron, 2014) are used here to understand the possible health-care provisioning needed to support U36.Sh2.B10 in the community. Tilley and colleagues use the terms 'health-related care', 'care', 'caregiving', and 'care provision' interchangeably. These terms are defined as "the delivery of assistance to an individual experiencing short, medium, or long-term disability as an outcome of pathology" (Tilley, 2015b:3). Health-related caregiving is loosely divided into 'direct support' which relates to activities such as provisioning, hygiene maintenance, nursing, physical therapy, and 'accommodation', which is related to activities where strategies are adopted to enable or facilitate a level of participation in cultural, social, and/or

economic activities. Importantly these care-related terms are not meant to be interchangeable with compassion. The bioarchaeology of care methodology comprises four distinct stages of analysis, each building on the observations and conclusions of previous stages, with the goal of achieving the most comprehensive understanding of the individual's experience of disability and health-related care and allows. Researchers are able to utilize different portions of the model depending on the types of evidence available. These stages are reminiscent of the strategy employed in Hawkey (1998), where the first stage is concentrated on description and measurement and then built upon until the final stage focused on inference. Data gathering and interpretation protocols corresponding to each stage of the bioarchaeology of care analysis were developed into the Index of Care (Tilley, 2015b; Tilley and Cameron, 2014). The goal of the Index of Care is to achieve consistency in data collection and analytical approach across research into past health-related caregiving by providing a structured process for researchers to think through the analysis of a case study. However, the Index of Care provides flexibility and each researcher can choose the aspects of the Index protocol utilized in the study. A detailed account of the bioarchaeology of care methodology and the Index of Care can be found in Tilley (2015b) and Tilley and Cameron (2014), respectively.

4.3 U36.Sh2.B10 and the Bioarchaeology of Care Approach

4.3.1 Index Step 1: Document, Describe, and Diagnose

Step 1 of the Index of Care provides a foundation for subsequent steps and includes information regarding lifeways, mortuary treatment, the individual, possible diagnoses, and health information.

Lifeways context

The cemetery at Tombos and the associated settlement were in use beginning in the New Kingdom Period (*c*. 1450-1050 BCE) and U.36.Sh2.B10 is found within a New Kingdom Period structure. Tombos is located close to the Nile River at the Third Cataract. Cataracts are outcroppings of granite rock that slow the flow of the Nile River and can be used to control movement up and down the river. Tombos' position here is important as it lies on the border of direct and indirect Egyptian control during this period. Given recent findings within the Tombos settlement, it is likely that Tombos is the fortress of Taroy (Smith and Buzon, 2018). Regardless of whether Tombos is, in fact, Taroy, the site's location at the Third Cataract would have been important in controlling the movement of people and goods along the Nile. Tombos was an Egyptian administrative center that facilitated the tribute to Egypt from Upper Nubia, with documented evidence of a high-level administrator, Siamun, "Scribe Reckoner of the God of Kush." As such, individuals at Tombos would have been connected to a wider Egyptian network to the north and a Nubian network to the south (Buzon and Smith, 2018; Smith, 2003). The area surrounding Tombos includes sandy terrain, with small steep areas around the Nile embankment. Next to the cemetery are rocky outcrops, which in later periods were mined and used for the creation of art, such as a large statue of an unnamed ruler, perhaps Taharko, a pharaoh of the 25th dynasty (Schrader and Buzon, 2017).

Even with differences between mortuary treatment, previous studies suggest that the individuals living in New Kingdom Period Tombos were relatively healthy, had low incidences of traumatic injury, and were not participating in strenuous labor (Buzon, 2006; Buzon and Richman, 2007; Schrader, 2012; Schrader and Buzon, 2017). Most individuals do have evidence for oral health issues, especially dental attrition, which can likely be attributed to the sand and grit from quern stones that would have been present in bread (Buzon and Bombak, 2010).

Mortuary treatment

There is evidence for socioeconomic differentiation at Tombos. Some Egyptian-style structures in the cemetery are more modest underground burial chambers, while other structures in the cemetery are elite pyramid and chapel complexes. In addition, the cemetery also has Nubian-style tumuli, circular mounds with underground shafts with side niches. The vast majority of individuals in the cemetery from New Kingdom Period structures are buried using typical Egyptian practices. However, these standardized Egyptian mortuary practices found in many of the adult burials do not extend to the youngest members of the Tombos community and burials of individuals under approximately four to five years of age demonstrate variability in the position and orientation of the remains. There are a few exceptions to these trends, which may be related to factors other than age. One four- to six- year -old individual (U36.Sh2.B5) was interred flexed, on the left side, inside of a basket and associated with a ceramic vessel. However, this individual was much smaller than other four- to six-year-old individuals at Tombos as a result of a type of skeletal dysplasia, probably LWD (Whitmore and Buzon, 2019). Despite the near ubiquitous use of Egyptian mortuary traditions, there is variability in mortuary treatment. Some individuals are buried with extensive and expensive grave goods, ceramics, and offerings, while others have few or none. Many individuals are buried supine and extended with head to the west, following Egyptian standards. However, there is variability in the use of burial furniture such as reed mats, wooden coffins, and ceramic coffins. Nubian-style beds are also found in some graves. Still, other individuals are buried with no trace of burial furniture. U36.Sh2.B10 is buried in a manner similar to other individuals from this period at Tombos. U36.Sh2.B10 is interred in a pyramid in an extended and supine position with the head to the east. While many adult individuals at Tombos are buried with their head oriented to the west, the vast majority of individuals in the same structure as U36.Sh2.B10's are buried with the head to the east. However, this burial orientation is not

unique to U36.Sh2.B10 or to individuals buried in this structure. U36.Sh2.B10 was found with a green glazed steatite scarab on the right hand with an inscription of Amun Re.

