

Drew University College of Liberal Arts
The Black Death: Exploring the Possible Link of the Great Famine and *Yersinia pestis*
through a Bioarchaeological Examination.

A Thesis in Anthropology

By

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Abstract

The goal of this Honors Thesis project was to examine the possible link between the Great Famine (1315-1318) and the Black Death (1348-1351). Three archaeological sites in London were utilized in an attempt to find the link using skeletal remains. St. Mary's Spital Square, Dominican Friary Carter Lane, and East Smithfield Black Death were the three sites chosen based on the time periods they were in use. A definitive link was not established but this project led to a possible new population to study in order to find a skeletal link.

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Introduction

Fear and panic were never so close to me until I started watching the news regarding the Zika virus. Hearing the Zika virus mimics other illnesses, you might not be aware that you have actually contracted the disease. The World Health Organization does not have a confirmation of the incubation period. When mild symptoms such as fever, skin rashes, muscle and joint pain, and headaches occur, they last for a period of two to seven days. There is no specific treatment or vaccination at this time. Prevention for contracting Zika is to prevent mosquito bites by covering the skin or with mosquito repellent (World Health Organization 2016). However, it is now known that you can contract Zika from an infected person via saliva and sexual intercourse (Centers for Disease Control 2016). Zika, once contracted can lay dormant in one's organs. This is frightening because once a woman becomes of age for child bearing, it is unknown if the child will be born with birth defects. My concern with the Zika virus provides insight on the incredible fear those faced in the time of the Black Death.

My goal for this project is to determine if there is a link between the Great Famine (1315-1318) and the Black Death (1348-1351) through the study of skeletal material. I have always been interested in the way illnesses impact the human skeleton. The Great Famine impacted many crops leaving a large percentage of the population without their main dietary staple. The Black Death will be investigated through the human remains at three archaeological sites in London. Each of the three sites represents a unique period of time. St. Mary's Spital Square cemetery is the control site because it spans a period of time before the Great Famine and the Black Death. The Dominican Friary Canter Lane

cemetery spans the time from the Great Famine through the Black Death. The East Smithfield cemetery is an exclusively Black Death only site. In order to determine if there is a direct link between the Great Famine and Black Death, three groups/areas need to be examined in the research. I will address the questions below, in an attempt to identify a possible link.

Who is represented in the burials? Is there a disproportionate representation to different age groups or sexes?

Before I begin my analysis of any archaeological site, I need to assess these basic demographic questions. First, I will determine the sex and age of the individual. I will look at attritional death curves, which will consist of a high percentage in infant and child mortality. I should find the presence of low numbers for adolescent while the death rate of adults increase after skeletal maturity. I predict that adolescent individuals should be low in frequency in the non-black death cemeteries. This would be an attritional death curve, which represents the natural survivorship patterns. In contrast, I predict that Black Death cemetery populations should fit more along the lines of a catastrophic death curve. In catastrophic death curves, the distribution of individuals sex and age should be roughly similar to the distribution of living population. People of all ages will be present due to the high risk of mortality for all age groups. Once I establish age groups, observation of the differences between sex and age can be done.

Are there any differences between burial types of non-plague and plague burials?

This question uses skeletal remains, burial type, and additional objects associated with the burial. I see determination of burial types is crucial to being able to compare

individual burials. Studying patterns in burials will assist in the discovery, if any, between plague and non-plague burials. Dominican Friary Carter Lane cemetery has one mass grave that holds plague victims. East Smithfield Black Death cemetery contains a variety of burials that are all plague victims. East Smithfield has various internments types, such as individual burials, multiple burials, and mass graves. I needed to be able to answer the question completely to find the differences between plague and non-plague. Burial type, presence of grave goods, coffin type, or even cremation are all of interest when attempting to answer this question. Identification of any patterns can assist in establishing the plague and non-plague burial types. Grave goods can help in establishing the status of individuals in the plague burial group.

Do different sites reflect variations in status?

I see that this question is similar to the last because burial type can provide information on the individuals status. You will see that status is complex when observed in human remains. Markers of trauma, occupation, diet and health are also indication of status. As noted in todays world, socioeconomic status can give individuals an advantage in the community. I read while researching that food resources are limited to those who have little money and living conditions vary based on wealth. All of these factors can influence the health of an individual which makes the identification of status variations necessary to comprehend the whole picture.

Does status affect plague mortality?

Status markers in the skeleton are complex and often are markers that are shared. Establishing status of the individuals will allow me to be able to compare the groups of

people by socioeconomic status. Status, along with other factors, will be observed to see if mortality is affected by comparing the groups of socioeconomic status. If status does affect plague mortality, then it could be linked to the famine. Those who had greater access to a wide variety of food resources would not have been impacted as much as those who just relied strictly on grain.

Did a history of malnutrition affect mortality?

I will show that diet is important in growth and maintaining health. To determine an individual's health, various markers can be found throughout the human skeleton. Physical stature is important; those who do not have a proper diet or are ill will not reach the maximum stature. The Great Famine impacted the grain supply which was a major staple of the diet in England. Looking at the change of diet and health, markers will provide insight on malnutrition. If individuals who were malnourished made up the majority of the population, it could be said that malnutrition did affect the mortality. A history of malnutrition, if found, is a step toward identifying the possible link between the Great Famine and the Black Death.

Did the famine impact plague mortality?

For me, this question will provide the answer in identifying the possible link between the famine and the plague. Individuals that are at the Dominican Friary Carter Lane cemetery site that are non-plague burials will be analyzed in comparison to those that are plague burials. We see poor diet will leave individuals susceptible to contracting illnesses and having a poor immune system. If there is evidence of the famine impacting plague mortality, then a link between the two has been found.

Is there variability in representation between plague victims with adequate nutrition and malnutrition?

If the famine did impact mortality, there should be more plague victims with malnutrition than without. Dietary markers will be used to determine the individual's health. Those with markers that indicate poor diet, will be compared to those who did not suffer from malnutrition.

Introduction conclusion

Connecting the Black Death and the Great Famine will be done by examining data collected from archaeological sites of three medieval cemeteries. Skeletal remains provide a wealth of knowledge including injuries, information on diet, health, and social status. Demographic information, like age and sex, will provide a basic understanding of who was dying. Observing markers of stress and injury will help determine the social and health status of the individual. The markers of social status and health status will be the most important to see if there is a connection between the Great Famine and the Black Death.

I find that even with all the information provided on past plagues, society hasn't learned how to effectively prevent the spread of disease in underdeveloped countries. The Black Death was a plague that reoccurred in cycles. The spread of the Black Death and the medical information is valuable to today's society. Differential mortality rates serve as a grave warning. An epidemic like the Black Death could be even worse in today's globalized world. The Black Death spread across Europe in four years in the 14th century. Today the plague would spread even faster. Today the Black Death is making headlines

as scholars begin to study the cyclical epidemic outbreaks (Chung 2016). This project, started in 2015 using archaeological evidence. I will examine if there is a possible link connecting the plague and the famine.

Issues that faced those during the time of the Black Death face us today in modern times. Today, food availability and resources are still limited by status. Urbanization today puts pressure on the land and food resources and this in turn makes farm fresh food more expensive. Social inequity is still a problem that faces modern countries all over the world. If people learned anything from the Black Death research, they should take it as a warning that it was one of the worst natural disasters in history.

The Spread of the Plague

Foci are naturally occurring places where the plague resides (Kelly 2012). The foci located among the Kirgiza lake region, in Asia, is thought to be the point of origin for the strand of *Yersinia pestis* responsible for the Black Death (Kelly 2012). Lake Issyk Kui, also known as the fast road to China for trade travels through the Kirgiza region, provided a path for *Yersinia pestis* to travel along. Kelly discovered historical documents and grave markers report of the plague's remarkable travels (Kelly 2012). Three distinct patterns emerged. Each of the three patterns delivered the plague to most of Europe in about four years. The first pattern went from inner Asia eastward into China killing an estimated 50% of the population. Next was a westward pattern moving towards Russia. The final pattern moved west infecting Crimea, Europe, and the Middle East. In the year 1348 much of central and northern Italy was, or soon would be, infected and by the summer the plague spread to Spain, France, the Balkans, England and Ireland. Later, in

1348, the plague hit Austria and Germany (Kelly 2012). The following year it infected the regions of Scotland, Scandinavia, Poland and Portugal (Kelly 2012).

Inner Asia, at the time, was fairly remote and the plague would have stayed there relatively isolated if the Mongols did not consolidate Eurasia in the 13th century.

Mongols, by unifying Eurasia, aided in the growth of activities that would in turn spread the Black Death. Trade, travel, and communication were the activities responsible for the spread of the plague allowing humans to either bring infected rats in ships or infected fleas through the use of camels for transportation. Along with human factors in the decades prior to the plague, there were environmental issues that caused humans and animals alike to flee foci and seek shelter.

Environmental events are theorized to be caused by unusual seismic activity in the earth's oceans. In addition to human records, there are records found in trees. Tree rings recorded the two thousand-year episode that caused great stress (Kelly 2012). Trees react to the environment around them. Stress would be a shift in temperature, a devastating storm, and periods of floods or droughts. Tree rings are created as the tree grows creating close rings. In periods of stress, the width of the tree rings increase as the tree will not grow in such periods (Carrer and Urbainati 2006). In the West and East, volcanic eruptions, earthquakes, floods, tidal waves and swarms of locusts would be observed by the people of that time period (Kelly 2012). Europe, at the time, was transitioning from a medieval warm period to a little ice age that would cause the Great Famine.

An illness, labeled by many in the time period as "a wandering sickness", infected areas so quickly because of the urban lifestyle. People began populating cities and trade

boomed. Medieval Europeans called the Black Death “the great mortality” and Muslims called it “The year of Annihilation” (Kelly 2012). Cities during the Black Death were described as littered with corpses and plague pits where “corpses were packed like lasagna in municipal pits” (Kelly 2012). Cities provided a breeding ground for infection with rats and other animals moving between cities by squeezing through walls.

Yersinia Pestis

The plague is caused by a bacterium belonging to the *Enterobacteriaceae* family called *Yersinia pestis*. *Y. pestis* is a gram-negative, facultative anaerobic, rod-shaped bacterium. Zoonosis are diseases that are transferred from animals to humans. The zoonosis found in feral rodents were infected by fleas. Infected fleas would attach themselves to rodents which quickly spread through Eastern Europe and made their way via caravan to Western Europe (Kelly 2012). Rodents created a reservoir that contained the plague within the rodent population for years. *Y. pestis* shifted to humans because their population of rodents, or reservoir, was killed off and resulted in the shift from rodent to insect ecology. The nature of these reservoirs also explain the cyclical nature of the plague (Gottfried 2004). The infected flea would infect the rodents and eventually jumped species to human hosts (Wiechmann 2012).

Plague types: Bubonic, Septicemic, Pneumonic, and Abortive

Infected individuals can have one type of plague that transitions to another. In my research I found the four types of plagues are bubonic, septicemic, pneumonic, and the abortive plague. The Black Death is a combination of the Bubonic, pneumonic and septicemic strains of the plague (Gottfried 2004). Fleas must be blocked or the plague

pathogen must be contained in the digestive system. Secondary hosts have to die in order for the plague to be transferred to a tertiary host. Climate also impacts the flea's activity. Cold weather limits the flea's activity and heat slows it down. If there is less than 70% humidity, the environment will not sustain the life of the flea. Climate is another factor that limits plague outbreaks to select seasons. European conditions for plague outbreaks are only in the late summer and early autumn (Gottfried 2004).

The Bubonic plague is caused by a bite from an infected flea. The incubation period for this strain of plague is between two to seven days (Wiechmann 2012). Bubonic is the most common of the strains. First to appear is a black or gangrenous blister at the bite location (Gottfried 2004). Sores, through time, changed color spectrum from blue to black. The color is the result of the bleeding within the lymph nodes (Wiechmann 2012). The symptoms are not as noticeable as the swelling of the lymph nodes and lymphatic vessels that produce sores by the bite. The swelling of the lymph nodes occurs relative to the bite site and affects the armpits, groin or neck. Subcutaneous hemorrhaging happens following the sores that cause the cells in the nervous system to become intoxicated. Intoxication of the nervous system leads to neurological and or psychological disorders. Bubonic plague is not the most toxic of the strands but is very lethal with a death rate of 50-60% (Gottfried 2004). As the plague continues to infect the individual's body, it is not uncommon for the bubonic plague to turn into the septicemic plague.

Septicemic plague is a result of the pathogen (*Y. pestis*) entering the blood stream to attack the whole body. Large scale bleeding within the internal organs and bleeding in the skin is fatal without medical intervention (Weichmann 2012). A rash forms quickly

after infection and death follows within a day. It is a rare type of the plague and the exact etiology is unknown. Though it is rare it is always fatal. Transmission occurs through a flea, *P. irritans*, and the human body louse (Gottfried 2004).

Transmission of the plague through droplet infection is primary pneumonic plague. This can be done through a cough or a sneeze. The most common types of plague are bubonic and pneumonic due to an easy transmission from a bite or a sneeze. If the pathogen reaches the lungs, it is possible for the pneumonic plague to develop and is referred to as the secondary pneumonic plague (Weichmann 2012). Once the plague enters the lungs, body temperature decreases dramatically. Pneumonic plague is unique in its human-to-human transmission yet has a short two to three day incubation period. After the body temperature drops, a severe cough, cyanosis, and discharge of bodily fluids (bloody sputum) develop. Sputum is what contains *Y. pestis* making it airborne. Coma is typical and neurological damage also occurs. The death rate for this type of plague is 95% to 100% (Gottfried 2004).

