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Dying of Pestilence: Gender, Stature, and Mortality From the Black Death in 14th Century Kyrgyzstan

David Wayne Hansen II

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DYING OF PESTILENCE: GENDER, STATURE, AND MORTALITY FROM THE
BLACK DEATH IN 14TH CENTURY KYRGYZSTAN

by

David Wayne Hansen II

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Central Michigan University, 2015

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Accepted by:

Sharon DeWitte, Director of Thesis

Carlina de la Cova, Reader

Magdalena Stawkowski, Reader

Tracey L. Weldon, Vice Provost and Dean of the Graduate School

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ABSTRACT

Bioarchaeological studies have provided important information about mortality patterns during the Second Pandemic of Plague, including the Black Death, but to date have focused exclusively on European contexts. This study represents a temporal and spatial expansion of plague bioarchaeology, focusing on Central Asia, the origin of the Second Pandemic. I examine the relationship between stature, gender, and plague mortality during an outbreak of plague at two fortified settlements in northern Kyrgyzstan in 1338-39, the earliest archaeological sites known to contain victims of the Black Death in Eurasia.

Stature is frequently used in bioarchaeology as a proxy for exposures to developmental stress. Previous research in England examining the association between stature and risk of mortality during plague outbreaks found higher risks during the Black Death for relatively short individuals. These studies used sex estimated from the skeleton as a proxy for gender; however, this study uses culturally specific data on gender from epigraphs. Epigraphic data and in situ measurements from Syriac Christian cemeteries at these sites, obtained from field notes from excavations conducted by Russian archaeologists in the 1880s (n=119 individuals), provides detailed information about the interred individuals, including occupations, year of death, and gender. This study uses Chi-square, Fisher's exact, and Mann Whitney U tests to examine relationships between stature, plague, age, and gender at the sites.

This study finds that shorter men are disproportionately affected by plague when compared to non-plague years. Conversely, there is no significant association between stature and mortality during plague and non-plague years for women. These results might reflect variation by gender/sex with respect to physiological or cultural buffering.

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CHAPTER 1

INTRODUCTION

By far one of the most well-known and important diseases in human history is the first wave of the Second Pandemic of Plague during the 14th-century, a pandemic of bubonic plague commonly referred to today as the Black Death. Based on current molecular evidence, the bubonic plague bacterium, *Yersinia pestis*, originated in Central Asia and spread via trade routes and Mongol expansion across the continent, ravaging areas throughout Afro-Eurasia (Green 2014, Green 2020, Eroshenko et al., 2017, Barker 2021, Spyrou 2022). Most of the existing scholarship on the Second Pandemic of Plague focuses on Europe, where the first wave of the pandemic killed millions of people between 1346-1353, and produced dramatic and long-lasting demographic, economic, and social changes (Borsch 2005, Schamiloglu 2017, Varlık 2015, Herlihy 1997). However, this largely Eurocentric focus ignores the effects of the pandemic in other, equally devastated, regions of Afro-Eurasia. While numerous studies have been published on the disease in Europe, little work has been done examining the origins of the pandemic in Central Asia – particularly from an archaeological perspective (Slavin, 2019). Most recent scholarship in the area uses historical texts as primary evidence, leaving a large gap in our understanding of the context and consequences of plague at its origin that bioarchaeological research can address. Bioarchaeology, and biological anthropology more broadly, provides a multifaceted approach to understanding pandemics by

examining the intersections between social and biological factors that influence the ways people experience disease.

For this project, I study the impact of the Black Death on Central Asian populations, just prior to the European outbreak. Specifically, I examine the cemeteries at the sites of Burana and Kara-Djigach in northern Kyrgyzstan. These two sites are located in the Chuy River valley and along the Ala-Too Mountain range. The human remains at these cemeteries include a large proportion of known victims of a pestilence, based on the inscriptions on the grave markers. This reference to “pestilence” could refer to a wide range of diseases that impact a population at an epidemic level. However, given the continued presence of *Yersinia pestis*, the causative agent of bubonic plague, in the fauna of Kyrgyzstan and the Black Death epidemic in Europe just a few years later, Slavin (2019) argues that these individuals were killed by bubonic plague and thus victims of the spreading pandemic that was later called the Black Death. This hypothesis has recently been confirmed by the presence of *Y. pestis* in tooth samples taken from 1338 burials from Kara-Djigach, pointing to the site as an origin point for the Black Death (Spyrou 2022).

Research Questions

Building off previous studies of the associations among sex, stature, and mortality during the Black Death, to address the question of whether the Black Death exhibited variation in mortality patterns in Central Asia, this study uses data from archaeological field notes from the excavation of two Christian cemeteries in the Chu Valley of Kyrgyzstan to address the following questions. First, given frequently observed mortality

differences between men and women from various diseases, including plague (Bramanti et al., 2018; Aikimbajev et al., 2003, Kamugisha et al., 2007), is there a relationship between gender and mortality during plague years, which would suggest that plague was selective with respect to gender in this context? Second, given the relationship between short stature and Black Death mortality in medieval London (DeWitte and Hughes-Morey 2012), is there a relationship between short stature and plague mortality at these sites in Kyrgyzstan which would suggest that plague was selective with respect to short stature? Finally, are there different mortality patterns between genders when comparing stature and plague mortality?

Theoretical Considerations

When conducting research in paleodemography, it is important to incorporate an understanding of hidden heterogeneity in frailty and selective mortality, aspects of the Osteological Paradox described by Wood et. al (1992). Frailty is defined by Vaupel et al. (1979) as the force of mortality that acts upon an individual relative to others of the same age in the same population. Hidden heterogeneity in frailty refers to the fact that there is variation in mortality risks for individuals that cannot be seen, a problem that is compounded in studies that rely on data from the skeleton. While skeletal samples are often viewed as a single population across time and space, there are differences in risk between each individual in the cemetery based on a wide range of factors. These include age, sex, ethnicity, social status, occupation, and other factors that can impact health outcomes and exposures to a disease. While age and sex can be estimated for individuals, broader social factors and other identities can only be inferred using additional data, such as those from archaeological context and historical documents. For example, a single

cemetery could include people from different social classes who had vastly different levels of risk of mortality from a particular disease. Therefore, it is important to understand the cultural context of the population to consider relevant cultural details that can impact health outcomes. Biosocial categories such as age and sex have both biological and social implications for risk and frailty. Increased age correlates with increased mortality, but mortality can also be further impacted by social perceptions and expectations based on age. This too occurs with sex, where societal expectations of how sex is performed can interact with sex specific trends in mortality risk (Wood et al., 1992; Milner et al., 2008).

Selective mortality occurs because of heterogenous frailty, which means that mortality is selective toward those with the highest frailty. Selective mortality biases the sample of skeletal remains available for study as we cannot see the entire population who was at risk of dying at a certain age, only those who did die at that age. In bioarchaeology, we typically use skeletal indicators of stress or skeletal pathologies to evaluate health in past populations. However, because of selective mortality, we might underestimate levels of health, or conversely, overestimate the prevalence of disease or other poor health conditions in past populations based on the presence of stress markers in a skeletal sample. That is because individuals who express skeletal signs of poor health might have had higher degrees of frailty and therefore had higher mortality risk. Because those with high risk of mortality are more likely to die, the skeletal data may show higher rates of disease than were present in the living population. Conversely, expression of illness may not be visible in the skeleton, either because the disease is not manifested in the skeleton, or as discussed by Wood et al. (1992), the individual was so frail they did

not survive long enough for the pathologies to be expressed. This can further skew the data as a skeleton with no skeletal pathologies could be considered “healthy,” but their presence in the cemetery population demonstrates their frailty (Wood et al., 1992; Milner et al., 2008).

The osteological paradox has been a frequently used theoretical approach within bioarchaeology, though not all research has utilized it effectively (DeWitte and Stojanowski 2015). In recent years, there has been a growth of meaningful engagement with the concepts in research in a wide range of contexts. McFadden and Oxenham (2020) have used the osteological paradox to propose a framework for analyzing cribra orbitalia, a commonly found non-specific indicator of biological stress. They found that examining the disease by subadult vs. adult provides more nuanced understandings of frailty, as adults who exhibit signs of cribra orbitalia have decreased frailty compared to subadults with the lesions. Kyle et al. (2018) use the osteological paradox to examine skeletal stress markers of frailty between civilian and battlefield deaths in Sicily, finding that members of the soldier class seemed to have fewer marks of early life stress when compared to the general populous. Wilson (2014) uses the osteological paradox to reexamine health and the shift to agriculture in the Eastern Woodlands of North America, unsettling some long-held notions in archaeology about this period of transition, finding that the shift to fortified settlements, not the shift to agricultural production, increased mortality risk for women. These studies all move beyond relatively simple frequentist approaches and examine variables across the life course to find variation across different contexts, rather than simply comparing two variables to see if there is a relationship between them.