U36.Sh2.B10 description

U36.Sh2.B10 is estimated to be female and approximately 50+ years of age at death. The majority of U36.Sh2.B10's postcrania were consolidated *in situ* and recovered, while the skull was extremely fragmented and unable to be reconstructed.

U36.Sh2.B10 has an estimated stature of ~130 cm, using the stature regression formulae developed by Raxter and colleagues (2008) for ancient Egyptians. However, given the difficulty in estimating stature in individuals with disproportionate dwarfism, U.36.Sh2.B10's elements were compared to the elements of other New Kingdom Period females in Whitmore and Buzon (2019). U36.Sh2.B10 displays a reduction in length for all of the long bones, with standard z-scores ranging from -6.38 to -4.34 (measurements for the fibulae were not available from the reference population). A mesomelic pattern of dysplasia (where the middle elements of a limb, i.e. the ulnae, radii, tibiae, and fibulae, are shortened compared to the proximal and distal elements) is observed in U36.Sh2.B10, with the greatest reductions in maximum length as compared to the reference population are found in the radii and ulnae (Whitmore and Buzon, 2019).

In addition to the shortened limb bones, U36.Sh2.B10 displays additional bilateral changes to the forearm, including characteristics associated with Madelung's deformity and decreased carrying angle of the elbow (Figures 10, 11, and 12). U36.Sh2.B10's forearm extension would have been limited to approximately 130 to 135 degrees and is a result of constrained humero-ulnar articulation. Specifically, the distal radius is deformed in both the coronal and sagittal planes, which increases both radial inclination and volar tilt. The carpals, in turn, are arranged in a triangular shape to accommodate these changes (Whitmore and Buzon, 2019). Individuals with

Madelung's deformity, including U36.Sh2.B10, have shortened and thickened styloid processes of the ulna and radius and increased radial angulation of the distal radial articular surface of the ulna (Kozin and Zlotolow, 2015).

Figure 10. U36.Sh2.B10's upper limb compared to the upper limb of a New Kingdom Period female of average stature (based on femur length) from Tombos. Insert displays U36.Sh2.B10's left elbow with decreased carrying angle.

Figure 11. U36.Sh2.B10’s articulated left radius and ulna.