The last and least drastic is the abortive plague. This plague is accompanied by a mild fever with some swelling in the lymph nodes. The abortive plague gave individuals with decent to rapid immune systems the ability to survive and ascertain immunity to the plague bacterium (Weichmann 2012).

London “Bring Out Your Dead!”

Environmental Changes in Epochs

During the 12th to 15th centuries, London and the surrounding areas were in a period in the climate changed. A Medieval warm epoch was about to end and a little ice age would begin. Little ice ages will create cooler temperatures resulting in shorter growing seasons, longer winters, and bring more precipitation. All of the climate shifts would affect agriculture. Land that was once used for agriculture would not be viable in a little ice age (Connell et al 2012). This decrease in agricultural land affected food production thus raising prices of grain. Residents of London would be impacted in a variety of ways based on their socio-economic status. This section focuses on life in the City of London in the years of the great famine (1315-18) and the Black Death (Walker 2012).

Socio-economic status impacted many areas of life for London’s residents. Socio-economic status also impacts personal health risks differently for all the classes in society. There are a lot of general risks associated with living in an urban environment and this section will highlight those general risks. Specific risks to social classes will also be discussed if the risks vary greatly, like in diet.

Medieval London- Sanitation and Water

Medieval London was crowded with lively streets packed with people and goods. Street activity leads to neighborly disputes and would tax the sanitation systems. Rich and poor residents would be out in the streets together in the city center which could promote disease spread (Walker 2012). Streets were gravel with ditches that were used

for drainage and would contain rainwater, human waste, and trash. Rain would flood or flush the ditches. Many of the streets were made with waterproof material that would not allow the water to be absorbed in the street as it does on dirty roads. When the ditches were flooded, the contents of the drain would wash up on the street and onto nearby properties. Rain also created muddy conditions on the city's roads which could lead to accidental injuries (Walker 2012). The water was stagnant in flooded areas. Stagnant water is a breeding ground for bacteria, parasites, protozoa, algae and viruses that can cause diseases (Walker 2012). Public latrines would be placed above running water to use the tidal flow to flush the waste out. These latrines would often flood because of poor maintenance and heavy rainfall, as well as, adding to the waste flooding out of ditches onto properties and streets. It was not uncommon for the floods to enter and pollute the city's drinking water. Drinking water being brought into the city could also be polluted. Public fountains were constructed. In the years 1236 to 1245 construction of the Cheapside Conduit took place, linking the River Tyburn to the city through lead pipes that would feed into public wells, which was used for washing and drinking water. The disposal of water, if handled poorly, would aid in the spread of disease.

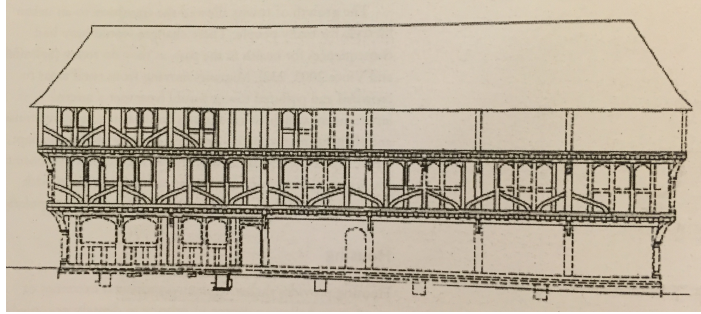
Health risks outside the home were equally as bad. Air quality was heavily polluted from homes and factories burning coal and lime. The air itself would have a horrible odor from the sulfur that was burnt. Sulfur levels in the city were thirty times greater than levels in the countryside. Adding to the odor would be foul smelling privies and cesspits located at the rear of the property lines. Originally, they were constructed with wood but the wood would rot causing problems. Later stone was used in the

construction (Walker 2012). The coal burning and lime would stain buildings. The smoke from the fire created such a dense cloud of smoke that it limited the sunlight. There is evidence of rickets at St. Mary's which is a condition caused by vitamin D deficiency (Walker 2012). The air pollution would lead to diseases like pneumonia, bronchitis, sinusitis, emphysema and lung cancer. Streets in public areas would be littered with animal carcasses and rubbish that would build up in areas that were not used by the public. London was a heat island. Heat islands are a phenomenon where the city's temperature is warmer than the areas around it. Studies have estimated that London's temperature was about two degrees Celsius warmer than the rural areas around it. Heat waves in cities have higher mortality rates than their rural counter parts (Walker 2012).

Streets at night were lively but the women would be in the home. The poorly lit streets would increase risks of accidental injury. The night also increased risks of injury from muggers who take advantage of the dark. Crimes like muggings and murders largely took places in the evening (Walker 2012). All of these risks would apply to those living in London during the time of the Great Famine and Black Death. Air pollution would cause infections from breathing in the air. Stagnate and polluted water would cause bad smells and as they believed back then the bad smells would make them ill.

Homes (Health Risks in the home), Violence Risks

Rapid growth in the 13th century saw the cities population double in size increasing the population density. Some properties were subdivided to



assist with the housing of the building (Connell et al 2012, 150).

expanding population. Expanding population left little room for homes to expand on the ground so homes added stories. Jetty houses gained popularity as a way to make the home larger with limited space. Each floor would project out past the floor underneath it like in **Image 1**. Homes in the city were constructed with various materials based on the family's wealth and status. Place of residence was also influenced by an individuals status. The wealthy would live in the center of the city on large plots of land. Often the wealthy would escape the city and have a house in the countryside. Their homes would be built with stone which gained popularity in the 13th century. Flooring was a choice of paving or tiles. Wealthy individuals would have a pond on their property that supplied fish for meals (Walker 2012).

Working class and poor families lived in various different ways. Most families lived in three rooms or less with these rooms already being cramped. Limited living space lead to people coming out to spend time on the streets. Jetty style homes would be built with a timber frame, a popular building material. Some of the wealthier families in the working class would have a stone foundation and shops on the ground level. Homes with shops on the lower level usually had two stories above. Regular two story homes

had the top level for sleeping and the ground floor was living space but also a work area. There was little distinction within the home between home and work space. Homes used to have thatched roofing but in 1212 a massive fire led to the increased use of ceramic tiles as the city banned thatching (Walker 2012). The ground floor would consist of earth or mortar with straw on top.

Poor residents of the city would have smaller homes that had wattle walls. Floors would be the same earth or mortar with straw covering it. Individuals who could not afford to rent a room from someone would have two options. One would be to make a temporary lean-to shack or squat in an empty lot. When homes were split into individual tenements, ladders or stairs would be used to access the rooms in the upper stories increasing risk of injury. Migrants moving into the city would live in cramped living quarters with multiple people (Walker 2012).

All homes relied on fire to provide warmth in the home. Fuel for the fire would be wood, coal, or organic waste. Most homes did not have the proper ventilation thus exposing residents to respiratory illness. In the winter when window shutters would be closed, the residents would be at higher risk for illness. Diseases associated with poor air quality and air pollution are pneumonia, bronchitis, sinusitis, emphysema, and lung cancer (Walker 2012).

Industry and the Job Market Divided by Gender

London was a socially divided town where status played a huge part in varying aspects of life, but one place that united everyone was the streets during the daytime. Streets would have the poor looking for casual labor jobs. Merchants would be selling

their products outside. Artisans would be selling their goods in hopes of trade or profit. Wealthy people lived in the central part of the city and the poor lived closer to the walls or even outside the walls of London. In the medieval city, there were 180 registered jobs with most work being labor intensive. Labor before the Black Death was cheap with low wages. Those with specific skills would have a better, less physically taxing job than those who were less skilled. Less skilled jobs required chores that revolved around fetching and carrying. Hucksters were individuals who buy a bulk order and sell it door-to-door to those who could only afford small amounts of the product. This job required a lot of heavy lifting throughout the long day and would not turn a high profit (Walker 2012). Men would find themselves in manufacturing jobs like building, leather tanning, making furs, linens, and metalwork, but a large population were involved in the wool market (Walker 2012).

Women remained in the home but had a lot of tasks to do. London's market was supportive of women selling goods. Women who were unmarried would serve families in their homes until they were married. Married women would make clothes for the whole family, do laundry, prepare and cook meals, stock up food for the long winters, sell produce in the streets, and finally assist their husband in his profession. Young children would follow their father or mother depending on their sex (Walker 2012).

Food Glorious Food

Cereals were a staple in the diet of many up until the 13th century. Cereals were harvested from late July to September. Pottage was the most basic food eaten by people in all of the classes. Pottage was made with broth that consisted of oats, vegetables,

herbs, and on some occasions meat. Grains and pulses were 80% of the calories poor people consumed (Walker 2012). Pottage was served either in bread or potter vessels that had a lead based glaze. Lead was in the water because of the pipes and also in the vessels food was in. This lead was slowly poisoning the people but women and children were more sensitive to the build up of lead in the body. Lead accumulates and does not leave the system eventually poisoning the person when the levels get too high (Walker 2012).

Taverns that served the people of London would serve fast food. Foods would be served mainly in pie form with beer as a drink. Family dinners would have been cooked in a single pot served with bread and beer. Common people would drink ale or beer with wine being reserved for the wealthy. The poorer people of London would get their protein and fat from dairy products. Milk from sheep was the main source until the 13th century because sheep were used for wool rather than dairy. In the 14th and 15th century, most dairy products were made from cow's milk such as butter and cheese (Walker 2012). The poor were very vulnerable to bad harvests like those in the years 1290-1320. High status in the 14th and 15th centuries did not have a lot of dairy in their diets. The exception being that wealthy children were given dairy. In the Great Famine (1315-1318), grain prices rose rapidly and as a result of the increase an estimated ten percent of the population died. At the time of the price increase, surplus plants or dairy were sold to buy bread. Pigs were also sold decreasing their value (Walker 2012).

Fish were important nutritionally and religiously for all classes. Fish added variety to the diet and would be consumed during lent or other religious fasting times. Animals from the sea were believed to have medical powers that would speed up healing.

A variety of an individual's diet relied on status. The poor did not have much variety as fish and meat were limited. The wealthy had the most diverse diet and were less vulnerable to food shortages (Walker 2012). Meat was limited due to the size of the city's population and the limited amount of livestock. Preservation of meat was crucial in maintaining calories in the diet. Meat provided an important source of protein. Meat cuts were smoked, salted or dried to preserve them for winter. Pigs were ideal for the urban lifestyle as they were used to poor land quality and living off of scraps of food. Pigs were popular with the lower status people because ham and bacon could be persevered. Fresh pork was reserved for the wealthy (Walker 2012). Wealthy would take old bread and create bowls, the bread bowls would be collected after the meal soaked with sauce and donated to the poor (Walker 2012).

Location, Location, Location

Where to Bury the Dead

When I started this research, selecting sites for this project required time and care. In order to connect the Great Famine and the Black Death, I needed a selection of sites in both of these periods. Preliminary research on the topic helped connect me to another scholar researching the Black Death. After locating the research database from the Museum of London Centre of Human Bioarchaeology, I was able to look at data from numerous sites. The choice was based on the time periods that each of the cemeteries was in operation. Providing a picture of the Famine and the Black Death will assist with determining if there is a possible link.

Site Introduction: St. Mary Spital

St. Mary Spital was a hospital founded by a group of wealthy merchants as a charitable act to the city of London in AD 1197. St. Mary was built to assist with the expanding population as migrants from all of Britain came to the great economic center in hopes of a better life. The wealthy saw the donations as a civic and religious duty to provide the needy with free health care (Thomas 2002). The charity targeted a specific group that consisted of the sick, elderly, poor, migrants and pregnant women in need of assists in childbirth. The priory of St. Mary Spital also catered to poor priests, retired rich people in good health, orphans, widows, royal servants, canons, lay sisters and brothers, and servants (Thompson et al 1997). St. Mary was not only a place of rest and healing for the poor but a permanent home and resting place for the elderly that were wealthy or

well-connected (Orme and Webster 1995). St. Mary was originally small but had to be expanded in AD 1235. There are records stating that there were 180 beds in the infirmary making it the largest hospital in London during this time period. Sixty years after it's re-founding in AD 1235, it was re-founded with a new charter that demonstrated the acquisition of new land for the hospital (Thomas 2004). Henry The VIII cleared the land to create homes for members of low aristocracy, while the southern portion of the land was used as an artillery ground (Thompson et al 1997).