When conducting statistical studies, it is important to account for hidden heterogeneity in population. Milner et al. (2008) describe hidden heterogeneity not as simply a problem to be dealt with, but a central idea to interact with when engaging in paleopathological research. Through the isolation of skeletal lesions or traits potentially associated with higher frailty, particularly across the lifespan (e.g., healed vs healing vs unhealed lesions), it is possible to reveal otherwise hidden heterogeneity and assess selective mortality with respect to those traits (Gage, 1989; Wood et al, 1992; Milner et al., 2008).

Sex and stature have both been utilized for uncovering hidden heterogeneity in frailty. Stature has been found to be inversely associated with mortality in bioarchaeological literature (Kemkes-Grottenthaler, 2005; DeWitte and Hughes-Morey, 2012; Klaus and Tam, 2009; Roberts and Manchester, 2009). Adult stature can reflect childhood nutritional status and maternal health, which is often correlated with social status, therefore stature can be useful for determining the role of social identity in shaping risks of mortality (DeWitte and Hughes-Morey, 2012; Klaus and Tam, 2009). Sex has also been correlated with uneven mortality risks in multiple contexts. In medieval Croatia, Šlaus (2000) found that women had higher mortality risk than men and a decreased average lifespan. In medieval London, DeWitte and Yaussy (2020) found that men had a greater survival advantage when compared to women during famine after the Black Death. In Mississippian-period Illinois, Wilson (2014) found increased mortality risks for women during reproductive years, particularly for women who experienced early life stress as evidenced by other stress markers on the body.

Because short stature is associated with malnutrition, which is often correlated with low income, stature can be useful for inferring the role of socioeconomic status and social identity in shaping risks of mortality (DeWitte and Hughes-Morey, 2012; Klaus and Tam, 2009). Vercellotti et al. (2011) found that males of low socioeconomic status had shorter stature and higher rates of stress markers than high status males, while females had more mild impacts by status. Haviland (1967) found stature differences between males at Tikal based on social status and overall lower stature for females at the site, which he suggests relates to not only sexual dimorphism in stature in the population, but also to females being viewed as lower class in society.

For this study, stature measurements from the archaeological field notes will be used as a proxy for individual health with the absence of extant skeletal remains. This study uses stature across different age categories and genders to examine varying relationships between these factors to find more specific associations between the variables. In doing so, I can address more specific relationships between early life stressors and later mortality patterns for smaller subsets of the population rather than generalizing for a larger group and obscuring variation within the population.

In addition, I will be using the Developmental Origins of Health and Disease (DOHaD) theoretical framework for interpretation. This framework focuses on the effects of stressors during fetal and childhood development on later health outcomes. Research has shown that poor maternal nutrition during fetal development and poor nutrition during childhood can lead to epigenetic changes and/or nutritional stress that cause negative health outcomes in adults (Barker and Osmond 1986, Gluckman 2010). As poor nutrition is often related to low socioeconomic status and/or marginalization, or

environmental stressors that reduce food access, this has clear theoretical implications for bioarchaeology. This framework aligns well with the biocultural approach of bioarchaeological research, as it can help tease out the relationships between cultural practices and biological stressors that influence longevity and future health. (Gowland 2015; Kuzawa 2008; Worthman and Kuzawa 2005).

A significant body of bioarchaeological literature related to DOHaD has been published since Gowland's (2015) review of its potential in the field, though engagement with the theory goes back to the 1980s, such as Goodman and Armelagos' (1998) examination of longevity and linear enamel hypoplasia presence at Dickson Mounds. Temple (2019) provides a solid grounding for DOHaD research within the Osteological Paradox and reviews specific methods through which such theoretical questions can be addressed in bioarchaeology. These include examinations of how stress markers like linear enamel hypoplasia relate to early life stress events and are mediated by sociocultural contexts and buffering systems, placing non-specific markers of stress into broader contexts of intersecting factors. Some recent examples of specific studies utilizing DOHaD include Garland (2020), who has examined the relationship between mortality risk and early life stress in colonial Florida, examining life history trade-offs for surviving said stressors. In the Ancestral Pueblo Southwest, Ham et al. (2021) use linear enamel hypoplasia to examine early childhood stress and frailty later in life, finding cultural buffering may have prevented LEH associated mortality at one site. Using isotopic data for evaluating diet, Miller et al. (2020) examine gendered dietary differences from childhood and their impact on adulthood in early Eastern Zhou dynasty China, finding early gendered differences in millet consumption between boys and girls,

the former receiving higher concentrations of the grain. They found these gendered divisions in diet continued across the life course, resulting in differential development based on gendered social structures.

Cultural and Historical Context

Central Asian Geopolitics in the 13th – 14th Centuries

At the beginning of the 13th century, the cities of the Northern Silk Routes in what is now Kyrgyzstan were ruled by the Qarakhanid Khanate. This polity had ruled over most of Central Asia from the 10th-12th centuries, with Balasagun (Burana) being the northernmost of their four capital cities. By the mid-12th century, the Qarakhanid Khanate had become a vassal state of the Qara Khitai (Appendix 1) from China, becoming part of the broader Chinese state – with Balasagun remaining a capital of the new dynasty. While this political reorganization did not cause much change to daily life in the cities at the time, the weakened state was easily exploited by the Mongols in their invasion just a few decades later (Kamishev, 2012; Golden 2011).

At the beginning of the 13th century, the Mongol armies of Chinggis Khan conquered the local khanates that ruled various small states located in the region, bringing death and destruction to those who opposed the takeover. However, the Mongols did utilize the local rulers and political organization as a way to maintain control over their newly conquered territories, provided those entities remained loyal to their new overlords. Many specialists (artisans, architects, etc.) from across the empire were moved across regions for the benefit of the ruling elite (Golden, 2011).

Following the death of Chinggis Khan in 1227, his empire was divided into four parts, each one administered by a different son. At this time, most of the lands of Central Asia fell under the rule of the Chaghadai *ulu*, or state. It was during this time that use of the cemeteries at Burana and Kara-Djigach began. The city of Balasagun had lost some importance as it was no longer the capital of either the Qarakhanids or the Liao, as the Chaghadai ruler shifted his capital to Almalīq in modern Xinjiang, China (Golden, 2011). This shift in capital location caused a population decrease in the city and shifted the movement and type of goods along the trade routes in the years prior to the founding of the cemetery in the city. By the time of the plague in 1338-39, the city population was already much smaller than at its peak as capital.

The Church of the East (Nestorian) Community in Central Asia

The populations of the Burana and Kara-Djigach cemeteries are from the Eastern Christian (Nestorian) community. The Church of the East was an early Christian group that was active in the Middle East, Central Asia, and China. This group was viewed as heretical by the Western church based on their interpretation of the divinity of Jesus – his *Anthropos* (humanity) and *logos* (lit. “word,” divinity) being divided in the Eastern belief. This was a view held by Nestorius, a canonized saint in the East but viewed as heretical by the Western church. It is from him that the label Nestorian was applied to the Church of the East, but this was not a label used by the practitioners of the religion. As modern adherents of the faith use Church of the East to describe themselves, I will use Church of the East rather than Nestorian throughout this paper, except where quoting historical literature. When the title Christian or “the Church” is applied, this too will refer

specifically to practitioners from the Church of the East; European Christians will be labeled accordingly (Jenkins 2008).

The Church of the East was protected by the Sassanid Persians following the group's persecution for heresy by the Byzantine Empire. The Church set up their Patriarchate in what is now Iraq and set to work proselytizing along trade routes, acting as merchant traders to support both their communities and their missionary activity. This religious group was very influential along these networks, so much so that the Christian merchant monks who first brought silkworms from China to Byzantium in 552 CE, provided the namesake for the ancient trade routes many now call the Silk Road. Most religious dissemination came from traders, like the Sogdians or these Sassanian Christian monks, who brought new religions and goods with them from the Middle East and Levant deeper into Asia (Klein, 2004; Comneno, 1997; Howard, 2012).

The Church of the East survived through various political changes in both the Middle East and Central Asia, though in China the church ebbed and flowed with the availability of trade networks. The Church gained a foothold in the Uyghur population in what is now Xinjiang, China, but not with the ethnic Han population. During times of prosperous trade, the Church sent many missionaries to China to establish churches in the country, but with dynastic changes that shut down trade networks these churches were cut off and their presence in the region faded (Howard, 2012).

Following the Mongol conquest, the Church of the East once again began to expand. The Mongol government allowed for the practice of Christianity within their lands, and Kublai Khan even established a State office for the Church of the East in

Khanbaliq (modern Beijing) during his rule. The Church of the East established a church at every major trade center in China during this period, and this is the same period in which the cemetery sites were occupied – both located at trade centers along the northern Silk Routes (Halbertsma, 2015; Howard, 2012).

