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Secrets from the Well:

A Biohistory of Ancestors Discovered in the East Marshall Street Well

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Battle Creek, Michigan

Bachelor of Science, Northern Michigan University, 2019

A Thesis presented to the Graduate Faculty of The College of William & Mary in Candidacy for the Degree of
Master of Arts

Anthropology

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APPROVAL PAGE

This Thesis is submitted in partial fulfillment of the requirements for the degree of

Master of Arts

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Yes | No	Question	Oversight Committee	Protocol number and date of written approval
☐ ☒	Did this project involve surveys, testing of human subjects, or collection of information from living human beings?	Protection of Human Subjects Committee	
☐ ☒	Were live vertebrate animals be used in this project?	Institutional Animal Care and Use Committee	
☐ ☒	Did this project use any (a) recombinant DNA molecules (including transgenic animals or the transfection of cell lines), (b) infectious agents, (c) human tissue or body fluids (including saliva, urine, blood, semen, or primary human cell cultures), or (d) wild-caught or random source animals or animal tissue (for anyone employing animals that may carry zoonotic disease)?	Institutional Biosafety Committee	
☐ ☒	Did this project involve research with radioactive materials?	Institutional Radiation Safety Committee	

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Advisor Signature [signature] Date 7/22/2022

ABSTRACT

In 1994, during construction at the Kontos Medical Science Building on the campus of the Medical College of Virginia (now VCU Health), a well was discovered containing a commingled deposit of at least 44 adults and nine children dating to the antebellum industrial period of Richmond, Virginia. Dubbed the “East Marshall Street Well” (EMSW), a descendant-led ethical clientage model (Blakey, 2020) was put into effect between Virginia Commonwealth University (VCU), the Institute for Historical Biology (IHB), and the local black Richmond community. Following research recommendations developed by the Family Representative Council, this study entails biogeochemical profiling to construct lived experiences from Ancestral Human Remains recovered at the EMSW. Research goals include: understanding how can isotope data help us identify discrete individuals from a commingled assemblage of human remains for reburial and memorialization? Furthermore, what does dental analysis contribute to a broader understanding of diet, geographic origin, and migration for EMSW ancestors?

A novel, minimally destructive dental sampling methodology allows for a small sample of dental enamel to be analyzed via laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) to render elemental concentrations data along a chronological axis. The dental data is compared to EMSW bone data previously collected by researchers at the Smithsonian National Museum of Natural History where the Ancestral Remains were curated until recently to reveal the diet of enslaved urban industrialized workers. This study looks at four isotopes associated with diet (δ13Ccollagen, δ13Ccarbonate, δ18Ocarbonate, and δ15Ncollagen) that were sampled from bone. Smithsonian researchers took samples from one African site and 11 sites across the Mid-Atlantic region. Isotope data samples, differentiated by ethnic group, were placed on a scatter plot to reveal the EMSW Ancestors samples had a similar regional origin to the other Mid-Atlantic samples; they relied heavily on maize but little on marine resources. Using LA-ICP-MS analysis, the elemental intensities (counts per second, or cps) of ^{88}Sr and ^{138}Ba for 7 individuals were compared in ratio to ^{43}Ca to construct the trophic level of EMSW ancestors. This thesis serves as a pilot study for my dissertation research, suggesting directions for further investigation into dietary practices as well as geographic origin and migration via dental chemistry.

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ACKNOWLEDGEMENTS

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This thesis is dedicated to Ancestors and my Family.

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Introduction

Lesley Rankin-Hill (1997, 2016) coined the term "invisible people" while investigating the biohistory of those interred at the First African Baptist Church in Philadelphia, Pennsylvania. These were African Americans interred at the church between 1824-1842; marginalized people largely without the power of literacy or the ability to write their own stories, whose historical narratives had been lost or omitted from most collective understandings of American history. In Richmond, Virginia, the site of this study, such invisible people included those Africans who were initially enslaved within an industrial complex much less familiar to most than the plantation settings in the American South (Dew, 1994; Takagi 1999). Once freed, they remained socio-politically marginalized – though critical to the city's economic development – due to social institutions enacting sharecropping, redlining, and Jim Crow laws. Their full, human stories remain untold. Publicly-engaged biocultural anthropology may help to fill in and correct some of these historical omissions as researchers work to acknowledge and better understand those pushed to the wayside of American history and, thereby, render them socially visible.