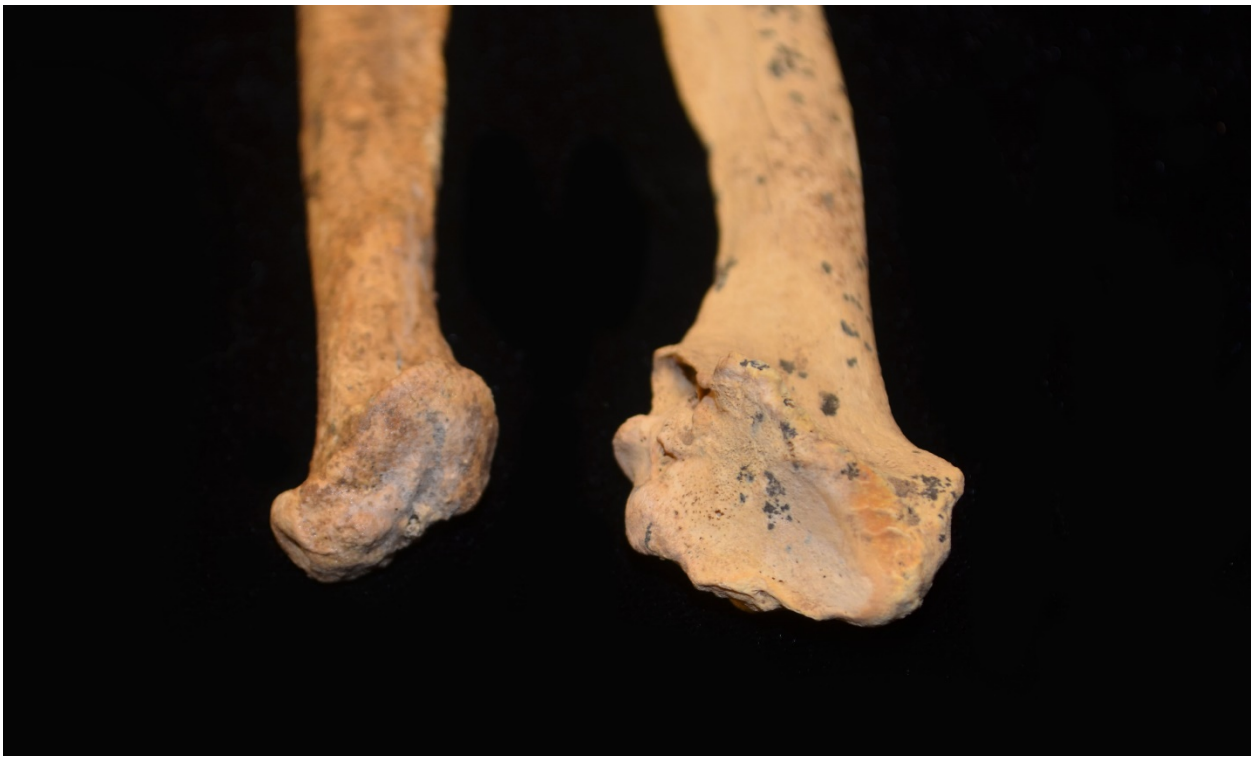

Figure 12. Close-up of the distal aspect of the radius and ulna. Note the unusual shape of the radial and ulnar styloid processes, the ulnar head, and the articular surfaces for the scaphoid and lunate on the distal radius.

U36.Sh2.B10 diagnosis

A differential diagnosis of U36.Sh2.B10 was conducted by Whitmore and Buzon (2019). The full suite of characteristics associated with skeletal dysplasias could not be analyzed given the extremely fragmented nature of U36.Sh2.B10's skull. However, the most likely diagnosis is LWD, a form of mesomelic dwarfism associated with haploinsufficiency of the short stature homeobox-containing gene (*SHOX*) (Belin et al., 1998; Binder, 2011; Bunyan et al., 2016; Child et al., 2015; Ross et al., 2005; Shears et al., 1998).

4.3.2 Index of Care Step 2: Determine Disability

The Index of Care Step 2 examines the individual's pathological conditions and characteristics in conjunction with clinical literature to attempt to understand the impacts that were experienced. In addition, estimates for the duration of these impacts and how these experiences might have changed over time, are assessed.

Clinical impacts

The symptoms, and the severity of the symptoms, of LWD can vary widely between individuals, even those within the same family. However, females tend to have more severe symptoms as compared to males (Child et al., 2015; Lichtenstein et al., 1980; Ross et al., 2005; Schiller et al., 1998). Intelligence is unaffected in individuals with LWD (Heath, 2016).

Compromised mobility: There is a potential for compromised mobility due to short stature and, more specifically, shortened lower limb lengths, which may impact gait. This can lead to early-onset osteoarthritis, although this is not apparent in U36.Sh2.B10, who has few indicators of degenerative joint disease in the spine (limited to minimal osteophytic growth on six vertebral bodies) and few indications of osteoarthritis (limited to minimal lipping and minimal porosity in the upper body) of the limb joints. Short stature and differences in gait may have impacted U36.Sh2.B10's ability to move throughout the landscape, especially in the rocky terrain surrounding the settlement and the steep inclines around the Nile River.

Restricted forearm and hand use (wrist): Pathological characteristics of the upper limbs include incomplete elbow extension to approximately 130-135 degrees. This is a common complication for individuals with LWD. However, the restriction of elbow extension may not fully develop until late childhood or adolescence (Olney, 2016). The restricted forearm extension may have impacted U36.Sh2.B10's ability to participate fully in certain activities. Madelung's

deformity was originally described in 1878, as a painful abnormality of the wrist and forearm that begins in adolescence (Felman and Kirkpatrick, 1969). However, in modern clinical settings not all individuals with Madelung's deformity report discomfort or pain and those that do, report variability in the severity of these symptoms (Al Kaissi et al. 2016). Individuals with Madelung's deformity and incomplete elbow extension also may be unable to fully pronate or supinate their arms (rotate their palms face down or face up). These types of conditions are also associated with degeneration, stiffness, tenderness, and pain at the elbow joint (Olney, 2016). However, as discussed above, U36.Sh2.B10 has limited indications of osteoarthritis throughout the body. Individuals with Madelung's deformity can display limited range of motion or pain, but more commonly exhibit a loss or decrease in wrist extension. Often pain is a result of the dorsal displacement of the ulna and radiocarpal pain often occurs when the wrist is forcibly extended, such as during upper limb weight-bearing activities (Kozin and Zlotolow, 2015). Abnormalities of the wrist associated with Madelung's deformity generally become apparent around puberty and might be visually observed (Heath, 2016). However, in clinical settings many patients are unaware of the abnormal radius or the volar subluxation of the hand and wrist (Kozin and Zlotolow, 2015). Mesomelia is often not noticed until children reach school age and may increase in severity as individuals age (Heath, 2016). The spectrum of SHOX deficiencies is highly variable in phenotype, which is often unnoticed at early ages because the main characteristics of mesomelia disproportions and Madelung's deformity develop over time and may not appear until the second decade of life (Binder, 2011). In fact, in children under six, short stature might be the only visible characteristic and the limb disproportions may be absent (Binder, 2011).

The symptoms of LWD tend to be more severe in females as compared to males, so it is possible that U36.Sh2.B10 may have experienced some of the more significant symptoms

associated with LWD. Characteristics associated with LWD, such as mesomelic shortening of the limbs and Madelung's deformity, were likely not visible during the earliest years but would have become more apparent as U36.Sh2.B10 aged, starting around the second decade of life/puberty. Short stature would have been apparent in U36.Sh2.B10 beginning in early life.