The Mongol government utilized religious tolerance as a means for maintaining political and social power in newly conquered regions. They allowed religious groups, like the Church of the East, to practice freely and did not levy taxes on them. Marriages frequently occurred between Mongol rulers and Christian women, though these relationships did not provide greater social power for the group. In many cases, proselytization expanded for communities who were repressed by previous state administrations – the Church of the East included. European travelers, such as Marco Polo, viewed the Mongols as tolerant of religious differences and completely indifferent to the practices happening in their lands. In the Chaghadai *ulu* (polity), in which Balasagun (Burana) and Tarsakent (Kara-Djigach) were located, Islamization began to happen in the early 1330s after the conversion of the khan Tarmashirin, but prior to this point, the ruling Mongols had little influence on religious practices. This conversion trend continued with the conquering of the region by Timur less than twenty years later, which, in conjunction with the plague of 1338-39, ended the Church of the East in the region (Jackson, 2005; Dickens, 2009; Halbertsma, 2015; Howard, 2012).

There is a large body of archaeological and archival data supporting the widespread existence of the Church of the East in Central Asia, particularly in the Chu Valley of Kyrgyzstan. In addition to the hundreds of gravestones found at Burana and Kara-Djigach, several church ruins have been found across the region. In the Chu Valley,

the site of Ak-Beshim (Suyab) is the only clear example of church architecture in the archaeological record. Ceramic, bronze, and stone artifacts with crosses and other Christian symbols have been found in excavations of cities in the Chu Valley, as well as in the Zhetysu (Semireyche) region of southern Kazakhstan, Xinjiang province in China, Samarkand in Uzbekistan, and Merv, Turkmenistan, among others (Zhukova, 1994; Comneno, 1997; Klein, 2002, 2004; Kamishev, 2012; Dickens, 2009).

In the historical record, there are several accounts from European travelers who wrote about their journeys across Asia who mention “Nestorian” Christians living in different parts of Central Asia. Marco Polo noted the presence of “Nestorians” in numerous towns along his route, particularly in Samarkand and Kashgar (Yule 1993). Similarly, William of Rubruck, a Catholic friar who traveled to the Mongol court from western Europe, briefly describes his encounters with the Church of the East in Central Asia and their relationship to the earlier Sogdian traders (Jackson, 2009). Additionally, the account of Spanish travelers detailed the existence of an Armenian Christian monastery on the shores of Issyk Kul, where Saint Matthew was said to have been buried (Dickens, 2015).

The association with the Church of the East with trade networks has potential implications for the transmission of plague across Central Asia. As the Christian communities of Central Asia were primarily located at commercial hubs or fortified settlements between these hubs where caravans would stop, they would have encountered people moving across the region, whether they be traders or Mongol soldiers. This, in conjunction with interaction from the *Y. pestis* carrying marmot population in the mountain foothills nearby, provides potential exposures to plague for these communities

that the nomadic pastoralists (most of whom were not Christian) living in the surrounding areas would not have faced.

Black Death in Afro-Eurasia

The Black Death was a pan-continental pandemic that spread across much of Afro-Eurasia and was the first major pandemic of the larger Second Pandemic of Plague. However, the bulk of research on the pandemic has focused primarily on its impact on Western Europe. Monica Green's 2014 edited volume, *Pandemic Disease in the Medieval World: Rethinking the Black Death* is emblematic of the shift in Black Death literature, one that accepts *Y. pestis* as the cause of the Black Death and expands the geographic scope of research. In her opening chapter, Green calls for a new paradigm in Black Death studies that moves beyond historical texts from Western Europe. She argues for the formation of a global health focused research program, one which includes specialists from across academia, such as bioarchaeologists, zoologists, and climatologists, among others. She pushes the geographic boundaries of plague studies by asking questions about where else plague may have spread from the Tibet-Qinghai plateau in north-central China, where it had been believed *Y. pestis* first emerged, particularly focusing on sub-Saharan Africa and the Indian subcontinent. These questions, along with the volume more broadly, were a call to action for historians and scholars from all disciplines to expand the conversation to the whole of Afro-Eurasia and recognize the pandemic as a global event, not simply a European one.

Prior to Green, only two widely cited publications examined the Black Death outside of Europe, both focusing on the Middle East and North Africa (a 1995 paper by

Cao Shuji looks at plague in China, however it did not get cited by scholars outside of China until 2014, further discussion below). Michael Dols' (1977) book, *The Black Death in the Middle East*, was the first publication on the Black Death that focused entirely on a place outside of Western Europe. Dols looks specifically at Arabic language primary sources for his study, though he points out Turkish and Coptic language sources for future study. Unlike his predecessors who focused exclusively on plague in Europe, Dols spends his time discussing the origin and transmission of plague across Asia, rather than skipping over this step en route to discussing Europe. This helps provide important temporal context to transmission as the plague made its way to Egypt and the Levant, his geographic focus of study. Dols concludes his book by arguing that the Black Death caused a massive population loss that marked the end of Mamluk economic and political systems, causing economic downturns for everyone in Egypt and the Levant.

Borsch (2005) published the first book on a non-European region since Dols with his work, *The Black Death in Egypt and England: A Comparative Study*. This book looks at the social and economic differences between Egypt and England to show why the two regions had vastly different outcomes in social policy following the Black Death. Where the peasantry gained rights and quality of life in England, the reverse happened in Egypt. This was a result of the different conditions in each country, both economically and politically, before the pandemic hit the countries – pointing to the importance of rich contextual data for understanding plague and its impact on different societies. With this publication, Borsch points toward the new era of plague studies, one that expands beyond the borders of Europe and accepts that *Y. pestis* was the cause of the Black Death.

The work of Dols and Borsch laid the groundwork for future studies of plague in the Islamic World, though they focused on the Middle East and Egypt, respectively. From this point, scholarship has expanded to include all of North Africa and Islamic Spain. Nukhet Varlık's 2015 book, *Plague and empire in the early modern Mediterranean world: The Ottoman experience, 1347-1600*, traces the influence of plague on the Ottoman Empire from the Black Death onward. She uses Ottoman government documents to account for various waves of plague that moved through their lands across two and a half centuries. More critically, she takes to task scholars who she refers to as taking part in "epidemiological orientalism" through the use of Western European traveler narratives about life in the Ottoman lands instead of reading the documents from those lands. Her criticism goes further in a review of plague literature, pointing out that many scholars ignore scenarios which involve non-European actors rather than engaging with unfamiliar literatures (Varlık 2017a). Varlık (2017b) has also compiled an edited volume of plague studies from across the Islamic Mediterranean. While these articles primarily focus on plague epidemics after the Second Pandemic of Plague, many of the contributed papers discuss examples of the Black Death in various contexts across the region.

In addition to Varlık's work, several recent articles have been published that examine primary sources from Islamic historians across the Middle East, North Africa, and Spain. Hopley (2016) examines the accounts of two Islamic scholars living in Tunis and Granada during the Black Death to see the impact of the pandemic on these two cities. He argues that while the Black Death caused mass death and destruction for these urban areas, it also led to new scientific discoveries related to contagion. Mehfouz (2021)

provides further insights by describing Islamic tradition surrounding contagious diseases like plague to show how it could have been addressed in the past. He provides an extensive list of primary sources who discuss disease broadly across the Islamic world, as well as more specific cases which describe the Black Death, though more frequently he discusses the First Pandemic of Plague.

Singer (2020) published a call to action for historians working in the Maghreb to conduct plague research in the region. While Dols includes some of these data in his book, Singer points out that his research is nearly fifty years old and does not include any of the recent genetic and archaeological information about plague that has come out over the decades since it was published. More importantly, this is one of the only books that even mentions plague in the region, as most scholarship has so far ignored the topic in favor of other things. She, like Green, proposes new, interdisciplinary ways of examining the Black Death in the Maghreb and aims to encourage further research on plague in the region.

While Northern Africa has received some attention as part of the broader Islamic world, sub-Saharan Africa has received little attention to date in regard to the Black Death. A special edition of the journal *Afriques* includes four articles that begin to expand the literature into this region. Chouin (2018) opens the issue with a discussion of how scholars could find evidence of plague in the historical and archaeological data. He argues that the significance of the Black Death makes it an important topic of study despite the challenges faced by scholars trying to address it and provides frameworks for studying the movement of plague across the region. Green (2018) addresses similar issues while looking at genomic evidence for the plague as far south as the Democratic

Republic of the Congo. This genomic evidence shows the same strain of *Y. pestis* that ravaged parts of central Eurasia is also found in parts of Africa today, meaning there must have been some movement of the disease into the region soon after the Black Death in Europe. Green too provides means for historians to think about plague movement and impacts beyond simply the written record.