Small scale excavations were carried out as of 1976. The largest part that was named "the main part of the Medieval cemetery", was excavated between November 1998 and August 2001 and was led by Christopher Thomas. The main part of the cemetery was located to the south and east of the church. Part of the main cemetery was excavated 1982-1985 then later in the 1990's. There was a large and ambitious urban regeneration program. That program led to large-scale excavations which was necessary to protect cultural patrimony. Excavations, due to this program, was the largest cemetery excavation ever in Britain to date (Thomas 2004). In 1994, the northern part of the site was excavated in four phases due to a plan for residential properties to be built on the site. There were no archaeological remains found. The southwest portion of the site was excavated in 1995 and 1996. This site was "250 Bishopsgate" or "site Q", producing no archaeological materials. When skeletal remains were found, they were assigned to one of four phases based on stratigraphy and radiocarbon dating. Alex Bayliss and Jane Sindell were chosen to run the radiocarbon and Bayesian modeling to assess the dates. Their estimations were within an 84 percent accuracy and the radiocarbon dates followed

the stratigraphic data for the cemetery. With radiocarbon dating (absolute) and stratigraphic dating (relative) almost replicating each other, this gave archaeologists a solid time frame for each of the burial periods. The periods of interest in this study were estimated first. The estimations are as follow Period 14 (1040-1155), Period 15 (1170-1210), Period 16 (1230-1260), Period 17 (1365-1410). The time periods compared with the cemetery records that survived and the stratigraphy are as follows Period 14 (1090-1145), Period 15 (1180-1205), Period 16 (1235-1255), Period 17 (1380-1400). Burials were likely to have ended between the estimated time of 1485-1525, and the most likely of 1485-1510 which had a 68 percent probability. Burial could have continued until the priory closed in the year AD 1539. Unfortunately, I was unable to locate records to support when burials ceased. The actual periods used by the archaeologists, assuming use until closure, were Period 14 (1120-1200), Period 15 (1200-1250), Period 16 (1250-1400), Period 17 (1400-1539). This cemetery was also thought to have been used prior to the founding of the hospital starting in AD 1197 (Thompson et al 1997).

In the mid-13th century, large pits were dug in to phases which interred thousands of individuals. Period 15 internments usually contained ten to twenty individuals. These internments were dug West to North West and West to Southeast. Period 16 contained twenty to forty individuals. These pits were dug east to west. In Period 16 internment, a significant number of complete limbs were found that did not belong to the individuals in Period 16. These limbs have significant meaning in terms of the internment periods. The bodies in Period 15 pits were not completely decomposed when Period 16 pits were dug. This caused individual bones to disarticulate and become part of the Period 16 pits. This

suggests that Period 16 pits were dug no more than a few years and as little as a year after Period 15. This provides an ante-quem and post-quem to the pits, meaning Period 15 was first followed by Period 16.

Site Introduction: Dominican Friary Carter lane

In the early 14th century, there was a chapel that was dedicated to St. Mary Magdalene and St. Edmund the Bishop that was built on the cemetery. It housed the bones from the disturbed graves. The Chapel was destroyed in the 17th century and all the human bones are unaccounted for.

There were two phases of excavations at 54-56 Carter Lane, 1-3 Pilgrim Street and 25-27 Ludgate Hill. The first phase of excavations took place in 1987 and 1988. It puts 1987 and 1988 as one excavation while 1989 was a different excavation. It was believed that Blackfriars bought the land in AD 1274 or AD 1276 that once was the Norman Fortress (Bekvalac 2007). When the friars acquired the land, all that was left was a stone quarry. The friary built here was known as the London Blackfriars.

The burials revealed were identified to be dated from the 13th century to the 16th century. A majority of those uncovered from the previous finds dated to the 13th or 14th century (Bekvalac 2007). Wooden coffins with no linings were found. There were some with lining and one individual was interred in a lead coffin. It is unknown how large or in what condition the cemetery is. During my research, I found the southern ditch north of the church was known to have been the friary cemetery. Burials followed Christian burial practices apart from the identification of one mass grave.

The mass grave contained 13 individuals of various ages and both sexes were interred at the time which may have been from the epidemic. There was a total of 58 individuals that were found but only 57 of them were analyzed. The site preservation for the majority of skeletons was good (75%) and were included in the demographic analysis. Having good preservation of skeletal elements allows for age and sex to be determined. Results consisted of 48 adults with 16 male, 12 females, and 20 unassigned to sex. The mass grave that totaled 13 people consisted of 6 sub-adults, 3 males, 2 females, and 2 unassigned adults.

This site's time period for the burials encompassed a significant time during the Great Famine and the Black Death which explains the mass grave. This site alone gives insight to the famine and the Black Death providing information that is crucial to answering the research questions (Bekvalac 2007).

Site Introduction: East Smithfield Black Death

Royal Mint, the Medieval cemetery, was situated at East Smithfield which the archaeologists referred to it as E1. East Smithfield was positively identified as a Black Death cemetery after it was excavated in 1986-88. The site was two hectares (ha) in size while being used between 1348-1350. This was the first established Black Death cemetery in London. There were two clusters that consisted of burials. The western cemetery had a total of 558 burials consisting of 300 individuals uncovered from a mass grave and 258 from single inhumation graves. On the eastern side of the cemetery, there were 192 individuals revealed after excavation. Out of all the remains excavated, the demographic break down was 102 individuals from a mass grave with 90 individuals

from individual inhumations. After the excavation, it was estimated that about 40-50% of the Royal Mint's courtyard is in situ below. From both site areas, there is a total of 636 individuals.

The recording of this cemetery deviates from all other cemeteries methodology. Dental pathology was not recorded with the 0-9 scale. Notes were only taken when pathological conditions were observed. The preservation was good but, unfortunately, the completeness of skeletal materials was poor for sub-adults. Due to the incompleteness of the skeletal material, a large portion could not be assigned to an age category.

Museum of London: The Wellcome Osteological Research Database (WORD)

The data for this project was collected by the Museum of London. The Museum of London has been excavating human remains in the greater London area since the mid 1970s. The archives from the project includes 17,000 individuals. These individuals were excavated at various sites that were conducted by various archaeologists. The Museum of London evaluated the issue of standardized methods after many archaeologists in the US were facing the issue head on. The American government passed the Native American Graves Protection and Reparation Act (NAGPRA) in 1990. This law created a need for a standard set of methods for all archaeologists to use. The Museum of London followed America's footsteps and began to re-evaluate the skeletal remains using a standardized system. All the data would be put in an online database called The Wellcome Osteological Research Database (WORD). The data used in this project came from this database. The database spans from Roman to Post-Medieval dates in history. This project utilized the

medieval archives of the database. The sites selected were St. Mary's Spital Square, Dominican Friary: Carter Lane, and East Smithfield Black Death cemetery.

Data collected from each individual site now had a standard procedure to follow. Individual remains would be identified by site code and context number. Stains on the bone would be noted. An example would be, a green stain on the bone would come from copper and it would be noted in the data with a brief description. Intrusive bones were also noted as it was not uncommon to find intrusive bones in the burials. Burials could contain animal bones or other remains of another individual in cemeteries with high burial density. The type of intrusive bone would be noted. Some times it is not possible to differentiate between intrusive and non-intrusive bones due to similar morphology, preservation and size of the elements. It is particularly a problem with smaller bones in the hands and feet. The small bones in the hands and feet are difficult to identify even in isolation due to unreliable siding procedures. In order to have a working knowledge of the data, it is important to understand what was recorded and what was not (Powers 2012).

The human skeleton contains 206 bones that ossify when an individual matures. Individual bones that are not fused represent an individual who has not reached skeletal maturity. In recording an individual, bones of the skeleton are often recorded in sections or parts. There are five bones that are excluded from the catalogue, which are the ethmoid, lacrimals, palatine, vomer, and turbinates. The bones of the cranium that are recorded are recorded in sections. The listed bones are the ones that have been divided up and catalogued in parts. Starting with the cranial bones, the ones that are split into

multiple categories are the sphenoid, occipital and, in this database, the hyoid. The Sphenoid bone is recorded as five elements called the basisphenoid or the body, greater and lesser wings for each left and right side. The occipital bone is recorded in terms of its four primary centers: the basioccipital (*pars basilaris*), left and right exoccipitals (*pars lateralis*), and the squamous portion. The last bone included in the cranial section that is divided into parts is the Hyoid. The hyoid bone is catalogued in three parts: the two greater horns and the body. The auditory ossicles are only recorded if they were found, though there was no effort to remove them from individuals (Powers 2012).

Post-cranial bones vary in the way they are recorded. The parts of the sternum that are individually recorded into six sections: the manubrium, the four sternabrae of the body, and finally the xiphoid process. Rib fragments are studied for signs of pathology and are sided if intact. The vertebrae are catalogued by constituent parts and divided into three. The three parts are complete vertebrae with both the centrum and neural arch, centrum only, and neural arch only. The Pelvic Girdle is divided into the original bones that fused together. The bones that compose the pelvic girdle are the ilium, ischium and pubis. The scapula is divided into four parts. The four parts start with the glenoid fossa, which is the surface that looks like a tear drop, then the coracoid process (can be unfused in sub-adults), the acromion, and the infraspinous portion of the blade. The final bone included in this category is the clavicle. The clavicle is talked about being seen and wanting to be seen in the modeling industry. The clavicle is recorded in three part: the medial or sternal third (This is the part closest to the sternum or the center of the chest), the middle third or acromial third (the acromial third is located lateral and would assist the humeral head in

staying in its joint). The last category of bones that are divided up in the data are the long bones. The long bones are the humeri, radii, ulnae, femora, tibiae, fibulae. These bones diaphysis are each subdivided into three equal parts and then recorded (Powers 2012).

METHODS

The Osteological Paradox

For me, it is important to begin any discussion of human remains with the challenge that professionals face when working with skeletal material. In any archaeological site, there are many factors that influence preservation and number of individuals. One site sample is not representative of the total living population. Burial practices at the time influence who is buried and where. Preservation is influenced by the soil. Preservation also is influenced by the treatment of the remains and what the remains are interred in. Infant remains do not preserve as well compared to an adult, therefore, the infant remains would not be present in the archaeological sites record (Wood et al 1992).

Remains that are preserved in archaeological sites create another issue. Often people die from illnesses and those who study the remains attempt to understand the individual's health. Changes in bone (pathological changes) are markers of chronic conditions. Individuals with markers are often the survivors. This means that the individual has lived long enough for the condition to imprint on the bones. Wood et al discusses those who were killed rapidly. "Rapid death results in few, if any, skeletal lesions in the mortuary sample" (Wood et al 1992). Wood and his colleagues demonstrate that even individuals who look healthy, or had no markers present, could have been the ones who died from disease. The plague was known to kill quickly, as mentioned in the introduction, and would have left many individuals without pathological changes to the bone.

Methods were used to observe specific markers on the remains. Indicators present on the bone can provide information on diet, status, stress, and famine. Each of the categories contributes information that will assist in the process of answering the research questions. In the various subsections there will be a description on the markers that the researchers originally used and the ones I will observe through the descriptive data.

The Museum of London utilized various methods to extract information from the remains. Standardized methods that were applied are listed in the Rapid Method for Recording Human Skeletal Data, in addition to the method scores and codes assigned. I will discuss the markers relevant to each of the categories that will assist in answering the research questions. Then, I will discuss how these methods were scored and coded according to the manual.

Diet

Dental Diseases Gummy your Food

Dental diseases are a good indicator of diet because teeth are in direct contact with food. Teeth are the primary tools used to process foods and are in direct contact with the outside world. Human teeth have chemical properties that make them more likely to survive and be found on an archaeological excavation. Teeth provide information on the kinds of food eaten, preparation techniques, and finally cultural information on dietary behavior (Scott 1997). Processing activities can also impact the tooth and alter the structure. Teeth are often used as a “third hand” in certain activities (Scott 1997). Examples of these activities include carding wool or in more modern times holding writing implements or hair accessories with our teeth. (Scott 1997). Dental Caries is one

of the diseases that can lead to other pathological conditions. Most are caused by the fermentation of food sugars on the teeth. Starches can have the same effect but cause caries less frequently. The right combination of plaque bacteria and sucrose is needed to produce the acids that demineralize the structure leaving cavities. Crowns of the tooth, especially in molars and premolars, have fissures that plaque can become trapped in. When the gum line recedes, the roots can also be a target for plaque build up. Caries, if present, must be recorded and entered into the database. The score has two digits, one for location and the other for severity.

Dental Abscesses are linked to dental caries but can also be formed by trauma to the mouth. Bacteria enters the cavity of the tooth. Inflammation of the area begins and the body forms pus creating an abscess (Roberts et al 2005). Codes are given in the manual to Periapical Lesions (abscesses) based upon the location of the tooth and how the abscess formed.

Periodontal Disease is an inflammatory response to an irritant. The most common irritant is calculus. Calculus is mineralized plaque. Inflammation results in resorption of the alveolar process where tooth roots are located. Loss of alveolar bone can lead to tooth loss. To determine if an individual has periodontal disease the individual might have a presence of calculus in addition to alveolar resorption with little to no carious teeth.

Post-cranial markers

Porotic Hyperostosis found on the skull vault and in the orbital roof (eye sockets) is mainly associated with anemia, particularly iron deficiency anemia. The reaction in the bone is in response to inflammation This is typically seen in sub-adults and is a

thickening of the bone (Ortner 2003). Porotic Hyperostosis and Cribra Orbitalia are separate or together in various literature. In this method the focus is in the orbital region, therefore, the term Cribra Orbitalia is used. Cribra Orbitalia was recorded using a scale of numerical values 0-9. Starting with zero the values mean normal bone surface, capillary like impressions on the bone, scattered fine foramina, large and small isolated foramina, foramina linked into a trabecular structure, outgrowth in trabecular form from the outer table surface, and lastly, not present or unobservable. This simple scale was used to score individuals with this pathology that affects the cranium.