Functional impacts

The Index of Care Step 2 Part 2 continues the model's progress to have the researcher consider "the subject's functional ability to meet normal requirements of daily living and/or to participate within their community at a level appropriate to their demographic" (Tilley and Cameron, 2014:7). This can be further divided into two sections, 'essential' activities, those that are necessary for daily living including feeding, hygiene, and manipulation of objects, and 'instrumental' activities which are those related to daily living in the same 'normal' manner as their peers in a specific set of cultural, social, economic, and environmental contexts. U36.Sh2.B10 probably would have been easily capable of all essential activities from childhood onwards, excluding periods of acute illness.

Individuals with LWD display normal intelligence and U36.Sh2.B10 would likely not have faced any developmental delays as a result of this condition (Heath, 2016). In clinical settings, LWD is often not identified until later childhood or puberty, and it is likely that members of U36.Sh2.B10's community would have only noted U36.Sh2.B10's short stature in early childhood and infancy (Binder, 2011; Heath, 2016). However, during the second decade of life when the physical symptoms of LWD, such as Madelung's deformity and mesomelia, would have increased in observability and symptom severity, these characteristics would become more visible to U36.Sh2.B10 and other members of the community.

U36.Sh2.B10 may have had increased difficulty with mobility compared to peers given the short stature and the sandy and rocky terrain around Tombos. However, given that Tombos was an administrative town, and possibly a fortress, day-to-day mobility within the town would have likely been easier than traversing the surrounding countryside. U.36.Sh2.B10 does not display indications of osteoarthritis except for some minimal lipping and porosity in the joints of the upper limbs or indications of degenerative joint disease of the spine except for minimal osteophytic growth on approximately 25% of the vertebrae, which is not uncommon for older adults at Tombos. In fact, U36.Sh2.B10 is similar to other older adults at Tombos in that U36.Sh2.B10 displays few indications of osteoarthritis (Schrader, 2012; 2013). Long-distance travel may have been more difficult for U36.Sh2.B10. However, overall U36.Sh2.B10's mobility would not be severely limited.

Elbow and wrist limitations may have impacted U36.Sh2.B10's ability to participate fully in all activities without difficulty, discomfort, and/or pain. Using the upper arm to lift the weight of the body from a lying or standing position, pushing a heavy object using the hands/wrists, and other activities requiring full extension of the elbow, extension of the wrist, or supination or pronation of the hands would have been more difficult. While individuals with LWD may have a reduction in upper arm mobility, activities can be easily modified to remove potential discomfort. For example, if an individual is pushing a heavy object with the hand/wrist, another part of the body, such as the shoulder, could be used instead as the point of contact. Other activities, such as those associated with agriculture, may have been more difficult for U36.Sh2.B10. However, there is little evidence that the individuals at Tombos were participating in physically strenuous labor during the New Kingdom Period (Schrader, 2012; 2013) and U36.Sh2.B10 does not have evidence for increased or early-onset osteoarthritis. Individuals with Madelung's deformity may not be able

to fully supinate or pronate their hands/wrist, which may have limited object manipulation. Again, activities requiring these movements can be easily adapted for individuals experiencing a decrease in movement, discomfort, or pain. Movement and dexterity of the hand in not generally impacted in individuals with Madelung's deformity and U36.Sh2.B10 could have engaged in activities requiring finger and hand dexterity such as craftwork. As such, U36.Sh2.B10's participation in some activities at Tombos might have been hindered or modified, but not prevented.

Estimating the need for health care provisioning

There is no skeletal evidence that U36.Sh2.B10 required daily direct care as an adult. During early childhood, U36.Sh2.B10 might not have been perceived as being different outside of short stature, as mesomelia and Madelung's deformity are often not identified until adolescence/puberty. Individuals providing care to U36.Sh2.B10 during the younger years likely would not have required additional effort, outside of the limitations related to short stature. As U36.Sh2.B10 entered later adolescence and adulthood, differences would have become more noticeable. U36.Sh2.B10 would have been much shorter than peers and the mesomelic pattern of the limbs would have become more noticeable in appearance. Around the same time, characteristics of LWD in the upper limbs would have become more pronounced, including the decreased carrying angle of the elbow, visible deformity of the wrist, difficulty with wrist extension, and the inability to fully supinate or pronate the wrists and hands. These symptoms might be accompanied with other symptoms associated with LWD including joint stiffness in the wrist and elbows and pain at the radioulnarcarpal joint. However, the physical limitations associated with LWD would likely have been relatively mild. Potential physical issues could be overcome through simple modifications by U36.Sh2.B10, for example, using their shoulder to push heavy objects instead of pushing with an extended wrist and climbing, rather than stepping

over, barriers. Wrist pain may have greatly impacted U36.Sh2.B10's day to day living experience. However, it is impossible to understand the degree of pain or stiffness that U36.Sh2.B10 would have experienced from skeletal remains alone, as even within modern clinical settings patients experience differing pain levels.