This study contributes to the unfolding biohistory of those discovered in the East Marshall Street Well (EMSW) in Richmond, Virginia. Discovered in 1994 during the construction of a new building on the campus of Medical College of Virginia (MCV, now VCU Health), the well dates to the antebellum period and contains African graves robbed by anatomists to use as cadavers in early medical research. Here, I present bone isotope data collected by Smithsonian

Institution researchers. I then focus on elemental intensities (CPS) gained through dental chemistry, allowing for this analysis to extend into early life. Following the recommendations of the EMSW descendant community, i.e., the Family Representative Council (FRC), anthropologists at William and Mary's Institute for Historical Biology (IHB) are establishing a biogeochemical profile of the EMSW Ancestors. This will allow researchers to construct lived experiences of the Ancestors through skeletal analysis, with a focus on antebellum Richmond. Both bone and tooth isotope data will be examined to extend our understanding of later-life chemical exposures (bones) to early-life (teeth) in the context of urban slavery. Establishing a biogeochemical profile will allow researchers to better understand how isotope data can help us to identify experiences of discrete individuals from a commingled assemblage of human remains for reburial and memorialization? Furthermore, what does dental analysis contribute to a broader understanding of diet, geographic origin, and migration for EMSW ancestors, specifically?

The following section provides historical background for the East Marshall Street Well. I discuss the context of industrialized slavery in Richmond, likely the context in which the EMSW Ancestors lived and died, and the factors that led to these human remains being removed from a well on a medical school campus. I also explain the factors that led to the development of the EMSW Project, an interdisciplinary and inter-institutional effort to research, memorialize, and respectfully inter the Ancestral Remains. I then shine light on the challenges involved with studying commingled deposits and the research being undertaken at Virginia Commonwealth University (VCU) to assemble complete burials for Ancestors from the EMSW. In the following section, I explain how a biocultural theoretical approach bridges academic interests and insights from anthropology with those of diverse publics as determined through descendant-community engagement. I describe the theoretical perspectives of biogeochemical and mass spectrometer analysis of teeth to understand diet, origin, and pollutant exposure of past populations. Next, I introduce a new minimally destructive dental sectioning methodology favorable to descendant-communities because of the ability to rebury remains with teeth relatively intact. I then expand on how viable teeth were laser ablated in single line scans to track elemental intensities to assess change with chronological age. In the results section, I present box plots to illustrate the isotopic and elemental intragroup variability of the EMSW data. Then, using scatter plots and Mann-Whitney U tests, I compare isotope results to those presented by France et al. (2020) for contemporaneous African American and white populations within the region. Finally, I discuss what new insights are understood from this study and where more research is necessary.

Historical Background

The commingled deposit of human skeletal remains and artifacts recovered at the East Marshall Street Well represents enslaved Africans from Civil War-era Richmond, Virginia. This section describes the historical context that would have shaped various lived experiences that I explore via chemical analysis.

Industrialized Slavery in Virginia

It is impossible to separate the history of Richmond, Virginia from that of race and slavery in the United States. From its early roles as a central interstate slave-trading hub and capital of the Confederacy to becoming a tourist destination for antebellum and Civil War nostalgia, Richmond uniquely reflects the nation's founding contradictions around human freedom and racial slavery. Founded in 1737, Richmond later became Virginia's capital in 1779 because of its strategic location along the James River. Quickly, the city began to boom because of its prime location as a port city, transporting tobacco from western Virginia to Europe (Takagi, 1999, p.10). As the city grew, so too, did the need for cheap labor to keep up with its rapidly developing infrastructure. Enslaved Africans were brought to fill the demand for artisans, ironmakers, blacksmiths, tailors, and tobacco processors.

Industrial enslaved laborers' varying knowledge and relative privileges allowed members to create complex communities different from those of plantation laborers. The business practice of "hiring out" saw enslaved laborers leased as workers to large factories in the city. The concept of living out, unique to Richmond, allowed enslaved Richmonders to find their own housing. These novel concepts allowed for a small wage to be attained either through working overtime or saving what money was left over from their small rent stipends. Together, all these factors created a "quasi-free" lifeway (Takagi, 1999, p.4), allowing a level of independence rarely achieved by other blacks in the South.