Stature is a marker of diet that consists of two parts. One element to stature is the genetic or hereditary aspect of attained height. A large part of stature is the environmental factor that occurs during childhood and adolescence. The body must have proper nutrients in the diet to fuel growth. If an individual has problems with absorption of the nutrients, this can result in shorter stature. Manual labor may also deprive the body of nutrients needed for growth. Reduced stature compared to others in a similar population could indicate a poor diet and poor health. It is possible for the body to have a catch-up growth period if conditions improve (Roberts et al 2005).

Sex Estimation Methods

Sex assessment does not determine gender. Gender is a social construct and is not shown in skeletal remains. Researchers used the sexual dimorphism that exists in humans to aid in determining the individuals sex.

Sexual dimorphism simply means the

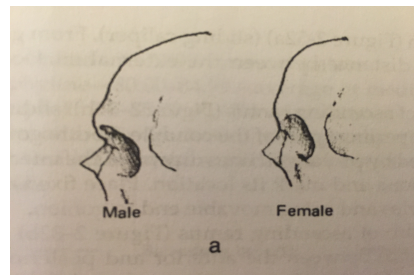


Image 2: differences in the frontal squama (Bass 2005:82)

differences found between male and female. Sexual dimorphism in modern humans is less pronounced than in other mammals. All are scored from one to five with one being hyperfeminine and five being hypermasculine. Supraorbital Ridges are located on the frontal bone so to view this trait one would look at the profile. A score of one for this feature would be characterized as a smooth profile with little or no projection. A massive projection would score a five (White 2012). The frontal squama (forehead) will be flat and gracile in females while in males the forehead tends to project outwards (Bass 2005).

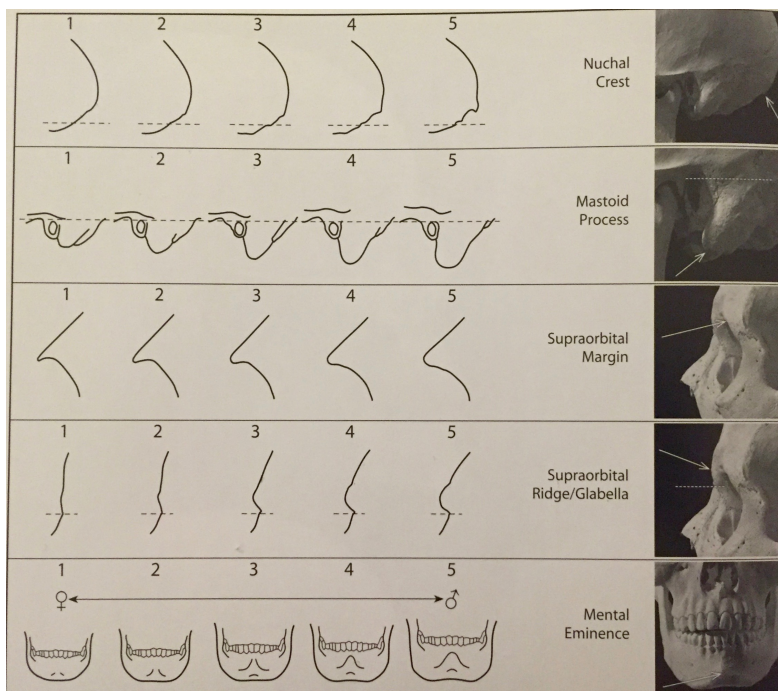


Image3: Sex characteristics in the skull. Scale: 1= hyperfeminine, 2= feminine, 3= intermediate, 4= masculine, 5= hypermasculine (White 2012:410)

See image number two for sex differences in the frontal squama. The Nuchal Crest is located on the occipital bone. A score of one would be characterized by a smooth surface with no bony projections as demonstrated in Image 3. A

massive nuchal crest that projects out from the bone

would have a hook or ledge appearance. The mastoid process is located on the temporal bone close to an individual's external acoustic (auditory) meatus or ear canal. This feature is compared by its size. Females will have a small mastoid process that does not project far. Males will have a large mastoid process (White 2012). The Inion

protuberance is located on the occipital bone at the base of the external occipital protuberance. Inion is a craniometric point used as a marker for measurements. Inion and the external occipital protuberance are located in the same place (Bass 2005). What is important to note is the variety in morphology. In men it is more pronounced than in women (White 2012). Gonion is another point located on the mandible and is used for craniometric measurements (Bass 2005). The final trait in the skull used by the researchers is the zygoma root.

The skull and the pelvis are the best in determining sex of an individual. The first method for sex determination uses another series of fused bones that displays differences between males and females. Phenice (1969) uses the os pubis (pelvis) and should only be used on adult individuals. Phenice established a method that is the most accurate for determining sex of an individual from skeletal remains. This allowed a more accurate and quicker sexing method that can be applied to any pelvis with well-preserved pubic region. Three features are used in this method, the ventral arc, subpubic concavity, and medial aspect of the ischiopubic ramus. A ventral arc is only present in females. Males will have a straight or a very slight subpubic concavity. The medial aspect of the ischiopubic ramus in males is flat, broad, and blunt. Females will have a sharp edge in the ramus. Accuracy of this method is dependent on the individual's experience.

Stress

Cranial Markers of Stress

Enamel Hypoplasia is a marker of an episode of stress during the years when the body is developing. Enamel Hypoplasia is a defect in the enamel that can appear as lines,

pits, or grooves on the tooth surface. The most commonly affected teeth are the incisors and canines. Defects occur in the childhood years as the permanent dentition is forming. Events that can cause defects are trauma, systemic stress, childhood illness, and nutritional deficiency (Roberts et al 2005).

Age at Death

Determining the age at death was the next section in the manual. A collection of age determination methods is included in order to cover the range from an individual who died in the womb to a fully mature adult. The focus for this paper are the adults, therefore the methods of adults are discussed. Sub-adults are individuals who have not reached puberty, and therefore cannot be sexed. Aging a sub-adult is more accurate than aging an individual who has reached skeletal maturity because of the growth rates that are very specific. Sub-adults can be aged within six months to a year where as adults are aged in decades. Age methods for this group will focus on tooth eruption, epiphyseal closure (bone growth) and the length of long bones that have not fused (Bass 2005).

Age at Death means to determine the age of the individual at the time of death using biological changes that occur in the skeletal throughout life. At the age of twenty-five to thirty when the skeletal maturity occurs, aging methods focus on degeneration. It is important to understand that variation exists between groups of humans and that aging methods have to account for this variation (Bass 2005).

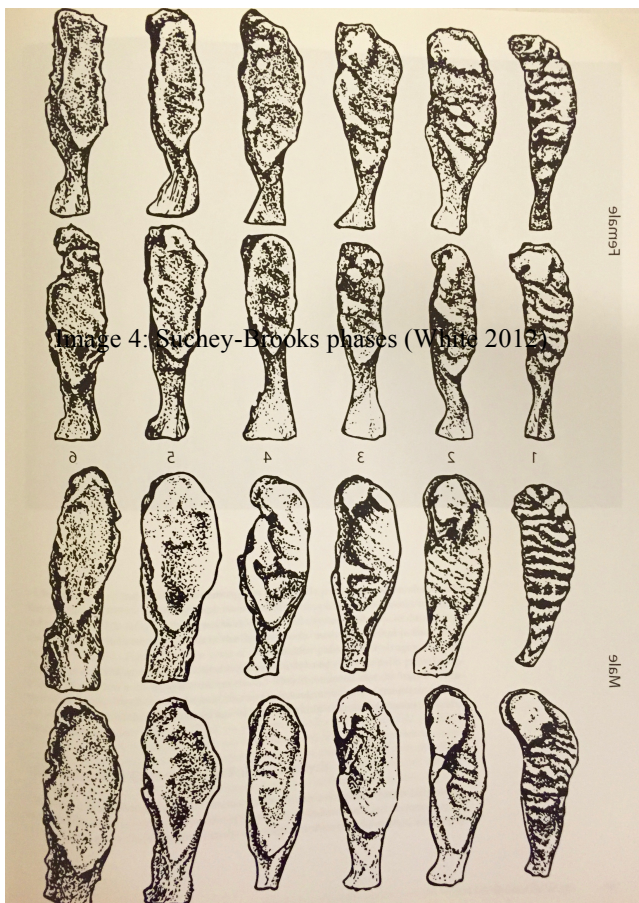
Lovejoy et al (1985) used the Todd Collection and the Libben Collection in addition to several forensic cases to establish age at death. The method focuses on the ilium specifically the changes to the auricular surface. Preservation of the auricular

surface is higher than the preservation of the pubic symphysis, another popular area for aging. This method was tested on 250 well-preserved auricular surfaces from the Libben collection and 300 from the Todd collection. Age categories extending past the age of sixty is rare in aging methods as senescence often masks age-making it hard to estimate after skeletal maturity. Starting at age twenty-five, the method can estimate age to a range of sixty plus.

Buckberry and Chamberlain (2002) wanted to make Lovejoy et al (1985) easier to understand and use. In addition to making the method easier to apply, they also attempted to reduce the error between researchers (observer errors). Buckberry and Chamberlain used the same terminology as Lovejoy et al. Both methods were tested and had their own advantages. Lovejoy et al proved to be more accurate for individuals in the age range of twenty to forty-nine. Buckberry and Chamberlain was more accurate for individuals aged fifty to sixty-nine.

Suchey-Brooks (1990) method revolves around the pubic symphysis containing a total of six different phases. In order to age the individual, the illustration and casts should be used to age the individual properly with both being consulted. The method has six phases that are divided into male and female groups. Phase one is characterized by billowing (ridges and furrows) on the surface of the symphysis. Ridges are well marked and run horizontal there is no difference between the upper and lower extremity in the billowing. Phase two shows the start of the delineation of the top and bottom, which can also have nodules of ossification or new bone. Phase three demonstrates the lower part with no lipping or bone outgrowths. Phase four has the oval outline completed and

demonstrates a fine-grained appearance with some ridges remaining. In Phase five, the outline is complete and the face is depressed relative to the rim around it with little to no rim erosion. Phase six, the rim erodes and can show an overall ongoing depression of the face. Image number four provides the stages. Females are represented in the top eight images followed by the male examples at the bottom of the image.



Another adult age method uses the sternal rib end and was put forth by Iscan et al (1984;1985) for both male and females. The method uses the fourth rib and only looks at the end that is located by the sternum. Observations center around pit depth, pit shape, rim and wall configuration as the degenerative age changes. Each of the characteristics has six phases, each numbered zero to five. This method has numerous problems that are important to note. Identification of ribs in their order is extremely difficult. The first two and last two are very unique and can be identified. Other ribs have no special marker to assist in determining their placement. Additionally, the ribs in the human body will go

from smallest to largest then back down in size. Correctly determining the fourth rib is difficult because it does not have distinct morphology. The methods criteria for the different phases are ambiguous which leaves a lot of room for error between examiners. Finally the method requires different standards for sex and ancestry. Therefore the method cannot be applied without known ancestry and sex.

Status

Status of an individual proves more challenging to determine. Stature of an individual can mark status. If an individual is of a higher status in society, typically their access to various foods is greater. Higher status individuals will have a better chance of achieving a greater height based on food resources available to them (Roberts et al 2005).

Stature is often one of the more concrete markers of status. Markers of status often are markers of other events making it more difficult to interpret status. One marker in bones that can ultimately be used for a marker of status is osteoarthritis. Osteoarthritis results in aging. Osteoarthritis can also mark occupation. Repeated tasks can result in changes to the skeleton. Heavy manual labor that places stress on joints will become a marker over time. A group of individuals with similar specific patterns could suggest that the individuals practiced similar tasks. Identification of occupational markers is not often concrete. Interpretations should be chosen cautiously and by doing so should not denigrate your findings.

Conclusion of Methods

The methods used on the bones aimed to get as much information as possible to create an online database that was accessible to researchers. Naturally, with the goal of

recording as much data as possible, the Museum provides any researcher with a wealth of data to answer many possible research questions. Provided with the data is a manual of all the methods and abbreviations used within the excel worksheets. Other methods included in the manual were tables with the keys created for the project. Tables would include the description and the numerical score, or code, associated with each characteristic observed. Description of the methods that applied to the research will go in order they are listed within the manual.

In addition to the methods applied by the researchers putting together WORD, the research for this paper utilized additional methods. The excel worksheets provided for each site was downloaded and placed into folders. In addition to the folders for each site, copies of all the excel workbooks were created and put together to have data from all three sites. I have taken the individual worksheets for each site and organized them into visual representations (bar graphs, histograms, pie charts) and then into pivot tables attached in the appendix. The combination workbooks containing all three sites varied slightly. I set up all combination workbooks to delineate individuals with a pathology or anomaly. In the site specific worksheets, duplicates were not deleted to preserve the detailed information on location and numbers of pathology or anomalies (i.e. how many teeth were carious in the maxilla).

Results

I've set up the results section to first discuss each site individually and conclude with a summary of inter-site comparisons. Each of the workbooks has the data converted to a pivot table with graphic representations, when possible. Combinations of charts or pivot tables are utilized to best represent the individuals with the specific feature, pathology, or anomaly present. Therefore, duplicates were deleted in the combination sheets. Individual site workbooks still contain duplicates present to allow for greater understanding of the data.

St. Mary Spital (MSS)

This archaeological site is dated from 1235 to 1280 CE. All of the individuals were located in the North Section of the hospital cemetery and given the code NRF85. Each of the burials were aligned east-west. St. Mary Spital had the overall best preservation with ratings only in the good or moderate category. One adult individual had a moderate rating; all of the other individuals had a good bone preservation score.