In the same volume, Gallagher and Dueppen (2018) look at archaeological evidence for plague in Mali and Burkina Faso. They found evidence of many settlements being abandoned during the 14th and 15th centuries, which they hypothesize could have been due to plague, rather than the more commonly believed climactic change. These areas had extensive trade connections with the Islamic lands north of the Sahara Desert, making it possible for disease to be transmitted to the region. Derat (2018) describes similar situations in Ethiopia, but unlike Gallagher and Dueppen, she has documentary evidence in the form of hagiographical texts and royal documents which provide evidence of mass population loss in the country in the 14th century. Like Mali, Ethiopia had many connections with northern Africa, particularly Egypt, and Derat found temporal connections between outbreaks of plague in Egypt and those found in Ethiopian archival material. These studies provide examples of expansion of research into Africa beyond the theoretical.

Not only has the geography of plague literature expanded across Africa and Asia, so too have European studies moved beyond the confines of Western Europe. aDNA studies have begun using Russian samples from historical plague cemeteries to attempt to create a timeline of plague events moving to and from Western Europe (Spyrou et al., 2016). In the same region, Schamiloglu (2017) examines the impact of the Black Death

on the lands of the Golden Horde, which stretched from Bulgaria to the Russian steppe north of the Caucasus Mountains. Prior to this paper, the impact of plague on the Mongols had been ignored, despite frequent publications on the empire in recent decades. Schamiloglu points to the economic impact on the Mongols rather than the population loss, as he found that due to their nomadic existence, the Black Death had less of an impact on the Golden Horde than it did for other parts of Europe that were more urbanized.

The earliest work clearly discussing the Black Death in East Asia was written by Cao Shuji in 1995. Cao suggests that the Black Death was endemic across China during the Song and Yuan dynasties and was spread across the region by the invading Mongol armies who were attacking Sichuan province. His documentary sources describe disease presentations which are similar in nature to bubonic plague, as well as the treatment given — rhubarb. He points out that in traditional Chinese medicine, raw rhubarb is only used for the treatment of boils.

This paper, though published decades ago, was not picked up by Western historians of plague until 2014, when Robert Hymes (2014) brought it to the table in the conclusion of Green's edited volume. Hymes too focuses on the potential Chinese origins of *Y. pestis*, suggesting the plague spread with the Mongols through the Gansu corridor and into Central Asia during the 13th century. While he does not entirely agree with the conclusions of Cao about the timeline of plague, he does argue that Western scholars need to be better engaged with non-European scholars and literature to truly expand our knowledge of the Black Death across Eurasia.

In Central Asia there has been an expansion in genetic sequencing of *Y. pestis* in the mountains of Kyrgyzstan and Kazakhstan. The Tian Shan range that makes up the borders of China, Kyrgyzstan, and Kazakhstan is home to a marmot population that serves as a plague reservoir. Numerous strains of *Y. pestis* have been found in the marmot population, including the strain found in Europe during the Black Death. Based on these studies, the geographic origins of the disease have begun to shift away from central China and into this borderland between China and Central Asia (Eroshenko et al, 2017; Kuttyrev et al., 2018; Sariyeva et al., 2019).

Despite Central Asia having known plague reservoirs and being identified as the potential location of origin of the disease, the only historian currently working on plague in the region is Philip Slavin. His 2019 article examines the impact of plague on the Christian communities living in the Chuy River valley of northern Kyrgyzstan. These cemeteries include gravestones that have the phrase “died of pestilence” on eleven graves from the years 1338-1339. These years make up nearly thirty percent of the deaths present in the epigraphic record, which ranges from 1248-1345. Slavin argues that the plague in this area was a deathblow for the Christian community, as the cemetery fell out of use less than a decade after the plague years, and traces of the religion disappear from the historical and archaeological records around this time. While these cemeteries are frequently mentioned in passing in publications on the Black Death, this is the only current work directly addressing these sites from a historical perspective. My project will be using these data to bring a bioarchaeological approach to the discussion of plague in Central Asia.

Much as in historical scholarship, within biological anthropology there has been a primary focus on European data sources. Previous paleoepidemiological research on the Black Death in London has revealed evidence that the most frail individuals had the highest chance of mortality from the Black Death, in this case primarily individuals who lived through stress events, such as famine, in childhood. Older adults were not as represented in plague cemeteries as younger individuals who showed evidence of childhood stressors (Godde et al 2020). Similarly, DeWitte and Hughes-Morey (2012) found increased mortality risk from the Black Death for individuals with short stature, though this study did not find a correlation between the Great Famine of 1315-1322 and short stature as discussed by Godde et al (2020).

It has been suggested based on European historical documents that women faced higher risks of mortality than men, however work by Godde (2020) suggests this is related to patriarchal bias in historical text rather than biological reasons. DeWitte (2009) also found no correlation between sex and mortality from the Black Death in medieval London. In a meta-analysis of anthropological literature on plague mortality across Europe, Bramanti et al. (2018) found no relationships between sex and mortality rates. In contrast, Curtis and Roosen (2017) found gendered differences in mortality in Belgium through mortmain records, potentially showing variation in gendered mortality between geographic and cultural contexts, though the statistical methods used in this study did not account for other categories which may be more significant, such as age or socioeconomic background. In the period following the Black Death, females had decreased stature but increased survivorship from prior to the pandemic, while men had increased stature and overall positive trends in health outcomes (DeWitte 2018).

Outside of the UK, anthropological research on the 14th century Black Death has taken place across Western Europe. Kacki et al. (2011) conducted an immunological study of the Black Death at a cemetery in southern France, finding that only during extreme mortality events did communities dramatically alter their funerary practices, otherwise burying plague victims how they would traditionally do so by individual inhumation. Kacki and Castex (2014) found overrepresentation of 5-19 year olds in a 14th century plague cemetery in Barcelona, Spain. More recently, Castex and Kacki (2016) have examined the demographic patterning that is found in plague cemeteries across Europe, demonstrating that plague did not discriminate based on sex. Additionally, they found that plague burial grounds have excessive mortality for children between 5-14 and overrepresentation of 15–19-year-olds, while far fewer than expected infants under one year of age. Studies from later periods of the Second Pandemic include cemeteries in Italy, Germany, Belgium, and Denmark, in addition to the UK, France, and Spain (Bramanti et al., 2018).

Research Design

Materials

For this project, I worked with digital archival materials from skeletal collections in Russia and Kyrgyzstan. Access to the data and collections for this project was made available by Dr. Philip Slavin at the University of Sterling, UK. He has translated archaeological field notes from a 1885-1886 excavation of “Nestorian” Christian cemeteries at Kara-Djigach and Burana by Russian archaeologist Nikolay Pantusov. These journals include the height and physical condition of 116 skeletons, which date

from 1248-1345 CE based on the grave epitaphs. These data have been compiled by Dr. Slavin, who has associated the gravestones, their inscriptions, translations, and the individuals associated with them using the archival records at the Kunstkamera Museum in St. Petersburg, Russia.

The archaeological sites of Kara-Djigach and Burana are both located in the Chu Valley of northern Kyrgyzstan. Kara-Djigach is located near the base of the Ala-Too mountains just outside of the city of Bishkek. Burana is located eight miles south of Tokmok, Kyrgyzstan, and was the site of one of the Qarakhanid Khanate capital cities, Balasagun, from the 9th-11th centuries. As the Qarakhanids were a Muslim polity, the majority of the population of the city was Muslim. The city was still populated during the later Mongol period and the cemetery was used by the Christian population through the 14th century. Kara-Djigach, formerly known as Tarsakent, was a large Christian city located just to the south of modern-day Bishkek. The remains of this city are currently located in an agricultural zone and the necropolis which the original excavations uncovered is now active farmland (Kamishev, 2012; Dickens, 2009; Yule and Cordier, 1993).

The identities of the 116 individuals are known, as their names, sex, and approximate ages have been translated from their associated headstones, which were written in Syriac script. In the Syriac language, like other Semitic languages, grammatical gender is used to match descriptors to the referent in a way that reflects the gender of the individual (or at least how an individual was socially viewed). On the gravestones, this is often found in relationship to the title of the decedent, with females described with the suffix “ta” affixed to the title being used. In addition, many of the epigraphic sources

describe the deceased with statements like “daughter of...” or “son of...”, which further provide direct examples of the individual’s gender, at least as ascribed by their community. This will serve as a proxy for sex, as it is likely that these inscriptions correlate to the individual’s lived experience in society. While the focus of this study is the patterning of mortality between gender and plague, there are biological mechanisms related to testosterone and estrogen, hormones often referred to as sex-linked, which impact the immune system. Recognizing that these hormones are found in all humans and vary greatly in their prevalence between differing bodies, for this study, binarizing sex and relating them to gendered biographical information can help with interpreting the results of the study by providing potential biological context to the findings, as hormonal level testing is not possible with ancient samples. In the Christian context at the sites, gender is generally linked to biological sex (though these are questions I wish to examine more closely in future research). Further, sex estimation has been done for a subset of skeletal remains, and all of their sex estimates were in complete agreement with the epigraphic data for those individuals where both data sets are available. This will provide the necessary context to understand demographic correlations with mortality rates in the absence of the skeletal material.