Hidden from the public eye, private housing options granted Richmond's enslaved individuals greater ability to keep their families together than traditional plantation laborers. Private housing ensured a degree of physical and psychological separation from owners and employers often not found in rural areas (Takagi, 1999, p.97). Although the enslaved urban industrialized worker had freedom to choose their housing, the conditions were bleak, often described as uninhabitable to tolerable at best. Workers often found themselves residing in shacks and tenements located in alleyways among open sewers and garbage; the conditions were considered a "breeding ground for disease" (Robinowitz, 1996 & Goldfield, 1989). In addition to the inhospitable living conditions, the diet of enslaved laborers offered them little to no nutrition for healthy development.

Diets of urban enslaved individuals varied greatly depending on their occupation, but all were nutritionally deficient. Domestic workers in antebellum Richmond often ate the leftovers of their enslaver's meals or were fed separately by the enslaved cook. This granted domestic workers a more varied diet consisting of a mixture of meat, grains, and vegetables compared to the much more limited diet of a factory worker. Enslaved factory workers were often guaranteed one meal a day generally consisting of pork or beef, when available, and cornmeal (Takagi, 1999, p.41). Enslaved individuals bonded to the City of Richmond received standardized rations at unspecified intervals. Food stipends consisted of 3 pounds of bacon, one and half peck of cornmeal, one quart of molasses, and one gill of salt (Richmond City Council, 1852). Outside of one guaranteed meal a day, factory workers were expected to fend for themselves with meals purchased from their leftover boarding money (Copland, 1820). Ostensibly this gave enslaved industrial laborers freedom of choice, but due to the small boarding stipends, purchases were limited to cheap and filling foods, including bread, cabbage, and potatoes. Skilled laborers would have eaten more varied diets than unskilled labors. With money earned through overtime, skilled workers supplemented their diet with ready-cooked meals from cookshops owned by freed black individuals for a few pennies (Takagi, 1999, p.42). The conditions of urban industrial slavery in Richmond led to unique circumstances experienced by the individuals recovered from the EMSW.

Underground Cadaver Trade

In antebellum Virginia, dissection remained illegal but was only enforced to protect white bodies, leading to public officials overlooking the act of grave robbing when enslaved people or free blacks were targeted (Koste, 2012). The same laws that defined enslaved Africans as property extended past death, allowing enslavers to sell deceased Africans “dying from natural causes” to medical schools for the use of anatomical studies (Hornie, 2016). Quickly, what Daina Ramey Berry (2017) terms a “ghost value” was projected onto enslaved Africans at death fueling an underground clandestine market of the cadaver trade, allowing an enslaver to extend profits beyond the grave. Early on, the demonstrator of anatomy bore the burden; however, after becoming standardized, the unsavory duty fell onto students, employees, and enslaved laborers titled “resurrectionists” to acquire and dispose of cadavers by any means necessary (EMSW FRC Report, 2018). Burial grounds such as Richmond's Potters Field and the Negro Burial Ground became frequent targets for grave robbing to the point that blacks in Richmond knew the outcome of seeking medical attention at MDHSC or a burial in town (Koste, 2012).

In 1845 Dr. John Staige Davis became the demonstrator of anatomy at the University of Virginia (UVA) where he was later appointed to professor and remained on faculty until 1885 (Berry, 2017). Davis was instrumental in collecting and transporting medical research cadavers from Richmond to Charlottesville for purchase by faculty members. From Davis's letters the cadaver trade resembles a fully functioning business with records of price negotiations, product specialty, compensation for missed shipments and delays, as well as shipment fees. Although slavery ended in 1865, the trade in deceased Africans continued until 1884 when the Virginia legislature created the anatomical review board, regulating the cadaver trade for anatomical training (Berry, 2017).

The East Marshall Street Well

The Medical Department of Hampden-Sidney College (MDHSC) was established in 1838, later becoming the Medical College of Virginia and, recently, VCU Health. As VCU historian Jodi Koste observes, the founders of MDHSC stressed the importance of anatomy courses, creating a curriculum centered around the dissection of cadavers that was the center of the institution's allure. Richmond, VA, was specifically chosen to be home for the new medical campus because of its relatively mild climate, which was less likely to interfere with

Figure 1: Construction of MCV's Kontos Medical Sciences Building in 1994. The building is located at 1217 E Marshall St, Richmond, VA 23298

cadavers' decomposition in dissection rooms than other southern cities. Another critical factor was the abundance of possible cadavers because the industrial context of Richmond shortened the lifespans of enslaved individuals either by accident or exhaustion (Takagi, 1999).