Age and Sex

Fifty- four individuals are represented at the site. There was a greater number of males (20) than females (8). Females, were found to be in the age range of 18-46. There were 19 males aged 18-46 with one unclassified adult male. Children, which can be aged but not sexed until skeletal maturity, had a total of 19. One of the children was perinatal. Four children were in the age range of 1-5 years. Five children were between the ages of 6-11. Eight children represented the 12-17 age range. There was one unclassified sub-

adult. The remaining two individuals were in the intermediate category; one of them was in the 18-25 age group while the other belonged to the 26-35 group.

Cranial Pathology

Dental pathological conditions observed were calculus, caries, enamel hypoplasia, abscesses, and periodontal disease. Teeth were counted individually and the numbers represented are the amount of teeth in each age group that had one of these pathologies. Adults older than forty-six had teeth with calculus on them (62) and had teeth affected by periodontitis (46) Numbers for the remaining pathologies were much smaller. Adults aged 36-45 within their age group had the most cases of calculus (98) and periodontitis (87). The same pattern continued for individuals aged 26 to 35 with cases numbering 83 and 22 respectively. Young adults 18 to 25 had calculus with the most number of affected teeth (133) but had an equal amount of cases for caries and enamel hypoplasia (18). Sub-adults had ninety-six teeth with calculus and fifteen teeth with enamel hypoplasia.

Cribra Orbitalia was marked for each side of the skull. Sub-adults had a total number of twelve cases with the majority of the cases (8) in the twelve to seventeen age group. The remaining cases (4) were in the one to five age group. Two cases were present in unclassified sub-adults. Males had a total number of seven cases with the lowest number (3) falling in the thirty six to forty five ages. The remaining cases (4) were found in individuals aged eighteen to twenty five. Females only had one case and was found in an individual forty-six or older.

Variation in burial types

All of the burials present at Spital Square were aligned east-west. The data did not include comments that revealed any differences between inhumations. Information on the burials are included in the comments section in each of the spreadsheets.

Dominican Friary Carter Lane (MDFCL)

This cemetery was in use from the 13th century until the 16th century. The site had individual internments and one mass burial. At the time of the epidemic, thirteen individuals were buried in the mass grave. A total number of fifty-eight individuals were discovered but only fifty-seven were analyzed. Preservation ranged from good to poor. There were seven individuals that had poor preservation. Five unclassified adults, one adult over forty-six, and a sub-adult were in the poor preservation category. Seven individuals were in the moderate preservation group. Forty-three were in the good bone preservation group.

Age and Sex

More males were represented (16) than females (12). A total of twenty unassigned adults were present and there were nine sub-adults. Three males and females were aged forty-six and above along with one intermediate. Four females were aged 36-45 and three males were in the same age range with one intermediate. One undeterminable individual was aged in the same group. Six males were in the twenty-six to thirty-five age group along with three females and two intermediates. Three males were aged eighteen to twenty-five in addition to one female and one intermediate. Unclassified adults comprised of fourteen undeterminable individuals, one female, and one male. Sub-adults

could not be sexed. Three sub-adults were in the age group of one to five years old. Six to eleven consisted of four individuals. Two individuals were in the twelve to seventeen age group.

Dental Pathology

Dental calculus again had the highest number of teeth affected than any of the other pathologies. The two age groups with the highest number of teeth with calculus are ages twenty-six to thirty-five (163) and thirty-six to forty-five (109). The next pathology with the second highest frequency was periodontitis. Adults over forty-six and those aged twenty-six to thirty-five each had a number of forty-seven teeth. Those aged thirty-six to forty-five had a total number of twenty-seven. Enamel hypoplasia was third with ages twenty-six to thirty-five and eighteen to twenty-five each having the same number of affected teeth (23). Following that order dental caries are next. Adults forty-six and older (15) followed by the age group of thirty-six to forty five (14) have the highest frequency. Lastly, abscesses with adults forty-six and up (5). Four teeth were found in the age range of thirty-six to forty-five and twenty-six to thirty-five.

Cribriform orbitalia was recorded on each side of the cranium. Sub-adults had the most cases (6) and the majority of them (4) were in the age range of twelve to seventeen. Two cases were present in the age group of one to five years old. Males had a total of three cases. Males in the age groups eighteen to twenty five, twenty six to thirty five, and forty-six plus all had one case. Females only had three cases in the forty-six plus age group.

Variation in burial types

Dominican Friary Carter Lane was a burial ground during the time of the Great Famine and the Black Death. The only variation in the burial that I noticed, occurred during the Black Death. Thirteen individuals were buried together in the mass grave. The mass grave included individuals of mixed ages and sexes.

East Smithfield (MESDB)

East Smithfield was specifically utilized for the epidemic. I read during my research this cemetery is unique as it follows a catastrophic death pattern. A total of 636 individuals were interred at this site. Bone preservation at East Smithfield ranged from good to poor. Twenty-three individuals had poor bone preservation. Moderate preservation had 189 individuals while good preservation had the most individuals (424).

Age and Sex

Age at this site has a wider spread than at the other sites. Sub-adults that are perinatal and sub-adults under a year old are present at this site. Unclassified sub-adults totaled thirty-nine individuals. Unclassified adults had the most individuals (92) in the undeterminable category. Four unclassified adults were given an intermediate score. In this specific subset are more males (11) than females (10). Beginning with the youngest sub-adults and moving up in age, five perinatal sub-adults were present. In the one to six-month age group there were four individuals. Two individuals were representative of the seven to eleven-month group. One to five year olds had fifty-two individuals. Six to eleven year olds had sixty-one individuals. Fifty-three were aged twelve to seventeen.

Adults can be sexed and provide a wider range of information on age and sex. Young adults aged eighteen to twenty-five had three intermediates and eight undeterminable individuals. Males were once again more frequent (36) than females (16). The pattern with males being more frequent continues in the twenty-six to thirty-five range. Males have sixty-eight individuals while females only have thirty-eight. Undeterminable individuals had a total of eight while intermediates had a total of seven. Males (62) in the age range of thirty-six to forty five were represented more than females (31). One individual was undeterminable and three were intermediates. Those forty-six and older continued the pattern with twelve males to nine females. Only one intermediate was present.

Dental Pathology

Individuals who had pathological teeth were recorded. Every individual tooth is counted, therefore, these numbers represent the number of teeth in a given age group with pathology. Calculus had the largest presence in the twenty-six to thirty-five age group (1359) and the thirty-six to forty-five year olds (1062). Dental caries followed the same age pattern with 174 and 125 respectively. The pattern continues with abscesses 29 and 22. Perodontis sees this pattern switch with thirty-six to forty-five year olds having the most cases (479) compared to the twenty-six to thirty-five age group (453).

Cribra Orbitalia

Cribra Orbitalia was recorded by the presence on the left or right side of the skull. It was not uncommon for one individual to only have cribra orbitalia present on one side. Sub-adults had the highest number of cases (45) with the majority of the cases within the

six to eleven age (19) category. Twelve to seventeen (17) was the next age group with the highest number of cases followed by one to five year olds (8). One case was present in the unclassified sub-adult category. One case was present in an undeterminable adult aged twenty-six to thirty-five. One case was also present in the unclassified adult category. Intermediates had a total of three cases, two in the thirty-six to forty-five age group and one in the twenty-six to thirty-five group. Males (43) aged twenty-six to thirty-five had the highest number of cases (20). Eighteen to twenty-five year olds had nine cases. Thirty-six to forty-five year olds had a total number of six cases. Unclassified males and those older than forty-six both had two cases each.

Variation in Burial Type

East Smithfield Black Death has different sections of the site that has variations within each of the sections. The sections are the Eastern Cemetery, mass burial trenches one to three, and the west row trench that has a total number of eleven trenches dug. Each section will be discussed in terms of variations with age and sex distinctions.

Identification of burial types was found in the comments for some of the individuals.

Individuals that did not have documentation on the burial type were not included in this section.

Eastern Cemetery

Burial types found in this section had specific codes. BD stands for confirmed Black Death burial. BTC is a burial type coffin that can include ash. Finally, grave goods are noted in the comments as well. Any of these codes can be combined together to describe the variations within each burial site. Individuals will be discussed in terms of

their burial code. A total number of individuals are stated, followed by age group that are within the burial type.

Individuals with the Black Death code consisted of three females, one sub-adult, one undeterminable, and one adult. The three females were in the age group of eighteen to twenty-five, twenty-six to thirty-five, and thirty-six to forty-five. The unidentified adult was aged twenty six to tirty five.

A total of nine individuals were in the Black Death burial type coffin category. Two intermediate adults were present, one was an unclassified adult and the other was aged thirty-six to forty five. One female was present and was aged twenty-six to thirty-five. One sub-adult aged twelve to seventeen as included. One undeterminable adult aged twenty-six to thirty-five was also present.

Individuals with only a burial type coffin totaled eleven with three undeterminable and unclassified individuals. An intermediate person aged eighteen to twenty-five was present along with an undeterminable eighteen to twenty-five year old. No females were present. One sub-adult aged twelve to seventeen was present. Four males aged thirty-six to forty-five and one male aged eighteen to twenty-five were included.

Only one individual was found to have been a Black Death burial type coffin with grave goods found. This individual was an undeterminable adult. The individual was aged twenty-six to thirty-five years of age.

Mass Burial

The mass burials found at the site had three trenches in total. The individuals found in each of the trenches will be combined and divided into the burial type groups. The mass burial trenches with the Black Death code combined had a total number of 115 individuals. The largest group represented in this group is the sub-adults (33) with the largest age group being twelve to seventeen year olds (14). Six to eleven year olds (10) followed by one to five year olds (8). One seven to eleven-month old was present. Males had a total of 32 individuals represented in the burial trenches. The eight to twenty-five, twenty-six to thirty-five, and thirty-six to forty-five all had nine individuals in each age group. Three males were aged forty-six or older and two unclassified adults are also present. Twenty females were also present in the Black Death burial group. Nine females were aged thirty-six to forty five, and seven females were twenty-six to thirty-five. Three females were aged eighteen to twenty-five and one was forty-six or older. Seventeen individuals were undeterminable unclassified adults. Unsexed and unclassified children totaled four. Intermediates had two individuals in the forty-six plus and twenty-six to thirty-five category.

Black death and the burial type coffin code combined had a total of sixteen individuals. Sub-adults were the majority of individuals represented in the trench with a total number of seven. Males and females each had three individuals. Males had one individual in the eighteen to twenty-five, twenty-six to thirty-five, and thirty-six to forty-five age group each. Two unsexed and unclassified sub-adults were present and one undeterminable unclassified adult was as well.

Burial type coffin category had a total of eighteen individuals. Undeterminable and unclassified adults had four individuals. One unsexed unclassified sub-adult was present. Sub-adults had a total of nine individuals. Six to eleven year olds had a total of five individuals in the age group. Two individuals were present in the one to five year olds category and the twelve to seventeen age group. Males had two individuals in the twenty-six to thirty-five age ranges. Females had one individual in the twenty-six to thirty-five and thirty-six to forty five group.

Five individuals had grave goods in the burial. Four of them were male with two males aged eighteen to twenty-five. Two males were also aged thirty-six to forty-five. One female had grave goods and she was aged eighteen to twenty five. Only two males had the Black Death and grave good codes. One male was aged twenty-six to thirty five and the other was thirty-six to forty five. Burial type coffins with grave goods had a total of three individuals one male aged twenty-six to thirty five. Two females were present and one was twenty-six to thirty five and thirty-six to forty five.

A burial type coffin with the presence of ash only had two individuals. Both of the individuals were male. One male was forty-six and older. The other male was aged thirty-six to forty-five.

West Row Trench

Individuals with the burial code for Black Death totaled forty-eight individuals. Sub-adults were the largest group (16). Two perinatal sub-adults were present with one sub-adult aged one to six months. Seven individuals were aged one to five years of age. Four individuals were in the six to eleven age group with only two being aged twelve to

seventeen. Unsexed and unclassified sub-adults had a total of six individuals.

Undeterminable adults had two individuals one was aged eighteen to twenty-five with the other being twenty-six to thirty-five. Undeterminable and unclassified adults had five individuals. Intermediates totaled three. One was an unclassified intermediate the other was aged twenty-six to thirty-five. A total of ten males were present with one being unclassified. Five males were aged twenty-six to thirty-five and four were aged thirty-six to forty-five. Six females were present with four being aged twenty-six to thirty-five. The remaining two individuals belonged to the age group of forty-six plus and thirty-six to forty-five.

Burial type coffins had a total of sixty-four individuals. Males were the largest group present with twenty-three individuals. Two of the males were unclassified. Two males were aged eighteen to twenty-five. Three males were forty-six and older. Ten males were aged twenty-six to thirty-five. Three individuals remaining belonged to the thirty-six to forty-five age group. Females only had fourteen individuals present. Three people were older than forty-five and one was unclassified. Three were aged eighteen to twenty-five. The age groups of twenty-six to thirty-five and thirty-six to forty-five both had four individuals. Undeterminable and unclassified adults had a total of nine individuals. Unsexed and unclassified sub-adults only had two individuals. One undeterminable adult aged eighteen to thirty-five was present. Sub-adults had fifteen individuals with two of them being perinatal. The age group of twelve to seventeen age group had three individuals. Five individuals were present in each of the one to five and six to eleven age groups.