Methods

In this study, I examine variation in mortality to infer whether there were differences based on age, sex, and frailty during the Black Death in Central Asia. Preliminary findings by Slavin (2019) regarding sex differences in mortality risk based on epigraphic evidence (gravestone inscriptions), suggest that females faced higher risks than males of succumbing to plague in the Kyrgyzstani cemeteries. However, Slavin

relied on sex ratios, which are sensitive to the potential confounding effects of small (potentially biased) sample size and variation in age-specific mortality rates between the sexes; Slavin notes that “robust statistical analysis of skeletal data”, of the kind proposed for this project, are necessary to resolve the question regarding sex differences in this context (p. 67).

Statistical analysis was done using SPSS version 28. Chi-square tests were used to assess the association between stature and plague year, gender and plague year, plague and age group, and stature and age group. Mann Whitney U tests were used to assess gender-specific differences in stature between plague and non-plague years as this test is more accurate for datasets that do not have a normal distribution. Fisher’s Exact Tests were used when 20% of cells had fewer than 5 individuals and were therefore violated the criteria for the Chi-square test. Due to the small sample size, associations were considered significant at $\alpha = 0.1$, following other bioarchaeological studies with similar samples sizes (DeWitte and Lewis 2020, DeWitte 2018). Associations at this level can show trends that may otherwise be ignored using a smaller alpha level.

Ethical Concerns

This study will be conducted using documentary sources from previous fieldwork done by Russian archaeologists rather than human skeletal remains. In the event that skeletal remains are eventually examined, each individual will be treated respectfully and appropriately while being handled. Additionally, while the individuals discussed in this study are identifiable by name, there are no direct connections between the populations of these cemeteries and modern populations. The data will be published in aggregate at a

population level, with no specific individuals being addressed. No harm is expected come to any descendant communities based on the conclusions of this study.

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CHAPTER 2

DYING OF PESTILENCE: GENDER, STATURE, AND MORTALITY FROM THE BLACK DEATH IN 14TH CENTURY KYRGYZSTAN

1. Introduction

Bioarchaeological studies have provided important information about mortality patterns during the Second Pandemic of Plague, including the Black Death, but to date have focused exclusively on European contexts. This study represents a temporal and spatial expansion of plague bioarchaeology, importantly focusing on Central Asia, the origin of the Second Pandemic (Spyrou et al, 2019, Kuttyrev et al 2018, Eroshenko 2017, Spyrou 2022). Specifically, I examine the relationship between stature, gender, and mortality during an outbreak of plague at two fortified settlements in northern Kyrgyzstan in 1338-39, Kara-Djigach and Burana, the earliest archaeological sites suspected to contain victims of the Black Death in Eurasia.

Historians have mentioned the cemeteries as likely plague locations since the 1950s, but recent work by Slavin (2019) has shown a massive increase in the number of deaths during the years 1337 to 1339 using epigraphic records from the cemeteries. Of the 439 dated gravestones, which date from 1248 to 1345, 26% date to the years 1337-1339 – with ten additionally stating that the individual “died of pestilence.” Slavin points to similar mortality ratios at Black Death cemeteries in Europe as suggestive that the pestilence present in 1337-1339 as being *Yersinia pestis*, a hypothesis recently confirmed

by the presence of a strain of *Y. pestis* ancestral to the European Black Death in 1338 burials at Kara-Djigach (Spyrou 2022).

The Black Death was a pan-continental pandemic that spread across the whole of Afro-Eurasia and was the first major pandemic of the larger Second Pandemic of Plague, which lasted until the 19th century. However, the bulk of research, both historical and anthropological, has focused primarily on its impact on Western Europe. It has only relatively recently been confirmed that the Second Pandemic of Plague was caused by the bacterium *Yersinia pestis*, and ongoing genetics research has honed the geographic origins to the mountainous regions of western China or Central Asia, most likely the Tian Shan range (Raoult et al, 2000; Spyrou et al 2016; Green 2014, 2020; Eroshenko et al, 2017; Kuttyrev et al., 2018; Sariyeva et al., 2019, Spyrou 2022). Recent historical work has argued for the dispersal of multiple plague lineages from the Tian Shan by the Mongol conquests in the 13th century and spread to Europe with their movements and trade networks in the 14th century (Green 2020, Baker 2021). Based on the current evidence, it is now known that the epidemics at Burana and Kara-Djigach were the earliest known plague cemeteries of the Second Pandemic (Slavin 2019, Spyrou 2022).

There has been a greater emphasis on non-European accounts more recently by historians, particularly following work by Monica Green (2014, 2018, 2020). Many of these studies combine genetic research, archaeological data, and historical accounts to create an account of the possible mechanisms and pattern of spread of the Black Death across Eurasia and into Africa. Recent studies uncovered plague in sub-Saharan Africa using historical texts and hagiographies from Ethiopia and archaeological materials from 14th-15th century Mali and Burkina Faso, respectively, demonstrating the movement of

plague along existing trade networks across the Sahara from the Mediterranean regions (Derat 2018, Gallagher and Dueppen 2018). There has been an increase in the examination of non-European primary source materials, including Ottoman government records (Varlık 2015), scientific reports from Abbassid Tunis and the Cordoba Caliphate (Hopley 2016), and theological texts (Mehfooz 2021). Schamiloglu (2017) describes the role of the Black Death on political and social changes in the territory of the Golden Horde, arguing their expansion was related to movement of plague across the continent. An older work by Cao Shuji (1995) examines endemic plague in China using the treatments described in documentary sources to deduce the symptoms present during disease outbreaks, arguing for endemic plague in Sichuan following the Mongol invasion.

As in historical scholarship, within biological anthropology there has been a primary focus on European data sources. Previous paleoepidemiological research on the Black Death in London has revealed evidence that the most frail individuals had the highest chance of mortality from the Black Death, in this case primarily individuals who lived through stress events, such as famine, in childhood. Older adults were not as represented in plague cemeteries as younger individuals who showed evidence of childhood stressors (Godde et al 2020). Similarly, DeWitte and Hughes-Morey (2012) found increased mortality risk from the Black Death for individuals with short stature, though this study did not find a correlation between the Great Famine of 1315-1322 and short stature as discussed by Godde et al (2020).

Outside of the UK, anthropological research on the 14th century Black Death has taken place across Western Europe. Kacki et al. (2011) conducted an immunological study of the Black Death at a cemetery in southern France, finding that only during

extreme mortality events did communities dramatically alter their funerary practices, otherwise burying plague victims how they would traditionally do so by individual inhumation. Kacki and Castex (2014) found overrepresentation of 5-19 year olds in a 14th century plague cemetery in Barcelona, Spain. More recently, Castex and Kacki (2016) have examined the demographic patterning that is found in plague cemeteries across Europe, demonstrating that plague did not discriminate based on sex. Additionally, they found that plague burial grounds have excessive mortality for children between 5-14 and overrepresentation of 15–19-year-olds, while far fewer than expected infants under one year of age. Studies from later periods of the Second Pandemic include cemeteries in Italy, Germany, Belgium, and Denmark, in addition to the UK, France, and Spain (Bramanti et al., 2018).

Building off these previous studies of sex, stature, and mortality, to address the question of whether the Black Death exhibited variation in mortality patterns in Central Asia, this study uses data from archaeological field notes from the excavation of two Christian cemeteries in the Chu Valley of Kyrgyzstan to address the following questions. First, given frequently observed mortality differences between men and women from various diseases, including plague (Bramanti et al., 2018; Aikimbajev et al., 2003, Kamugisha et al., 2007), is there a relationship between gender and mortality during plague years, which would suggest that plague was selective with respect to gender in this context? Second, given the relationship between short stature and Black Death mortality in medieval London (DeWitte and Hughes-Morey 2012), is there a relationship between short stature and plague mortality at these sites in Kyrgyzstan which would

suggest that plague was selective with respect to short stature? Finally, are there different mortality patterns between genders when comparing stature and plague mortality?