It is likely that individuals at Tombos regarded U36.Sh2.B10 with special consideration. Dwarves are known throughout Egypt from skeletal remains, artistic depictions, historical documentation, and religious iconographies, such as those related to the gods Ptah and Bes. If U36.Sh2.B10 was restricted from participating in certain activities with ease, like agricultural work, different professions, such as craft work or midwifery due to the association with dwarf gods, may have been considered more appropriate. However, participation in these professions are not limited only to individuals with dwarfism. There is nothing in U36.Sh2.B10's burial context that indicates that U36.Sh2.B10 was viewed differently, whether positively or negatively. In fact, U36.Sh2.B10's interment follows a similar pattern found throughout the New Kingdom Period Tombos cemetery. The only difference in U36.Sh2.B10's mortuary treatment was the direction of the body. However, the majority of the individuals buried in the same structure as U36.Sh2.B10 are buried in this orientation and variation in body orientation is observable throughout the Tombos cemetery. This supports other research concluding that dwarfism may have been considered a difference and possibly an impairment, but likely was not considered a disability by ancient Egyptians (Dasen, 1993; Kozma et al., 2011; Sullivan, 2001; Zakrzewski, 2014a; 2014b).

The bioarchaeology of care approach has previously been used to examine an individual with skeletal dysplasia. Romito 2 is an individual with acromesomelic dysplasia and the discussion around the case of Romito 2 (Frayer et al., 1987; 1988) and subsequent reevaluations of the case, including through the lens of the bioarchaeology of care approach (Bower, 2002; Dettwyler, 1991;

Tilley, 2015a) provides a useful comparison to U36.Sh2B10. Differences between the cases of Romito 2 and U36.Sh2.B10 highlight the importance of considering the historical, environmental, economic, and cultural contexts in conjunction with clinical information when utilizing this approach. Both individuals likely had a mesomelic condition falling on the SHOX spectrum, Romito 2 with acromesomelic dysplasia (possibly Maroteaux type) and U36.Sh2.B10 with LWD. Romito 2 and U36.Sh2.B10 would have shared some similar clinical characteristics including short stature, mesomelia, and possibly Madelung's deformity (see Cummings and Rega, 2008). However, the functional impacts on daily life and potential health care provisioning would have likely differed greatly. Romito 2 (estimated to be 17 to 20 years old at death) lived in a hunter-gatherer community in southern Italy. This area is mountainous, and the site is surrounded by heavily forested terrain. Archaeological evidence suggests that the economic and cultural activities of Romito 2's community were quite different from U36.Sh2.B10's community and included the reliance on medium to large-sized herbivores. Tilley (2015:70) evaluated Romito 2 from a bioarchaeology of care perspective and concluded that Romito 2 would "*not* have conformed to the normative role demands of his community – demands dictated by the realities of an active, mobile, periodically-stressed, subsistence lifestyle" and would have likely received care in the form of accommodation. It seems unlikely that U36.Sh2.B10 required much health care provisioning in the form of accommodation and little to none in the form of direct support. Discussions of impairment and disability in ancient Egypt often consider dwarfism. Analysis of U36.Sh2.B10's skeletal remains and mortuary treatment using a bioarchaeology of care approach indicates that LWD might have constituted an impairment or have been considered a difference but would likely have not been perceived as a disability at Tombos during the New Kingdom Period. In death, U36.Sh2.B10 was treated in a similar manner as other individuals who were

buried at Tombos. Additionally, U36.Sh2.B10 may have not been the only individual with LWD who was buried at Tombos. A juvenile individual likely had the same condition and was interred in the same pyramid and chapel complex as U36.Sh2.B10 (Whitmore and Buzon, 2019).

4.4 Conclusion

Many of the published cases utilizing the bioarchaeology of care methodology have focused on cases of impairment where the condition was at times severely limiting. The case of U36.Sh2.B10 demonstrates the utility of the bioarchaeology of care methodology in contexts where the condition is less severely physically limiting by providing a thorough model to investigate how an individual would have experienced life in the local community.

The bioarchaeology of care method and the Index of Care provide useful groundwork for investigating health care provisioning in the past. However, caution should be utilized when using this method, especially in cases where the community environment is unsure or unknown. Additionally, the manifestations of human agency might be absent in the archaeological or skeletal record. For example, analysis of textual documentation, art, etc. indicates that generally dwarfism was not perceived with disfavor by ancient Egyptians. However, that does not necessarily suggest that the members of U36.Sh2.B10's community or immediate family held this individual in high or low regard, with compassion, with hostility, and so on. These critical aspects of an individual's life experience are unfortunately often absent in the bioarchaeological record.

Skeletal manifestations of conditions do not always correlate directly with the experience of symptoms. However, the bioarchaeology of care approach provides a useful model for the consideration of impairments in the past, including those that were not severely physically limiting. Additionally, the approach highlights the importance of considering the historical, cultural, social, environmental, and economic contexts of cases such that even individuals with overlapping

clinical symptoms, such as Romito 2 and U36.Sh2.B10, may have very different impacts to daily life. While U36.Sh2.B10 was likely viewed as different, the combination of archaeological, artistic, textual, clinical, and skeletal data under the bioarchaeology of care approach suggests that dwarfism, including LWD, was not perceived as a disability in ancient Egypt.