Black Death and burial type coffins had a total of twenty-eight individuals. Unsexed and unclassified sub-adults accounted for two individuals. Undeterminable and unclassified adults totaled four individuals. One intermediate was aged thirty-six to forty-five. Sub-adults had a total of four individuals with two of them in the one to five age group. Six to eleven and twelve to seventeen each had one individual. Females had a total of four and the number was split evenly between the eighteen to twenty five and twenty-six to thirty-five age group. A total of thirteen males were recorded one of the individuals was an unclassified male. Six males were aged twenty-six to thirty-five while five individuals were in the thirty six to forty five age group. One individual was aged eighteen to twenty five.

A combination of Black Death, burial type coffins and grave goods had only two individuals. Both of the individuals were female and aged twenty-six to thirty-five. Burial type coffin with the presence of ash had a total of six. Two females were aged eighteen to twenty-five. One unsexed and unclassified sub-adult was present and one sub-adult was aged twelve to seventeen. Two males were present and aged twenty-six to thirty-five. Burial type coffins with the presence of grave goods also had six individuals. Three males were present; two of the males were aged eighteen to twenty-five. One male was twenty-six to thirty-five years of age. One unsexed and unclassified sub-adult was present. One undeterminable adult aged eighteen to twenty-five was included. One undeterminable and unclassified adult was present. Grave goods present by themselves was only found with one individual aged thirty-six to forty-five. One individual that was an unclassified adult had a Black Death burial with grave goods.

Inter-site Summary

St. Mary Spital had excellent bone preservation with the ratings only falling in the good or moderate category. The locations of the fifty-four individuals used for this research were from the North section of the hospital cemetery (NRF88). The site dates to 1235-1280. All the graves were aligned east-west. In this site, there was one individual (19) that had a piece of textile on her right tibia. In dental anomalies, there was only one case of impacted teeth. Dental pathology and multiple cases per individual was not uncommon. Caries, hypoplasia and perodontis had high numbers. Cases of dental calculus are not uncommon and were to be expected. When compared with the whole site the high rates of caries, hypoplasia and perodontis were thought to be indicative of social segregation (MOLA). Once again using the whole site to observe stature was necessary to get the best numbers using complete femora. The numbers generated were compared with the average heights of people at that time. Males (169.5 cm) and females (161.1 cm) at the site were standard height for their time period. Demographic data, specifically for NRF88, had a larger number of males (20) than females (8). Intermediate group had two individuals. There were five undeterminable individuals and nineteen unsexed.

Dominican Black Friary: Carter Lane had a total of fifty-eight individuals but only fifty-seven were analyzed. This site had single internments and one mass burial that was interred at the time of the epidemic. Thirteen individuals were buried in the mass burial. The cemetery was in use from the 13th to 16th century. Preservation ranged from good to poor. The site had more males (16) than females (12) with a total of 20 unassigned within the adult category. Nine sub-adults were present. Specifically in the

mass burial there were six sub-adults, and five adults. Five individuals were used to estimate stature using femoral length. Females had an average of 160.3 cm and males had the average of 171.5 cm, which was typical for the time. Males had more cases of hypoplasia and periodontal disease than females. This site was a burial ground that spanned the Great Famine and the Black Death.

East Smithfield was a cemetery that was specifically used for the Black Death epidemic. Preservation was good and completeness of an individual's skeletal remains was noted. Majority of the adults present died before the age of thirty-five while sub-adults died over the age of five. This cemetery is not like typical medieval cemeteries but follows the catastrophic death pattern that would be found in cemeteries related to epidemics. The average stature for males is 167.6 cm and for females 160.6 cm. Females relative to the other sites are within the standard height. Males are a bit shorter when compared to the averages of the other sites. Pathology was only noted if it was present, which limits the amount of data and interpretations that can be made. Dental anomalies and pathology reflects the challenges of the Great Famine and Black Death.

Only two sites had information on burial type and variations. Dominican Friary Carter Lane had only two individuals from the mass burial. East Smithfield Black Death had many variations of burial types. The combination of burial codes indicated the differences of burials, and what the burials contained. Grave goods were seen in Black Death burials, burial type coffins by themselves, or even in Black Death burial type coffins.

Discussion

Prior to discussing the results, I believe it is important to discuss the significance of the three individual sites. St. Mary's Spital Square was dated to 1235-1280 before the Great Famine (1315-1317) and the Black Death (1346-1353). Extensive archaeological research has been carried out and makes this site valuable for a glimpse at what health was prior to these historic events. All graves at this site were aligned East-West.

Dominican Black Friary Carter Lane had the remains in this study dated to the 13th and 14th century providing a record of those in the famine and of the epidemic. Internments followed the Christian style with one variation of a mass grave. East Smithfield Black Death was opened with the purpose of coping with high mortality rates. The cemetery was in use from 1348 to 1350. There were mass burials at this site.

Demographic Analysis

Males had a larger presence than women and the pattern was observed throughout the study. Adults made up most of the sites. At East Smithfield when comparing the number of adults to kids, children counted a little over half the number of adults. Majority of the adults died before the age of thirty-five and the majority of the children died over the age of five at the East Smithfield site. In the mass burials at East Smithfield, there were 205 adults and 109 sub-adults. Observations of the mass grave at Carter Lane indicated that there were seven adults to the six sub-adults. The variation in burial style could have resulted from the Black Death. In two Black Death sites, there were mass burials. One specifically was present at Carter Lane.

Stress Markers

Stress markers are present in the skeletal collections at each site. It is important to be able to use all the skeletal material for the individual to get a complete understanding of the individual's life. Some markers can be present but can be misleading to the researcher. Linear Enamel Hypoplasia is an important marker that is found on teeth. These markers are on permanent teeth and therefore reflect systemic metabolic stress (nutritional deficiency) or illness in childhood years when the permanent teeth are forming. Defects or lines and grooves in the teeth are easy to find on the buccal side (cheek) of the canines and incisors. In times of stress, development may stop or the forming enamel will not be as thick as areas formed outside the period of stress. Diet, health, weaning, and status all factor into the formation of these defects (Roberts and Manchester 2005).

At St. Mary Spital the females have a higher rate of hypoplasia than males do. Carter Lane had cases of hypoplasia but out of all three sites East Smithfield has the highest number of cases. Hypoplasia is consistent with life in medieval London. London, at the time leading up to the Black Death, was stratified based on status. The wealthy individuals would have a wide variety of food leaving them with more options than the poorer inhabitants. Cereals and grains counted for 80% of the caloric intake for the non-wealthy of the city (Walker 2012). For everyone, but the wealthy, a poor harvest like those in the great famine would leave a large part of their caloric intake missing. In the years of the Great Famine, bread price increased up to 10% leaving people to sell surplus plants and animals to be able to afford bread (Walker 2012). The number of cases at East

Smithfield echo the large population of the city's struggle to maintain a grain centered diet in the time of the Great Famine and Black Death. The number of bad harvests would be recorded in permanent teeth as the challenge to feed the family grew tougher.

Anemia is the next marker that demonstrates stress. Porotic Hyperostosis and Cribra Orbitalia are thought to be caused by iron deficiency anemia. It can also be caused by parasites in the gastrointestinal region

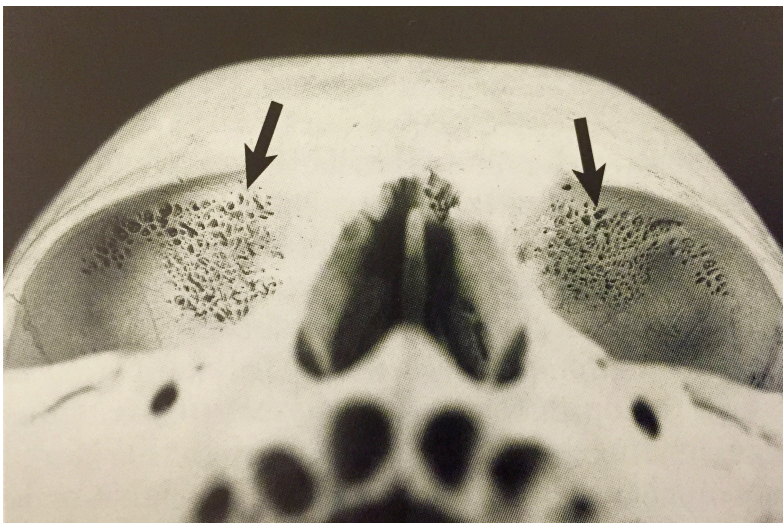


Image 5: Cribria Orbitalia (Roberts and Manchester 2005:231)

blocking the absorption of iron. Once again, the young are the most susceptible but it can be documented in adults with anemia as well. Porotic hyperostosis is used in literature to mean both the defects on the cranial vault and in the eye orbits. The bone reacts to inflammation by creating new bone (Roberts and Manchester 2005).

Periostitis is the formation of bone as a result of an infection. This new bone will look unique as it is thicker and more irregular than normal bone. Air pollution in medieval London caused many respiratory issues and ribs were noted to have additional bone formed in response to the chronic inflammation. Periostitis can result from injury or infection.

Status Markers

Markers of Status in individuals are commonly stature and related to trauma. There is not a lot of research on status markers when compared to stress markers. Stature is linked to status because of diet resources that poorer people do not have. Stature is both genetic and dependent on diet. In order to reach the genetic height, diet is needed to fuel growth (Ortner 2003). Trauma is related to status based on the fact that higher status people typically do not do manual labor-intensive jobs.

At East Smithfield there was a lack of pathological conditions. St. Mary's had two incidents of interpersonal violence while Carter Lane had none. There were six cases of interpersonal violence at East Smithfield. In the background of London, it was discussed that men have a greater risk to interpersonal violence than women. All but one of the six cases involved males. One case involved an unassigned adult. There were no female cases of interpersonal violence at the two sites. Violence was associated with those of the lower class as they are in city streets looking for work or selling items.

Dental Pathology was consistent with the time period. There was a slight increase of cases in dental pathology from St. Mary's to Carter Lane. Overall pathology was not as common in East Smithfield, but this could be attributed to the rapid mortality rates.

Research questions answered

In this last part of the discussion section I am going to address each question clearly. I believe that these questions have been crucial in directing me to the goal of this project. Finding bioarchaeological evidence that there is a link between the Great Famine

and the Black Death will forever change the discussion of the two historical events. The question will once again discuss how I worked to find an answer and include my findings.

Who is represented in the burials? Is there a disproportionate representation to different age groups or sexes?

Once I located the data for this project the first thing I did was answer the basic demographic questions. I looked at the age and sex of each individual present in my data to determine what death assemblage type was present. The only site that had a catastrophic death curve was East Smithfield Black Death. St. Mary's Spital Square had a large number of sub-adults and the total number of individuals at the site was fifty-four. In total, the sub-adults numbered nineteen making them the second largest group present. Twenty males were present. Eight females were also present. I found it interesting to see such a high number of sub-adults present at the site when compared to adults. Dominican Friary Carter Lane had fifty-seven individuals present. I found that at this site, too, there were more males than any other group. Sixteen males were present. There were more females at this site than St. Mary's with a total of twelve. Nine sub-adults were present. East Smithfield also had more males than females but the largest group represented was sub-adults. Sub-adults had a total of 216 individuals. Males had a total of 189. Females present totaled 104.

Males at each site had more individuals than females. The representation of males is disproportionate when compared to females at all three sites. Sub-adults at St. Mary's and East Smithfield had a large presence. I did not expect St. Mary's to have such a large

population of sub-adults at the site. I was expecting to see the number be smaller at St. Mary's when compared to Dominican Friary Carter Lane. I thought that by having a smaller number at St. Mary's than Dominican Friary it would be a shift from an attritional death curve to reflect the challenges faced during the famine. St. Mary's had the most adult individuals in the thirty-six to forty-five age group. Dominican Friary Carter Lane had the most individuals in the twenty-six to thirty-five age range. The largest age group at East Smithfield Black Death was the twenty-six to thirty-five. Twelve to seventeen year olds were the largest age group at St. Mary's and Dominican Friary. East Smithfield had sub-adults aged six to eleven as the largest group.

Are there any differences between burial types of non-plague and plague burials?

Dominican Friary Carter Lane had two plague burials that were marked by a mass burial. The only site that had variations in burials was East Smithfield. Burials were documented with the codes Black Death, burial type coffin, grave goods, or a combination of burial types. Not all individuals had documentation that marked the type of burial. The presence of these various types of burials to me, is evidence in differences between plague burial. Inter-site comparison through the documentation of burial types demonstrates that there is variation between plague and non-plague burials but also within these two groups.

Do different sites reflect variations in status?

I attempted to observe skeletal status markers in individuals then compare the sites. I looked for occupational markers such as osteoarthritis. Osteoarthritis was present, but the majority of the individuals I found were mature adults. I was confident in being

able to delineate those with osteoarthritis because of old age or if it was a result of their occupation. Next, I attempted to look at the trauma that was present in some of the skeletal remains. I found it interesting that males did not have healed fractures like the females did. The majority of the females had accidental trauma. Trauma found on male individuals was a result of interpersonal violence. The presence of trauma was used to see differences in risks for males or females. I looked at burial type with the presence of grave goods to delineate status. Comments on burial types were only documented at East Smithfield. I saw variations in status within East Smithfield but without documentation from the other sites, I can not say that status varied between sites. The types of burials provided a clue into status. Individuals were buried without coffins therefore those who do have coffins must have been able to pay for it. Wood at the time was expensive for the average person. I do believe the burials with coffins mark those of a higher status. I observed stature, dietary markers, and anemia markers. I did not see a clear cut pattern of statuses. I am unsure if this would change if I were to return to this project with more experience.