1.1 Archaeological and Historical Background

This study focuses on two fortified settlements, Kara-Djigach and Burana. These settlements are both located in the Chu Valley of northern Kyrgyzstan along the Ala-Too mountain range. These settlements were located along the northern branch of the transcontinental trade routes often referred to as the Silk Road. Burana is located just south of Tokmok, Kyrgyzstan, and was one of the Qarakhanid Khanate capital cities, Balasagun, from the 9th-11th centuries. The city population decreased during the later Mongol period, but the cemetery was used by the Christian population through the middle of the 14th century. Kara-Djigach, formerly known as Tarsakent (lit. “Christian city”), was a settlement located just to the south of present-day Bishkek. The remains of this city are currently located in an agricultural zone, and the necropolis which the original excavations uncovered is now active farmland (Kamishev, 2012; Dickens, 2009; Yule and Cordier, 1993).

The individuals interred at the cemeteries of Burana and Kara-Djigach belonged to the Church of the East (Nestorians), an early Christian group that was active in the Middle East, Central Asia, and China from the 5th to 14th centuries (Klein, 2004; Comneno, 1997; Howard, 2012). There is a large body of archaeological and archival data supporting the widespread existence of the Church of the East in Central Asia, particularly in the Chu Valley of Kyrgyzstan. In addition to the hundreds of gravestones (kayrak) found at Burana and Kara-Djigach, several church ruins have been found across

the region, such as in the city of Ak-Beshim, located halfway between Burana and Kara-Djigach. Ceramic, bronze, and stone artifacts with crosses and other Christian symbols have been found in excavations of cities in the Chu Valley, as well as in the Zhetysu (Semireyche) region of southern Kazakhstan, Xinjiang province in China, Samarkand in Uzbekistan, and Merv, Turkmenistan, among others (Zhukova, 1994; Comneno, 1997; Klein, 2002, 2004; Kamishev, 2012; Dickens, 2009). Additionally, medieval European travelers, such as Marco Polo and William of Rubruck, discussed the Christian populations of Central Asia they encountered on their journeys (Yule 1993, Jackson 2009, Dickens 2015).

Within the cemeteries of Central Asia, including Kara-Djigach and Burana, the epigraphic texts from the gravestones have been compiled by historians and translated in a series of volumes, such as those by Chwolson (1890) and Dzhumagulov (1968). These gravestones generally include demographic data including age, gender, year of death, and additionally may have information on occupation and relationships to others in the community. It is important to note that it is likely that the individuals interred with these grave markers are from higher status populations. In other contexts within the Church of the East, there is evidence that the presence of gravestones with long inscriptions correlate with higher social and/or economic status (Dickens 2015, Halbertsma 2015). At a Church of the East cemetery at the site of Ilibalyk in Kazakhstan, contemporary to both Burana and Kara-Djigach, many gravestones are far less elaborate, often with a cross and no inscription or a cross and a small inscription, potentially indicating lower status burials when compared to Burana or Kara-Djigach.

1.2 Stature

Adult stature can reflect childhood nutritional status and maternal health. Children who face severe biological stressors, such as malnutrition, can experience stunted growth and delayed development as the body focuses resources on maintenance of essential functions rather than growth. This can have long-term impacts on individual health and has been found to be correlated with adult health outcomes. The associated developmental stress that can cause short stature also negatively impacts the immune system, making people more susceptible to infection and infectious diseases (Steckel 1995, Kemkes-Grottenhaler 2005; Yaussy et al., 2016).

Stature has been found to be inversely correlated with all-cause mortality in a longitudinal study in Scotland, even after controlling for socioeconomic status at time of death (Smith et al., 2000). In Nepal, marriage and pregnancy before the age of 16 are associated with decreased stature after controlling for education level and socioeconomic status. This decrease in stature is related both to the biological stress of pregnancy that causes growth to stop but also likely related to the psychosocial stress of early marriage (Marphatia et al., 2020).

Stature has been found to be inversely associated with mortality and directly related to survival in bioarchaeological studies (Roberts and Manchester, 2009). For example, Kemkes-Grottenhaler (2005) found that taller individuals had a higher survival advantage than shorter individuals in a large archaeological collection. DeWitte and Hughes-Morey (2012) found that individuals with a below average stature for the population experienced increased mortality risk from the Black Death in 14th century London. Van Tiel and McFadden (2021) found an increase in mortality risk for Southeast Asian females of low stature during childbirth, while DeWitte and Yaussy (2017) found

increased mortality risk for short individuals during famine in medieval London. Individuals living in medieval York who died between the ages of 17-25 were shorter on average than those who lived to be older than 25, showing a relationship between mortality risk and short stature in the population (Watt 2011).

Because short stature is associated with malnutrition, which is often correlated with low income, stature can be useful for inferring the role of socioeconomic status and social identity in shaping risks of mortality (DeWitte and Hughes-Morey, 2012; Klaus and Tam, 2009). Vercellotti et al. (2011) found that males of low socioeconomic status had shorter stature and higher rates of stress markers than high status males, while females had more mild impacts by status. Haviland (1967) found stature differences between males at Tikal based on social status and overall lower stature for females at the site, which he suggests relates to not only sexual dimorphism in stature in the population, but also to females being viewed as lower class in society.

1.3 Gender

There has been much discussion within bioarchaeology about the relationship between gender and sex. (Agarwal 2012, Agarwal and Wesp 2017, Zuckerman 2021). Agarwal (2012) points out that most bioarchaeological literature starts out by separating the population into male and female, thus affirming a binary division based on estimated biological sex as a natural part of humanity. This can negate the impact of other factors and enforces a binary view of sex that ignores gendered and queer experiences that may not correlate to what we assess in the bioarchaeological record. DuBois and Shattuck-Heidorn's (2021) recent article further challenges the necessity of using sex/gender as a standard point of division in biological anthropological research. The authors argue for an

intersectional approach to human biology research. This approach originated in Black feminist scholarship and focuses on the social and political structures that intersect and influence the way an individual experiences the world, such as gender, race, socioeconomic status, and sexual orientation. Intersectional approaches consider not only these structures and experiences, but also the power imbalances and systems of oppression and inequality which act on an individual in differing ways depending on their intersecting backgrounds (Crenshaw 1989; DeWitte and Yaussy 2020). DuBois and Shattuck-Heidorn argue that these intersecting factors can be more impactful on a health outcome than gender/sex.

While an intersectional approach cannot be used for this project due to the limited dataset, I am drawing on the work of Agarwal (2012) and DuBois and Shattuck-Heidorn (2021) and others regarding using gender/sex in research. As the individuals in this cemetery have headstones that provide gendered information, I am using the identities given to each individual in death by their community as a means to compare men to women in the population, rather than relying on estimated sex from skeletal remains as a potentially problematic proxy for gender. Further, I wish to point out that the information on the headstones was written by someone else to memorialize the decedent, and this name may not correlate with the social experience of the individual. I have not found historical references to third or non-binary gender categories in the region nor in religious texts from the population; however, absence of discussion does not mean gender diversity was not present in this population.

Gender is an important axis of examination for this study due to the differing experiences of pandemics by individuals of different gendered backgrounds. It has been

suggested from European historical sources that women faced higher risks of mortality than men, however work by Godde (2020) suggests this is related to patriarchal bias in historical texts rather than biological reasons. DeWitte (2009) also found no correlation between sex and mortality from the Black Death in medieval London. In a meta-analysis of anthropological literature on plague mortality across Europe, Bramanti et al. (2018) found no relationships between sex and mortality rates. In contrast, Curtis and Roosen (2017) found gendered differences in mortality in Belgium through mortmain records, potentially showing variation in gendered mortality between geographic and cultural contexts, though the statistical methods used in this study did not account for other categories which may be more significant, such as age or socioeconomic background. There are also sex differences for health outcomes following the Black Death. In the period following the Black Death in medieval London, females had decreased stature but increased survivorship from prior to the pandemic, while males had increased stature and overall positive trends in health outcomes (DeWitte 2017). In Sweden, the reverse was true, where females had increased stature following the Black Death while males had decreased stature, though the latter was not found to be statistically significant (Arcini et al., 2016).

Contemporary plague cases also have gendered differences in exposure and morbidity. Women and children under 18 were found to be most at risk for plague in northern Tanzania due to gendered and age-based labor and sleeping practices, while men in Kazakhstan are more at risk due to occupational exposure (Aikimbajev et al., 2003, Kamugisha et al., 2007). Such sex and gender-based variation in morbidity and mortality is not limited to plague, as Gibb et al. (2020) show that such unequal experience of

disease for sexual and gender minorities continues to exist during the SARS-COV2 pandemic. Individuals who face stigma and increased psychosocial stressors have increased rates of negative health outcomes during non-pandemic times, and these outcomes are exacerbated by epidemic and pandemic disease.