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CHAPTER 5. CONCLUSION

The examination of health in the past has been an integral part of bioarchaeology since the inception of the field. Over the decades, theoretical and methodological orientations grew and progressed in bioarchaeology and today a detailed understanding of past health is possible. There are several core components to building a more complete understanding of health and revolve around the utilization of varied data. This dissertation explored aspects of health in the ancient Nile Valley from the C-Group Period (*c*. 2000 – 1600 BCE) to the Napatan Period (*c*. 750-660 BCE). Specifically, this dissertation explores a more detailed reconstruction of health during this period under a life course approach through the inclusion of individuals of all ages, a contextualization of social age categories, the examination of multiple non-specific indicators of general health/stress, and the timing and development of specific conditions in relation to impairment and disability. In combination, these data address overall population-level health and individual-level health. A life course approach is an ideal model for the integration of multiple threads of evidence and identity to understand health in the past.

5.1 Population-Level Health

Examination of population-level data included the examination of non-specific indicators of stress and infection in Chapter 2. These data were compared within and between collections to identify potential patterns related to age, sex, region, and time period. Notably, there was a significant difference between individuals that survived periods of childhood stress (adults) and non-survivors (juveniles) when examining cribra orbitalia. Cribra orbitalia was significantly different between juveniles and adults (as determined by traditional osteological indicators) and social juvenile and social adults (as indicated by archaeological and historical evidence) in all

collections where juveniles and adults could be compared (Tombos, SJE C-Group, and SJE Pharaonic). More specifically, higher frequencies of individuals with cribra orbitalia were observed in the late juvenile social age category (7 – 14 years) and the transition adult social age category (14 - 20 years). These two social age categories correspond to periods of transition, where individuals underwent significant changes in cultural norms and expectations. Both males and females from Al-Widay I had longer femoral lengths in comparison to the other collections. These data suggest that the individuals at Al- Widay I may have been experiencing differences due to social or environmental conditions. Additionally, the Al-Widay I collections originates from the 4th Cataract region, whereas the other collections originate from further north, and it is possible that the differences are related to genetic components and potential femur length. However, in combination with the very few instances of cribra orbitalia (2/68), porotic hyperostosis (0/69), LEH (2/60), and osteoperiostitis (0/1) in the same sample, the larger femur length in the C-Group collection might be related to differences in stress and health between collections.

The importance of including juvenile data in investigations of health is highlighted at Tombos. Previous studies of health at Tombos did not benefit from the addition of the newly excavated juvenile sample. For both cribra orbitalia and LEH, juveniles from Tombos had higher frequencies compared to adults from the same site, especially for cribra orbitalia. Additionally, the use of social age categories revealed important patterns in the non-specific stress indicator data. Individuals in the late juvenile social age category had high frequencies of cribra orbitalia and LEH, indicating that this transitional period was particularly precarious at Tombos. The inclusion of juvenile data in the study of Tombos expands the understanding of health at this site, revealing higher frequencies in non-specific indicators of stress in juveniles compared to adults and high frequencies in individuals in the late juvenile social age category.

Individuals from Tombos were also considered in a broad examination of old age in Chapter 3. This study revealed that many individuals were living into their 60s, 70s, and 80s. Individuals at Tombos do not have many indicators of osteoarthritis or entheseal changes, indicating that the inhabitants of Tombos were not subjected to strenuous physical activities throughout their life. These results correspond to evidence that suggests Tombos was an administrative center involved in the coordination of the tribute from Kush to Egypt. Individuals throughout the Tombos cemetery display oral health issues and it would be common for members of this community to have significant dental wear, carious lesions, abscesses, and antemortem tooth loss. Dental health would have worsened as individuals aged and may have impacted day to day life through difficulties with chewing and pain. The data investigating health at the population-level in the Nile Valley, and at Tombos in particular, was expanded upon in an individual-level analysis.

5.2 Individual-Level Health

Investigations of individual-level health are important components of bioarchaeological and paleopathological research. In this dissertation, two case studies were used to highlight the findings of the population-level analyses and provide a more detailed and intimate narrative of the experience of health. Individual-level analysis does not only stand to highlight population-level data. For example, in Chapter 3 population-level data related to old age provided a rich background to the case study of U34.B1. The intersection of old age, impairment, and disability were explored in U34.B1's case study and detailed the potential impacts and accommodations related to U34.B1's spinal degenerative joint disease and oral health. U34.B1's physical changes related to degenerative joint disease may have impacted U34.B1's mobility, pain level, and daily life. In addition, visible changes in U34.B1's dentition, such as significant dental wear and antemortem

tooth loss, may have been associated with older adults at Tombos. These age-related changes observed in U34.B1 correspond to the patterns observed in the broader Tombos community. Additionally, near the end of life, U34.B1 experienced a severe, non-union femoral neck fracture with subsequent avascular necrosis. U34.B1 would have required direct support for this impairment. This injury would have very suddenly changed U34.B1's daily life. Femoral neck fractures are often accompanied by high levels of pain and would have required U34.B1 to immobilize the right leg and hip joint. During this period, U34.B1 would have relied on others for daily necessities, including obtaining food, water, and basic hygiene. It is likely that U34.B1 would have also needed assistance with eating and drinking. This acute condition would have required direct care by other members of the Tombos community.