Does status affect plague mortality?

I looked at Dominican Friary Carter Lane to answer this question. Pathology at this site was not drastically different from St. Mary's. At Dominican Friary only five individuals at the site could be assessed to determine stature. Stature was similar to those individuals at St. Mary's. I noticed trauma was present in the Dominican Friary. Interpersonal and accidental trauma was observed on a few individuals at the site. Fractures that healed were only found on females. No males presented with healed

fractures that I found to be interesting. I attempted to look at all the possible markers of status to see if status affects plague mortality. I did not find any significant variation. I was not able to find evidence that would assist with answering the question. I looked at the various status markers but was unable to distinguish status patterns at the sites. I do not have a conclusive answer to this question. I hope with further research that I can have a definitive answer for this question.

Did a history of malnutrition affect mortality?

I looked at Dominican Friary Carter Lane to answer this question. Pathology at this site was not drastically different from St. Mary's. My research found that those of higher socio-economic status would have more access to food resources than others. Lower socio-economic status individuals would rely on grain to account for most of their diet. During the Great Famine those individuals who relied on grain would not have sufficient resources to other types of food. Therefore, these individuals would not have been able to maintain a diet that would provide the necessary calories. I believe that malnutrition does affect mortality, because a healthy diet supports a strong immune system. Through the study of the human remains, I did not see a clear definitive answer to the question.

Did the famine impact plague mortality?

Dominican Friary Carter Lane was also used to compare individuals while attempting to answer this question. Once again, the pathology was very similar to that at St. Mary's. This site makes it harder to answer such a big question due to a small skeletal assemblage. I tried to answer it through observation of dental pathology and stature.

Researching the Great Famine led me to discover that those of lower socio-economic status depended on grains for the majority of their caloric intake. Only two individuals were from the mass burial. The historical background provided me with the knowledge that people in this time could not sustain the caloric diet that they needed. A proper diet supports a strong immune system. I believe that the famine did impact the plague mortality based on the historical documents. Further excavations at the site will assist with providing better skeletal material that would answer this question. My goal of this project was to try to find a link between the two using skeletal remains. At this point in time, I do not feel that the remains in the assemblage provide an answer to the question. If there are excavations in the future, I would like to revisit this question in hopes to find a definitive skeletal markers that assist in providing the answer.

Is there variability in representation between plague victims with adequate nutrition and malnutrition?

Individuals at East Smithfield were shorter when compared to those at the other sites. Stature is a marker that is used to provide insight on diet and health of an individual. Dental markers of diet were present. The dental markers found were caries, enamel hypoplasia, periodontitis, and abscess. Higher rates of enamel hypoplasia were recorded. Enamel hypoplasia results from a trauma and poor diet in childhood while the permanent teeth are forming. These high rates of enamel hypoplasia throughout the population across the age groups, provides evidence of a link to the Great Famine. People who were exposed to the famine during their developing years would show signs of stress. I believe through the presence of high rates of enamel hypoplasia, a link

between the famine and the Black Death is present. Individuals who were dead as a result of the Black Death in the early days of the plague, would have been alive during the great famine. The individuals that were born over thirty years before the plague would have been alive during the famine. These individuals should be used to see the specific affects of the famine in the Black Death epidemic. Study of those specific individuals might assist with the discovery of other skeletal markers that would help me definitively answer the other research questions.

Conclusion

As you can see in my presentation of data burial sites, economic status, and age ranges, provide a connection between the Black Death and the Great Famine. The increase in pathology rates from the baseline of St. Mary's leads me to believe that there was an impact on people of that time. Taking the osteological paradox into account, some of the evidence of pathological conditions could have been lost due to rapid deaths. I believe as I continue to work and gain confidence in the field, it will be a lot easier to comprehend this data. Medical practices at the time assisted in the spread of the Black Death. Without a proper diet to maintain a strong immune system, people would be more susceptible to the plague.

Environmental shifts at the time caused a famine. Population growth in a short amount of time also limited resources for certain classes. Therefore, social status would influence your diet prior to the famine. Once food prices increased as the famine began, this would only make things harder for those who were not wealthy. These two events must be discussed together and be linked in any future discussions. In archaeological work, context is always stressed. Context for the Black Death is, without a doubt, the Great Famine that happened a few years before.

I hope to revisit this work when I am more experienced in the field. New directions for this project could be found as I learn more throughout my career. I would have liked to have had included in the database images of each of the remains as this might have helped me with my understanding of the data.

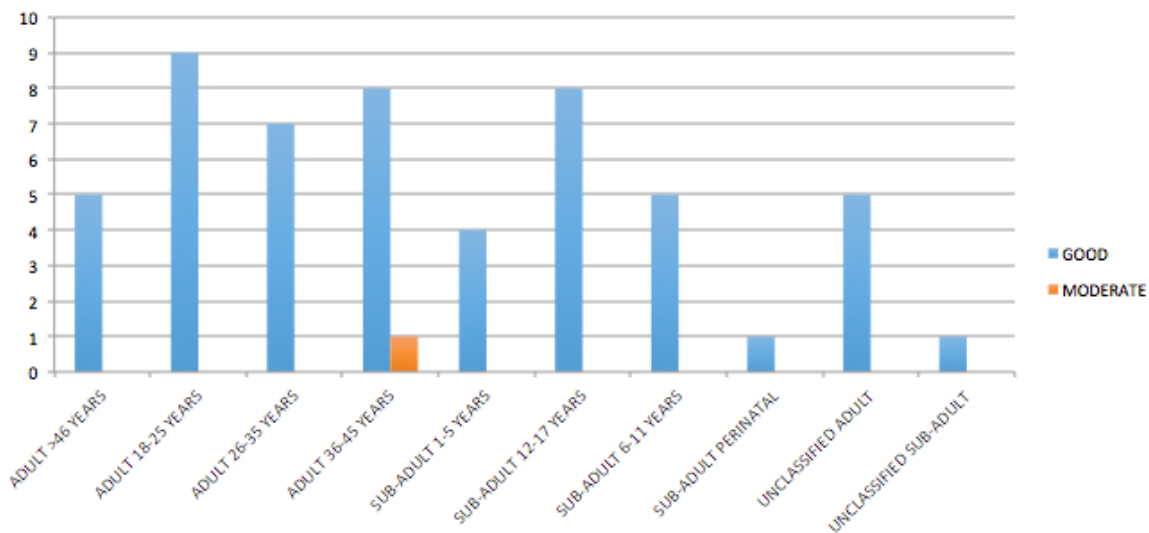
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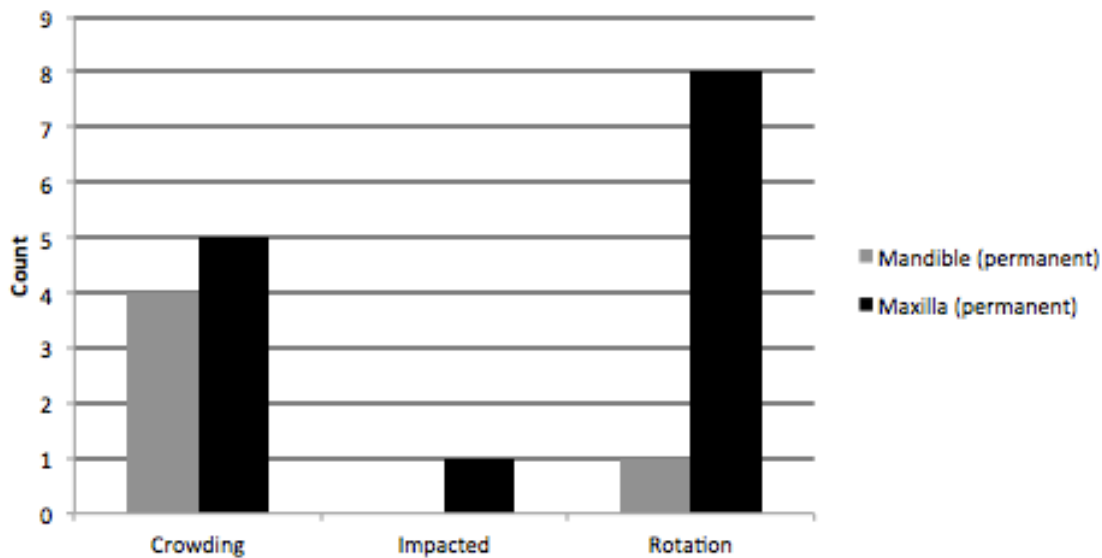
Appendix

St. Mary Spital Square



Bone Preservation by Age

MSS Dental Anomalies



Dental Anomalies

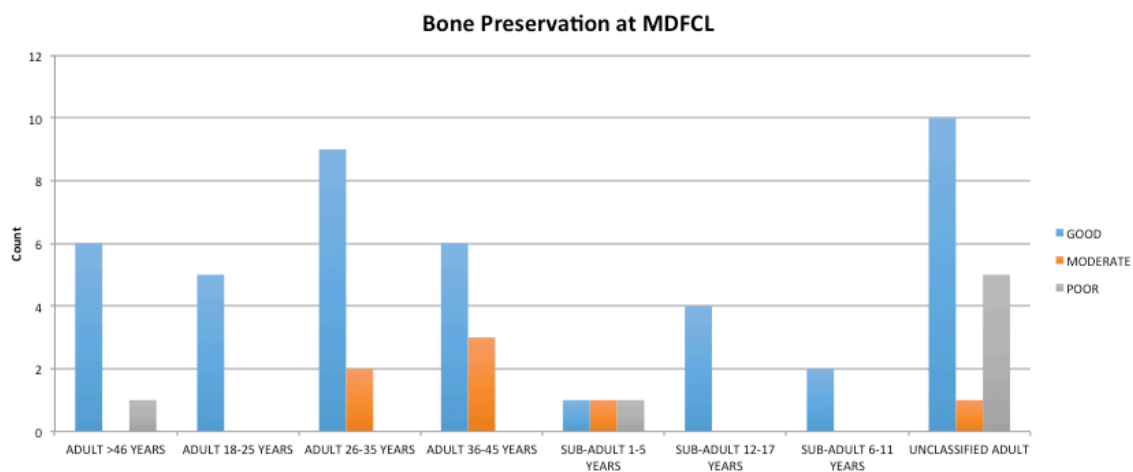
Count of EXPANSION	Column Labels				
Row Labels	Calculus	Caries	Hypoplasia	Periapical Lesion	Periodontitis
19	24			6	10
22	23			6	2
25	11	1		2	2
31	27	2		7	1
33	7			2	
35	18			4	
58	13	4		1	3
62	12	1		10	
76	9	4		5	2
269	7	5			1
298	24	1			
309	22	1			1
324	16	3		8	3
330	13				
336	15			5	
339	20			2	
349	16	4			1
351	23			1	
358	21			3	4
360	11	1		1	
367	9				
383	14	2			1
387	15			1	
391	28	4			
394	15			2	
397	30				
430					
472	4				
503	18				
578	4	1			
625		3	1		
629				2	

This pivot table counts the individual by context and how many teeth they have with each pathological condition.

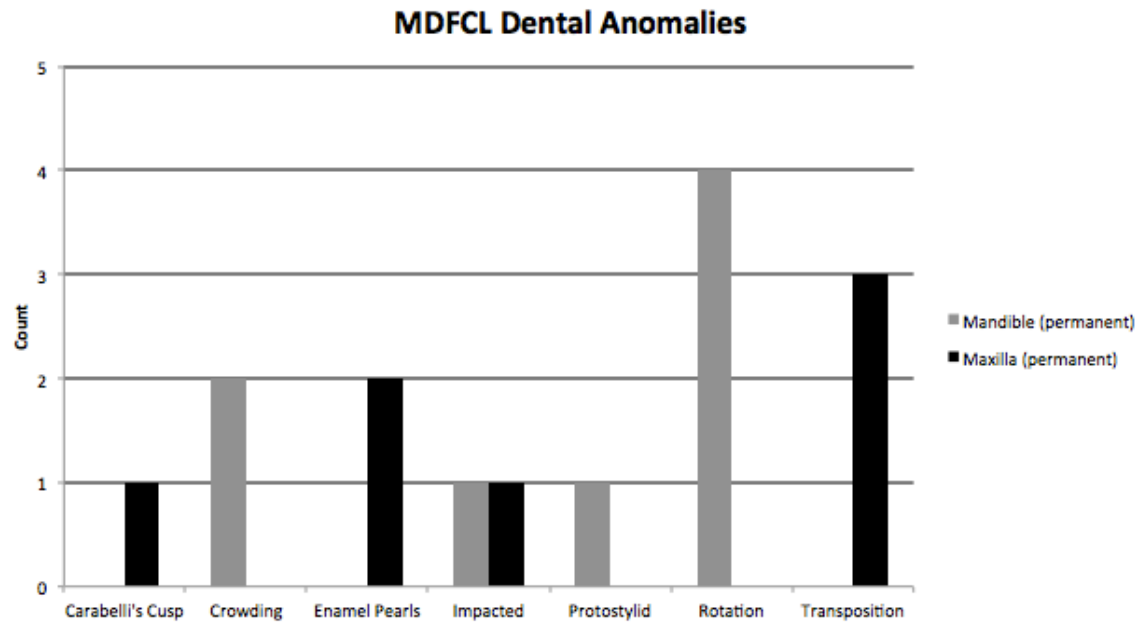
Age in years	Cribra		Orbitalia	
	Males	Females	Sub-adult	
1 to 5		0	0	4
6 to 11		0	0	0
12 to 17		0	0	8
18 to 25		4	0	0
26 to 35		0	0	0
36 to 45		3	0	0
46+		0	1	0
Unclassified		0	0	2

The number of cases of Cribra Orbitalia present in each age group at St. Mary's Spital Square.