2. Materials and Methods

The sample used for this study (n=119) comes an excavation of two Christian cemetery sites in northern Kyrgyzstan, Kara-Djigach and Burana, which were excavated by Nikolai Pantusov in 1885 and 1886 (Appendix B). The data from these field seasons, including skeletal condition, measurements, and burial goods, were compiled and sent to the Archives of the Institute of History of Material Cultural of the Russian Academy of Science in St. Petersburg, Russia. These documents have been photographed, translated, and tabulated by Dr. Philip Slavin at the University of Stirling, and these data were provided by him for this study. Plague years were determined by epigraphic inscriptions, ten of which state “died of pestilence” during the years 1337-1339, a period which accounts for 120 of the 464 dated epitaphs. Additionally, aDNA evidence confirms *Y. pestis* in burials from this period at Kara-Djigach. As such, all burials from these years are classified as plague burials.

Due to the fragmentary data from the archaeological reports and epigraphic data, varying subsets of the 119 individuals in the cemeteries were used in this study depending on the available information. Data from both Burana and Kara-Djigach were used to examine mean stature at the population level and for comparisons between plague and non-plague years (n=90). These 90 burials were adult burials measured in situ for skeletal length. The Burana cemetery did not have grave markers associated with

individual burials and so was only used for this purpose. A further subset (n=56) was used to compare age at death and gender, all from Kara-Djigach. Finally, 49 individuals for whom age and gender were obtained from epigraphic data and for whom stature was measured during the excavation process were examined to compare these three variables (Appendix A).

2.1 Gender and age-at-death

N=61 of the 86 burials from Kara-Djigach are associated with *kayrak* (headstones) that include demographic information, including name, age, gender, and year of death. Additional information on age and sex were collected during the excavation and by G.F. Debets in 1948, following the transfer of collections to St. Petersburg. The methods used by Debets for age and sex estimation are not clear from the literature. I compared the findings of Debets to the epigraphic materials, and the estimated sexes agree with the gendered information from the epitaphs, based on the community religious context which assumes male is man and female is woman. However, while I examined the association between estimated sex and gendered information from the epigraphic data to see if there were any discrepancies, I am not using the sex estimation data for this study, only the gendered information provided by the epigraphic data. Of the 119 individuals from the cemeteries, approximate age is known for n=96 and sex and/or gender is known for n=79. This number includes both the estimated sex by Debets and the gendered epigraphic information, with the individuals with only estimated sex coming from Burana where there are no associated gravestones. Of these 79, n=40 are men, and n=39 are women.

The identities of 61 individuals are known from their associated headstones, which were written in Syriac. In the Syriac language, like other Semitic languages, grammatical gender is used to match descriptors to the referent in a way that reflects the gender of the individual. On the gravestones, this is often found in relationship to the title of the decedent, with females described with the suffix “ta” affixed to the title being used. In addition, many of the epigraphic sources describe the deceased with statements like “daughter of...” or “son of...”, which further provide direct examples of the individual’s gender, at least as ascribed by their community. The subset of skeletal remains which have been examined with traditional sex estimation methods in the decades after the original excavation have correlated with the epigraphic data for those individuals where both were present.

Age at death was determined using epigraphic information. Exact age at death was not recorded, rather linguistic information provided broad age descriptors that fall into three age categories, children under 12, adults 12-20, and adults 20 and older. An older adult category exists in the epigraphic sources but only covered one individual from this study, so that person was excluded from calculations and placed into the 20+ age category. Children under 12 were excluded from this study as the focus is on adult stature specifically.

2.2 Stature

Stature was measured for n=90 individuals. Measurements were taken of burials *in situ* for both coffin length and skeletal length. These measurements were taken in Russian imperial units as the excavations took place prior to the adoption of metric units of measurement by the Soviet Union. Calculations were done using the metric conversion

of these data, as provided by Dr. Philip Slavin. Mean stature was first calculated for the entire population for all adults to compare plague vs non-plague mortality at the population level, and then by gender for adults at both sites combined to examine gender-specific patterns of vulnerability to plague mortality resulting from developmental stress. For men, stature ranged from 135.57 to 175.58 centimeters, with a mean height of 159.16 centimeters. For women, stature ranged from 102.23 to 174.47 centimeters, with a mean height of 148.57 (Figure 2.1). Stature was considered short if an individual fell below the gender-specific population-level mean height.

2.3 Statistical analysis

Statistical analysis was done using SPSS version 28. Chi-square tests were used to assess the association between stature and plague year, gender and plague year, plague and age group, and stature and age group. Mann Whitney U tests were used to assess gender-specific differences in stature between plague and non-plague years as this test is more accurate for datasets that do not have a normal distribution. Fisher's Exact Tests were used when 20% of cells had fewer than 5 individuals and sample sizes were therefore too small for the Chi-square test. Due to the small sample size, associations were considered significant at $\alpha = 0.1$, following other bioarchaeological studies with similar sample sizes (DeWitte and Lewis 2020, DeWitte 2018). Associations at this level can show trends that may otherwise be ignored by adherence to a lower alpha level.

3. Results

3.1 Adult Stature, Age, and Mortality from Black Death

Of the 119 individuals from the cemeteries, 56 have known years of death. When comparing mean stature for all adults (≥ 151.64 cm) to below mean stature for adults

(<151.64 cm) who died during plague years, there is a statistically significant positive correlation between short adults and death during a plague year ($p=.015$ Table 2.1). When comparing age categories (young adult, adult) and stature, there is a significant correlation between age and stature. Young adults are more likely to fall within the short category ($p=.048$) when compared to adults over 20 (Table 2.2). However, there is no significant difference in the distribution of age groups during plague years when compared to non-plague years ($p=.555$, Table 2.3). Note that this is a pooled-sex sample, which raises the potential that this finding is an artifact of differences in age at death distributions between women and men (i.e., that there are more short individuals in the 12-20 age group because there are more women in that age group). However, as shown below (Tables 2.6 and 2.7), there is no significant difference in the age-at-death distributions between the genders.

3.2 Stature and Mortality by Gender

Of the 56 burials with known years of death, 29 died during a known plague year, with the gender ratio being evenly distributed: 15 men and 14 women (Table 2.4). 49 of these burials had associated stature measurements and ages at death (Table 2.5). Evaluation of the distribution of ages for men reveals a significant association between below mean stature and mortality in the 12-20 age category. There was a significantly higher rate of short men dying in the 12-20 age category than in the 20+ group ($p=.033$). This is unlikely to be related to an abundance of teenaged individuals in the dataset as the shortest men in the cemetery are evenly mixed between the young adult and adult categories. Four of the six shortest men belong to the 20+ category, contrary to what would be expected if there was a lower stature bias toward younger individuals who had

not yet finished growing. However, this result may be an artifact of small sample size for men in the 12-20 age category (Table 2.6).

In contrast to the result for men, there was no significant association between age group and below mean stature for women ($p=.471$). Women in the 12-20 age category are split between average/tall stature and short stature almost evenly at six and five individuals, respectively (Table 2.7). When examining age at death and gender, there is no significant association ($p=.302$). Neither gender is associated with higher mortality in either age group.

When looking at men who died during plague years vs. those who died during non-plague years, there is a significant association with below average stature and plague mortality ($p=.023$). 75% ($n=9$) of the men in the cemetery who died during plague years were of below average stature. In contrast, only 33.3% ($n=3$) of men among the non-plague burials were of short stature. However, this could be an artifact of the small sample size at this level of analysis (Table 2.5).

When looking at women who died during plague years vs. those who died during non-plague years, there is not a statistically significant association between below average stature and plague mortality ($p=.458$). There is a similar proportion of below average and average/tall women among the plague burials, with 53.8% ($n=7$) of the women in plague years being short while 46.2% ($n=6$) were average or tall height. This contrasts with non-plague years, in which only 26.7% ($n=4$) of the burials of women were short individuals. This suggests a potential increase in mortality for short women during the plague epidemic, but this finding is not a statistically significant one based on the current sample size (Table 2.5).

4. Discussion

The results of this study suggest that in general, at the emergence of the Black Death in Kyrgyzstan, relatively short people, and by inference those who experienced early life stress, were at heightened vulnerability to plague death compared to people of average or tall stature. This is consistent with the results of DeWitte and Hughes-Morey's (2012) study that found an association between short stature and increased mortality risk from the Black Death in medieval London. In this study, short men were found to be the most likely to die from plague at the cemeteries, while there was no significant correlation between stature and plague mortality for women. Additionally, when just looking at gender and plague data, there is no statistical difference in mortality patterns between men and women as a whole, consistent with bioarchaeological findings regarding patterning of plague in Europe, i.e., to date no studies have found evidence that the Black Death was sex- or gender-selective (Godde et al. 2020, DeWitte, 2009, Bramanti et al., 2018).

These results might also reflect variation by gender with respect cultural buffering. It is important to note that the analysis of stature in this study only includes adults, therefore reflecting the experiences of individuals who survived infancy and childhood and not directly reflecting patterns of frailty and mortality for children. One possible mechanism that produced this pattern for the adult population is that boys who experienced developmental stress may have been better buffered from death during childhood through cultural practices that favored them, such as dietary differences (Miller et. al 2020), gender biased weaning practices (Eerkens and Bartelink 2013), or

preferential treatment due to future labor output. Epigraphic data from the sites shows some occupational information for members of the clergy, all of whom are men.