In Chapter 4, the bioarchaeology of care approach was employed to understand how an individual with Léri-Weill dyschondrosteosis (LWD) might have been perceived in New Kingdom Period Tombos and the functional limitations associated with LWD. It seems unlikely that U36.Sh2.B10 required much health-related care provisioning in the form of accommodation and little to none in the form of direct support. Discussions of impairment and disability in ancient Egypt often consider dwarfism. Analysis of U36.Sh2.B10's skeletal remains and mortuary treatment using a bioarchaeology of care approach indicates that at Tombos during the New Kingdom Period LWD might have constituted an impairment or have been considered a difference but would likely have not been perceived as a disability. The case of U36.Sh2.B10 highlights the importance of considering the historical, environmental, economic, and cultural contexts in conjunction with clinical information when utilizing the bioarchaeology of care approach. Overall, this dissertation demonstrates that population-level and individual-level analysis can incorporate various types of contextual data gathering using a culturally specific lens to create a rich narrative

of health in the past. The integration of multiple frameworks and approaches aids in the expansion of knowledge on the experiences of health, impairment, and disability in the past.

5.3 Future Directions

One productive avenue for future research is the continued exploration of social age in the ancient Nile Valley. Social age categories in this dissertation were informed by ancient Egyptian texts, artistic depictions, and to a smaller degree, mortuary patterns. For some of the social age categories, such as those relating to older age, less evidence is available for reconstruction and researchers are left with significantly less to examine. Additionally, reconstructions of non-Egyptian social age categories in the Nile Valley are significantly more difficult. In many areas of Nubia, there are no written records until later time periods. Here, social age categories can continue to be investigated through analysis of material culture for clues to the perception of age in the past to augment existing understandings of Egyptian social age in order to approach an understanding of Nubian social age. At Tombos, continued excavation, especially of juvenile individuals, can contribute greatly to the reconstruction of social age categories and the change of these categories through time. The integration of multiple models under a life course approach positions bioarchaeologists to contribute to the growing body of knowledge on larger biosocial questions related to the experiences of health, impairment, and disability.

VITA

EDUCATION

Doctor of Philosophy, Anthropology *2019*
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Master of Arts, Anthropology *2014*
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Bachelor of Arts, Anthropology *2010*
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FUNDING AND HONORS

PROMISE Award, $1500, College of Liberal Arts, Department of Anthropology, Purdue University *2018*

Graduate Student Professional Travel Award, $500, Department of Anthropology, Purdue University *2018*

Humanities Without Walls "The Work of the Humanities in a Changing Climate" Grant. "Coping with Changing Climates in Early Antiquity: Comparative Approaches between Empiricism and Theory." Collaborative project between Purdue University, University of Chicago, and the University of Michigan. $136,302. Stipend, $20,000 *2018*

Center for Instructional Excellence Professional Development Workshop, $750, Purdue University *2018*

Graduate Student Professional Travel Award, $500, Department of Anthropology, Purdue University *2017*

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Graduate Student Professional Travel Award, $500, Department of Anthropology, Purdue University *2016*

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Purdue Research Foundation Research Grant, with Dr. Michele Buzon. Purdue University. "A Life Course Approach to Social Age and Health in the Ancient Nile Valley." $17,215. *2016*

Humanities Without Walls Consortium Pre-Doctoral Summer Workshop Fellow. Chicago, Illinois. $4,500. *2016*

American Association of Physical Anthropologists, Committee on Diversity Women's Initiative, Workshop Funding, $225	*2016*
PROMISE Award, $748, College of Liberal Arts, Purdue University	*2016*
Graduate Student Professional Travel Award, $400, Department of Anthropology, Purdue University	*2015*
Graduate Student Professional Travel Award, $300, Department of Anthropology, Purdue University	*2014*
Ross Fellowship, full tuition waiver and $16,065 stipend per year, for four years. Purdue University.	*2014*
Presentation Fellowship, $500, College of Graduate Studies, University of Central Florida	*2014*
Graduate Teaching Assistantship Mentor for Excellence in Graduate Teaching Assistantship, Department of Anthropology, University of Central Florida	*2013*
Graduate Research Assistantship, Dr. Tosha Dupras, the Laboratory for Bioarchaeological Sciences, $1,075, University of Central Florida	*2013*
Graduate Dean's Scholarship, $4,000 per year for two years, $8,000 total, University of Central Florida	*2012-2014*
Graduate Teaching Assistantship, full tuition waiver and $3,300 stipend per semester, for five semesters, $16,500 total, Department of Anthropology, University of Central Florida	*2012-2014*
Research Experience for Undergraduates in Biocultural Anthropology Fellow at the University of Notre Dame. National Science Foundation.	*2010*
Dean's List, six semesters. Arizona State University	*2007-2010*
Arizona President's Scholarship, $7,000 per year for four years, $28,000 total. Arizona State University	*2006-2010*

PUBLICATIONS

Whitmore KM, Buzon MR. 2019. Two cases of skeletal dysplasia in New Kingdom (*c*. 1400-1050 BCE) Tombos, Sudan. International Journal of Paleopathology 26, 135-144.

Whitmore KM, Buzon MR, Smith ST. 2019. Living on the Border: Health and Identity during the Colonial Egyptian New Kingdom Period in Nubia. In: D Martin and C Tica, editors. Bioarchaeology of Frontiers and Borderlands. University Press of Florida. pp. 135-159.

Whitmore KM, Dupras, TL, Williams LJ, Jankauskas R, Schultz JJ, Skipityte R. 2019. Stable carbon and nitrogen isotope inter- and intra- individual dietary reconstruction from the later medieval – early modern site of Alytus, Lithuania. American Journal of Physical Anthropology 168, 279-291.