Dominican Friary Carter Lane



Bone Preservation at Dominican Friary Carter Lane



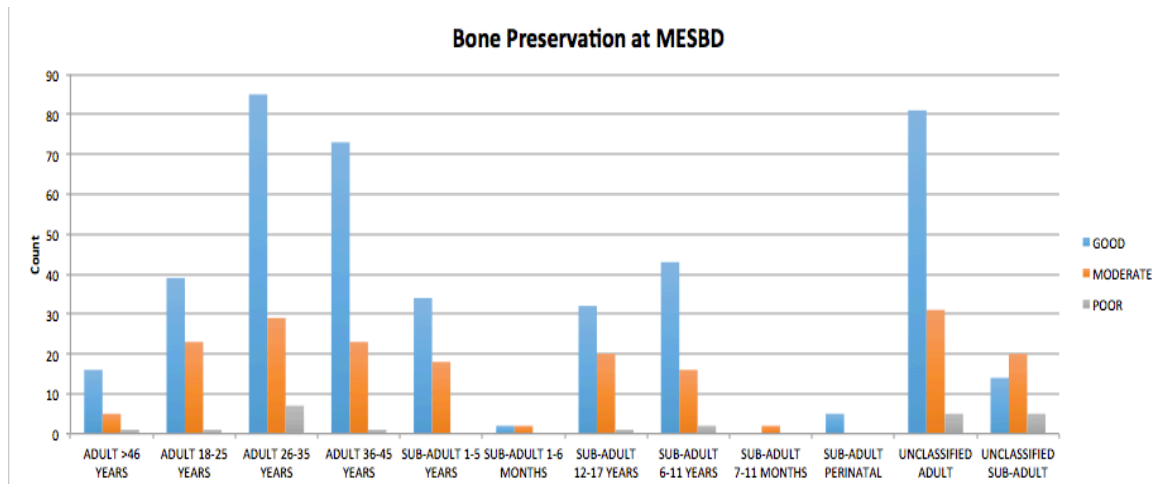
Dental Anomalies

Row Labels	Calculus	Caries	Hypoplasia	Periapical Lesion	Periodontitis
33		1			
111		9		2	6
142		16	15		
159		12			19
160		1	1	1	
170		18	7	12	
175		23	4	1	
198		9	4		
222		12	2	1	18
227		7		3	4
228		11	3		
234		4	10	4	
237		15			
239		3	7		
240		1	2		
241		24	5	1	3
243		16	8		
257		17	1		7
265		15			7
305		19	3	3	2
306		21	2	1	
320		5			
325		25			11
331		14	1	3	1
334		12			10
343		12	1	1	1
345		16	1		
355		15	2		
376		5	1	2	13
379		12	1	1	
382		21	3		3
405		14	2		
415		3			
450		24	2	1	9
504		22	3	1	16
648		4	2		

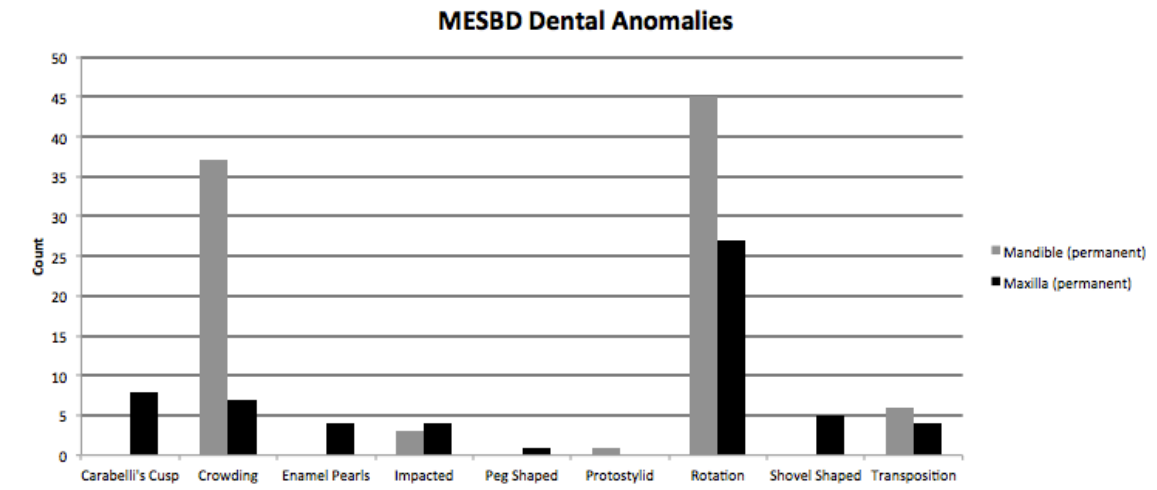
This pivot table counts the individual by context and how many teeth they have with each pathological condition.

	Cribriform	Orbitalia	
Age in years	Male	Female	Sub-adult
1 to 5	0	0	2
6 to 11	0	0	0
11 to 17	0	0	4
18 to 25	1	0	0
26 to 35	1	0	0
36 to 45	0	0	0
46+	1	3	0

East Smithfield Black Death



Bone Preservation



Dental Anomalies

Row Labels	Calculus	Caries	Hypoplasia	Periapical Lesion	Periodontitis
5257		9	2	1	
5260		6			
5261		6	1	1	1
5263		18		6	
5265		3	1		
5267		1			
5271		7		2	
5272		30		9	3
5274		17		10	
5275		22	3	1	1
5279		4			
5280		8	2	3	8
5281		23	5	1	
5282		18	3	15	12
5283		17	2	4	1
5284		2		2	
5285		10	5	3	8
5290		2			
5291		22	3	5	2
5292		18	4	3	7
5326		13		6	7
5343		16			
5344		21	2	11	
5728		12	3	4	1
5731		2			
5741		22	12	9	26
5779		25	5	16	2
5802		16	2	5	1
5805		14	2	8	
5812		3		2	
5819		1			
5858		29	1	6	26

5859	20	1	7		
5860	25	1	7		27
5861	13		3		1
5862	17	1	4	2	
5864	20	1	1		
5870	1				
5902	23	1			
5916	12	4	2		
5940	23	4	18		18
5960	21	2	3		1
6102	14	1	7		6
6108	14		4		
6120	24		4		
6158	17	2	2		3
6196	8	3	7		1
6216	2				
6228	26	4	6		
6285		1			
6287	20	8	15	2	
6313	7		2		6
6319	1				
6322	4	1			
6368	15	2	13		
6383	10	2	2		
6393	7		2		5
6398	24				
6405	18		9		26
6409	9		5		6
6412	1				9
6415	21	2	3		8
6418	19	1	5		11
6428	24				
6431	22	3	2		5

6441	6		1		
6442	18		3		1
6443	1		7		16
6452	21	1	8	2	12
6467	17				
6481	1	1	5	2	22
6483	23		6	1	8
6499	8		1		3
6500	4		1		
6512	6	2	3		1
6515	14		7		
6518	21	2	10		
6524	5				
6532	12		1	2	6
6539	5		9		1
6545	19	10	5		
6549	26	1	4		1
6552	14		6		
6561	9				
6612	11	6	4		
6625	15		17		
6628	6	2	2	2	3
6644	23	12	12		
6653			20		
6654	23		7		
6665	23		13		5
6676	5				
7025	20	1		6	3
7055	28	4	3		10
7064	14	5	10		
7065	3	2	2		20
7079			10		
7085	16	1			

7085	16	1			
7089	13	4	9	1	7
7094	27	2	7		12
7147	11	3	1		
7156	21	2	7	4	
7159	14	2	3		
7163	24	5	2		15
7248	21	3	3		1
7258	13	1	8		2
7307	9		5		
7332			1		1
7363	16		2		
7366	24	5	12		2
7375	21	15	6	2	5
7381	22	4	1	2	
7432	3		1		7
7447	14	3	14	2	19
8041			10		
8057	19	4	11		
8072	11	1			
8075	26	2	7	1	
8082	10		6	1	
8099	9				8
8124	13	2			2
8126	14	2	2		
8161	11	1	2	1	11
8171	1				
8202	11				
8217	4	3			
8235	25		1		15
8257	11	1	3	1	11
8260	6			1	6
8266	20	1	4	1	7
8277	6	5	19		5

8281	25				
8291	18	1	11		
8293	24	2	10	1	2
8299	25	6	3		
8305	19	3	6		
8311	10				1
8329	18		10		1
8341	14	1	3		7
8360	31		7		10
8366	5		1		
8378	11	1			
8379	3		14		
8380	10	1	5		2
8392	25		6		
8393	5		3	2	4
8414	23		7		
8427	18		9		7
8441		1			
8449	12	3	1		
8450	15	1			
8451	19	5			1
8456	23	1	3	2	14
8461	1	5		1	
8489	16		2		11
9008	13		6		
9032	8		3		
9066	6		4		6
9517	10		8		8
9522	18		3		4
9525	15	2	3		9
9540	16	2	3		15
9545	21	2	6	2	15
9547	11	5	2		

9548	8				
9574	16	1			11
9576	10		2		
9585			2		2
9652	11	4	2		
9674	22	2			30
9695	1				
9702	25		2	2	13
9707	14	5	2		
9710	5	1	2		
9731	22	1	8		6
9741	18	8	14		
9770	15				5
9782	16		3		
9797	27	1		1	
9807	10	1	2		4
9819	9	2			1
9832	9				
9848			13		
9849	22	1			
9853	22	4	10		
9856	16		2		
9894	6		1		
9898	6	1			
9910	5	1	2	1	
9914	7	2	2		12
9915	8	2	13		
9939	30		2		
9990	10				
11016	5	3	2		2
11028	13	3	3		
11037	8	1			5
11053	5	6	5	2	9

11109	7	2	5		
11110	9	12	6	1	
11111	14		1	1	7
11112	23	2	1		
11115	21	2	1		1
11116	3				
11117	21	1	9		8
11118	3		2		7
11124	6	3	2		3
11193	9	4	2		3
11232			2		2
11234	17	5	4		5
11244	24	1	10		3
11251	13				
11252	4	4	12	1	
11310	1		2		3
11314	1		3		
11424	2				
11425	9	14			18
11426	21	3	1	2	8
11428	17		10		5
11429	2				
11430	13	1	5		6
11431	22	1	6		
11432	23	1	3		9
11433	18	5	2	1	1
11442	2		1		
11449	28	1	2		10
11472	8		3		
11480	7	3	1		6
11491		1			
11604	4	3	8		9
11606	27				20

11619		2	4		
11624	2		2		
11625	22	4	1	1	2
11626	5		5		
11627	21		12		
11628	20	14	11		5
11629			3		
11631			2		
11632	16	1			5
11735	10	1	8		
11736	2				
11737	1		7		4
11740	14	4	1		3
11742	3	2	14		3
11747	14		6		
11780	29		5		4
11784	15	1	5		
11911	27	2	10		27
11914	20		10		26
11934	12			2	2
11939	3				
11944	19		2	1	8
11951	7	1	11		13
11972	23		4		16
12503	23	3	2	1	17
12506	28		13		20
12510	28				
12522	25				12
12523	9		2		
12548		1			
12552	13				
12553	29	1	1		8
12566	19	4	5		14

12567	11	4	10	2	4
12582	4				
12586	18	2	3		14
12601	13	2	5	1	
12630			4		
12632	23		13		
12633	17		1		
12634	18	2	8		21
12635	8	4		1	8
12636	17	1	9		
12643	20	1	1		1
12652	19	1	1		
12666	3		4		
12667	9				
12684	13	4	3	1	8
12690	8		3		2
12691	2		6		1
12700	14		8		11
12725	13	1	5		
12727	16	2	4	1	11
12748	7	2	9		4
12763	12	2	6		21
12773	27	3	12		12
12790	22	2	8		
12799	14	1			4
12801	20	6	8		
12813	12	1	2	2	6
12814	13	4	2		
12815	14	4	6		
12820	7				
12822			2		
12839	19		5		8
12843			1		2
12849	14	6			
12884	6		10		6
12897	19	1	6	1	2
12900	10	3	8		
12906	23	2	9		1
20003	1		2		3
20004	24		9	1	19

This pivot table counts the individual by context and how many teeth they have with each pathological condition.

Age in Years	Cibra		Orbitalia	Undeterminable Adult
	Males	Females	Sub-adults	
1 to 5	0	0	8	0
6 to 11	0	0	19	0
11 to 17	0	0	17	0
18 to 25	9	0	0	1
26 to 35	20	0	0	0
36 to 45	6	0	0	0
46+	2	0	0	0
Unclassified	2	0	1	0