Historical accounts of Central Asia from 13th century European traveler William of Rubruck describes bishops anointing all men and boys in a village as priests so they could baptize newly born or dying people in their towns (Jackson 2009). This religious based gendered labor could have been associated with cultural buffering practices. Due to these cultural practices, more short men might have survived to adulthood when compared to women, such that there were greater proportions of short men compared to short women in both plague and non-plague burials.

In contrast to potential cultural buffering for boys, biological buffering may have allowed short women to survive the Black Death, while lack thereof might have increased risks of death during the epidemic for shorter men. Previous research has shown that individuals with higher estrogen levels have stronger immune response than individuals with higher testosterone levels (Fish 2008, Bouman, Heineman, and Faas 2005). Zarulli et al (2018) found that women had consistently lower mortality rates during famines and epidemics across contexts in their multi-sited study. If individuals gendered as women in this study had higher estrogen levels, this could have enhanced their immune responses and decreased their mortality risk, while in contrast, individuals gendered as men with higher testosterone levels might have had an increased risk of mortality. This is in addition to the relationship between short stature and developmental delays, further increasing mortality risk for this demographic due to increased infection risk due to weakened immune response.

Not only do the findings of this study suggest that short men were at highest risk of plague mortality, but further that specifically short men between the ages of 12 and 20. Similar findings from medieval York show that people who died between 17-25 years of age were shorter on average than those who lived beyond 25 (Watt 2011). This is likely due to biological stress events in early development that increased frailty, stunted growth, and limited immune response, whereas individuals who did not experience such stressors were able to both survive beyond 25 but also grow taller. In contrast, women of the same age did not have the same mortality patterning, further suggesting biological buffering against death at younger ages.

In the epigraphic record at the sites, men are represented 1.43 times more than women, with young women being the least represented sub-group in the cemetery. This is similar to the London cemeteries which had a much higher number of male burials despite equal impact of mortality from plague (Godde et al, 2020; Waldron 2001; DeWitte 2009). This could point to higher mortality risk for female children, leaving those who survived to adulthood (i.e. those with the lowest frailty) with greater resiliency for survival during the plague outbreak. As children rarely have associated gravestones at these sites, it is unclear how many of the infant and child burials at the sites were of female children compared to males. This lower rate of representation for women could also point to lower numbers of burials for women in general at the cemetery, particularly lower status women. This could also be due to poor preservation of women's bodies, as is found with the skeletons of female children (Bello et al 2006).

Socioeconomic status differences are often associated with differential mortality and stature. Studies have shown a correlation between higher socioeconomic status and

increased stature due to increased access to nutrition and buffering against stress events during childhood development (Stinson 2012). In the case of Burana and Kara-Djigach, differences in socioeconomic status are likely not a reason for mortality differences. This is due to the presence of elaborate gravestones for both men and women, a marker of high status in the Christian communities of the region. When compared to the gravestones of the contemporary Christian settlement of Ilibalyk in Kazakhstan which have simple crosses and only the occasional short text, the Kyrgyzstani examples are significantly more ornate and descriptive. In other contexts of the Church of the East, longer inscriptions are associated with increased costs, as one needed both a linguistic specialist and stone carver to obtain write the inscription in Syriac, which was not the primary spoken language of the population, but rather a liturgical language (Dickens 2009).

Additionally, the presence of long-distance trade goods from the Indian Ocean and Mediterranean in burials, predominately in women's burials, also points to higher status individuals being present in the cemetery. These objects are primarily jewelry, though remnants of clothing and other fabric objects like bags were also found. Much of the jewelry was made of imported trade goods, particularly red coral beads from the Indian Ocean and shell beads from the Mediterranean Sea. Gold, silver, copper, and pearls were also commonly used in bracelets, rings, and necklaces found with the burials.

Further research is needed to better understand cultural practices of Christian communities in Central Asia that could impact this disparity in the association between stature and plague mortality between men and women

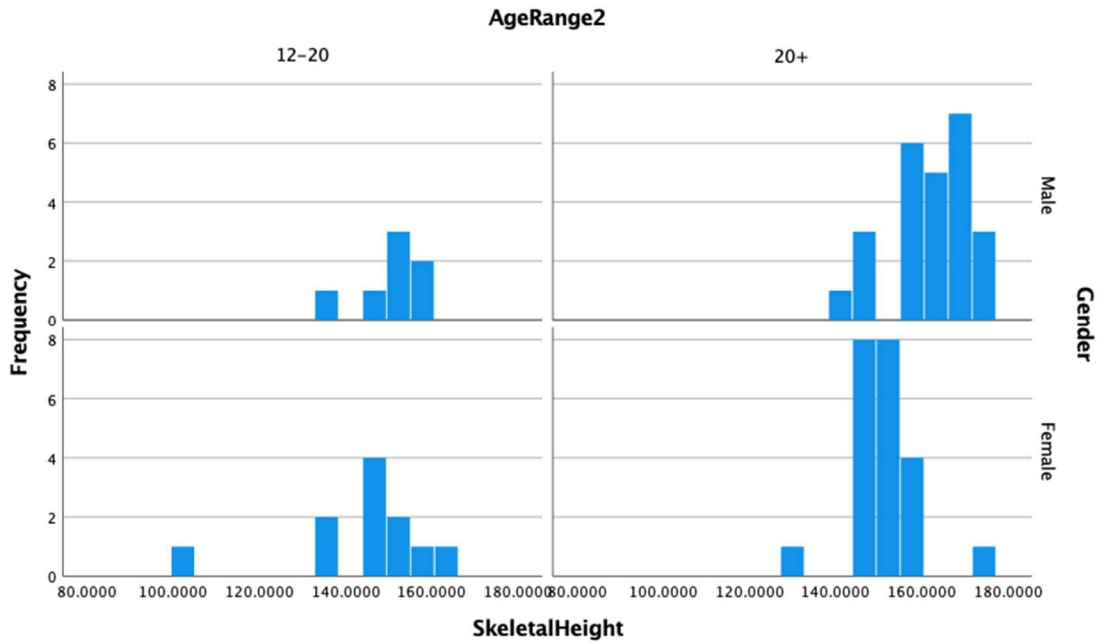


Figure 2.1 Skeletal height distributions by Age and Gender

Table 2.1 Stature and Plague Year

	Short	Average/Tall	Total
Plague	16 (64%)	9 (36%)	25
Non-Plague	7 (29.2%)	17 (70.8%)	24
Total	23	26	49

Table 2.2 Stature and Age Group

	Short	Average/Tall	Total
12-20	11 (61.1%)	7 (38.9%)	18
20+	16 (34%)	31 (66%)	47
Total	27	38	65

Table 2.3 Age Group and Plague Year

	Plague Year	Non-Plague Year	Total
12-20	9 (64.3%)	5 (35.7%)	14
20+	18 (47.4%)	20 (52.6%)	38
Total	27	25	52

Table 2.4 Gender and Plague Year

	Men	Women	Total
Plague	15 (51.7%)	14 (48.3%)	29
Non-Plague	11 (40.7%)	16 (59.3%)	27
Total	26	30	56

Table 2.5 Stature by Plague Year and Gender

	Short	Average/Tall	Total
Plague Men	9 (75%)	3 (25%)	12
Plague Women	7 (53.8%)	6 (46.2%)	13
Non-Plague Men	3 (33.3%)	6 (66.7%)	9
Non-Plague Women	4 (26.7%)	11 (73.3%)	15
Total	23	26	49

Table 2.6 Age Group and Stature for Men

	Short	Average/Tall	Total
Men 12-20	6 (85.7%)	1 (14.3%)	7
Men 20+	9 (36%)	16 (64%)	25
Total	15	17	32

Table 2.7 Age Group and Stature for Women

	Short	Average/Tall	Total
Women 12-20	5 (45.5%)	6 (54.5%)	11
Women 20+	7 (31.8%)	15 (68.2%)	22
Total	12	21	33

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APPENDIX A
SUPPLEMENTARY TABLE

Table A.1 Sample size data

Total Sample	119
Individuals with known age	96
Individuals with stature measured	90
Individuals with known gender	79
Individuals with known gender and age at death	56
Men	40
Women	39
Individuals who died during plague year	29
Individuals with known stature and death year	49

APPENDIX B
SITE IMAGES



Figure B.1 Burana citadel (photo by author)



Figure B.2 Approximate location of Burana cemetery (photo by Stephen Lioy, used with permission)



Figure B.3 Approximate location of Kara-Djigach cemetery (photo by Stephen Lioy, used with permission)