CONFERENCE PRESENTATIONS

Buzon MR, **Whitmore KM**, Sigworth C, Faroug Ali M. 2019. Public outreach and community engagement with the Tombos Archaeological Project in Sudan. 84th Annual Meeting for the Society for American Archaeology. Albuquerque, NM.

Whitmore KM, Buzon MR. 2019. Pathological changes associated with resorption of a proximal femur, injury or disease? 46th Annual North American Meeting of the Paleopathology Association. Cleveland, OH.

Whitmore KM, Buzon MR, Smith ST. 2018. Health and mortuary patterns in New Kingdom juvenile burials from Tombos. 14th International Conference for Nubian Studies. Paris, France.

Dupras T, **Whitmore KM,** Francigny V, de voogt A. 2018. Bioarchaeological investigations of the SAP-1 Napatan cemetery on Sai Island, Northern Sudan. 14th International Conference for Nubian Studies. Paris, France.

Whitmore KM, Buzon MR. 2018. Skeletal dysplasia in New Kingdom Tombos. 45th Annual North American Meeting of the Paleopathology Association. Austin, TX.

Whitmore KM, Buzon MR, Smith ST. 2017. Mortuary patterns and health in New Kingdom juvenile burials from Tombos. Invited poster presentation. 86th Annual Meeting of the American Association of Physical Anthropologists. New Orleans, Louisiana.

Whitmore KM, Buzon MR. 2016. Living on the border: health and identity during the colonial Egyptian New Kingdom period in Nubia. Invited podium session Bioarchaeology of Frontiers and Borderlands. 81st Annual Meeting of the Society for American Archaeology. Orlando, FL.

Rose M, Buzon M, **Whitmore K**. 2016. A case study of polio in ancient Nubian skeletal remains. Undergraduate Research Symposium. 85th Annual Meeting of the American Association of Physical Anthropologists. Atlanta, Georgia.

Caldwell SJ, **Whitmore KM**, Buzon MR. 2015. How many in the tomb of Tiy? Calculating the number of individuals interred in a Nubian 18th Dynasty pyramid tomb from Tombos, Sudan. Poster presentation. 84th Annual Meeting of the American Association of Physical Anthropologists. St. Louis, Missouri.

Skipityte R, Dupras TL, **Whitmore K**, Page K, Jankauskas R. 2014. First results of stable isotope analysis in Lithuanian medieval samples. The 3rd Baltic Bioarchaeological Conference. Riga, Latvia.

Whitmore KM, Dupras T, Williams L, Jankauskas R, Schultz JJ. 2014. Eating like a Catholic? The use of carbon and nitrogen isotope analysis of bone and dentin collagen from medieval Alytus, Lithuania, to assess the incorporation of marine resources. Poster presentation. 79th Annual Meeting of the Society for American Archaeology. Austin, Texas.

Whitmore KM, Dupras T, Williams L, Jankauskas R, Schultz JJ. 2014. Diet in medieval Lithuania: Stable carbon and nitrogen isotopic analysis of bone and dentine collagen from the site of Alytus. Poster presentation. 83rd Annual Meeting of the American Association of Physical Anthropologists. Calgary, Alberta, Canada.

Copes LE, Brown MR, Dlugosz EM, Judex S, Lublinsky S, Oldak A, Schutz H, Tommasini SM, **Whitmore K**, Garland T. 2012. Rodents and Monkeys and Apes, Oh My: Comparative and experimental investigations of systemic skeletal robusticity in rodents and primates. Invited contribution to "Discovering our inner animal: understanding human-ness via experimental and comparative models" a symposium at the 81st Annual Meeting of the American Association of Physical Anthropologists. Portland, OR.

Whitmore K, Rodriguez E, Ullinger J, Sheridan SG. 2011. It's all in your head: heat related deformation and color change in frontal bones at Bab edh-Dhra'. Poster presentation. 80th Annual Meeting of the American Association of Physical Anthropologists. Minneapolis, MN.

Copes LE, Schutz H, Dlugosz E, Garland Jr. T, Brown MR, Oldak A, **Whitmore K**. 2011. Experimental investigations of the effects of exercise, hormones, and diet on cranial vault thickness. Poster presentation. 80th Annual Meeting of the American Association of Physical Anthropologists. Minneapolis, MN.

Copes LE, Brown MR, Oldak A, **Whitmore K**. 2011. The effects of manipulating the frequency and magnitude of mastication on systemic skeletal robusticity in mice. 15th Annual Meeting of the American Association of Anatomists. Washington, DC.

Copes LE, Brown MR, Dlugosz EM, Judex S, Lublinsky S, Oldak A, Schutz H, Tommasini SM, **Whitmore K**, Garland T. 2011. Diet and exercise affect postcranial, but not cranial, robusticity in mice. Poster presentation. The Annual Meeting of the American Society of Bone and Mineral Research. San Diego, CA.

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Register of Professional Archaeologists	*2018-2019*
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PUBLICATIONS

Whitmore KM, Buzon MR. 2019. Two cases of skeletal dysplasia in New Kingdom (*c*. 1400-1050 BCE) Tombos, Sudan. International Journal of Paleopathology 26, 135-144.

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