In 1994, construction of the Medical College of Virginia's (VCU Health) Hermes A. Kontos Medical Sciences Building on East Marshall Street in Richmond, VA, led to the discovery of a well (Utsey & Shabazz, 2011; Figure 1). Within the well was a commingled deposit of human remains and artifacts that were promptly sent to the Smithsonian Institution National Museum of Natural History for preliminary analysis. Analysis revealed that the human skeletal remains belonged to at least 44 adult individuals and nine children, primarily of African descent (EMSW FRC Report, 2018). Archaeologists also found artifacts dating to the late 18th century through the early 19th Pre-Civil War period (EMSW FRC Report, 2018). Archival records describe a well's use as a "sink" for disposal of "medical waste" including human remains, from around 1848 until 1860, when MCV became a state institution (Koste, 2012). When anatomists disposed of the remains in the well, they took away their individuality and formed a group identity based on the association with the place of burial (Osterholtz, 2016).

Not until Utsey's (2011) film, *Until the well runs dry: medicine and the exploitation of black bodies,* and concerns from current MCV medical students, did VCU decide to launch the East Marshall Street Well Project (EMSWP). The university reached out to Dr. Michael Blakey, director of William and Mary's Institute for Historical Biology, in conjunction with the Virginia Department of Historic Resources to initiate a descendant community-based process. The ethical clientage model (Blakey, 2020) prioritizes community collaboration to bring the EMSW Ancestors to rest. Following this model, which was established at the New York African Burial Ground (Blakey, 2009), the Family Representative Council (FRC) was formed, a body of local descendant community members with a moral stake in the matter. The FRC is placed at the forefront of research, allowing researchers to structure questions helpfully for the academy and the community. The recommendations created by the FRC in 2018 have guided the research and initiation of memorialization and memory since (EMSW FRC Report, 2018). By dealing with this problem ethically and addressing past mistakes, VCU is setting a standard for other universities and medical schools as they engage with troubling institutional histories involving slavery for the future.

This unique collection of human remains is the basis of novel research methodology for new interpretations of African diasporic biohistory. Biocultural analysis of these "invisible people" through skeletal chemistry will illuminate new stories once lost from history. This project may serve as a model for other universities and descendant communities seeking to address similar histories of medical malpractice and racialized exploratory research. Conclusions discovered here will allow us to better understand the lives of enslaved Africans in industrial settings. This is a context rarely studied, but one that offers possibility for understanding how African American experiences varied beyond the traditional antebellum plantation.

Currently, research at the EMSW is in the implementation phase. Recommendations from the FRC have been taken into consideration, and research goals have been created based on descendant community questions. Researchers from William and Mary's IHB are interested in lifeway construction through chemical methodology. While researchers at VCU, are working to reassociate complete skeletons from commingled deposits, allowing whole individuals to be reburied. When researchers at the Smithsonian took bone samples for isotopic testing before properly sorting the Ancestors, they took away the individuality of the remains. Their actions limit the questions we can ask; rather than following one individual, inferences can only be made for the group. However, while working with the descendant community, it was deemed necessary to use all preliminary data in honor of the deceased and to avoid being overly destructive. The joint efforts of VCU and IHB researchers will allow thoughtful memorialization and answers that satisfy the community, while at the same time revealing new understandings of the African Diaspora.

Theory

Biocultural anthropology

Biocultural anthropology seeks to understand how, "sociocultural and political-economic processes affect human biologies, and then how compromised biologies further threaten the social fabric" (Goodman & Leatherman, 1998, p.5). A biocultural framework blends political economy with traditional biological analysis allowing researchers to understand human variation in terms of social relations, with the importance of macro-micro interconnections between the local and global. Giving agency to humans, we understand they control their environment and are makers of their history, which directly affects their access to resources, health care, and pollutants they may be exposed to (Goodman & Leatherman, 1998). When history, political economy, and biology are combined with grounded ethnography (Goodman & Leatherman, 2019), social and natural scientific analyses may be applied to questions surrounding the causes and results of stressors and facilitate discoveries of lost lifeways (Rankin-Hill, 2016).

The biocultural approach allows researchers to challenge and move beyond racial characterizations by relying on chemical variation rather than morphological traits. Genetic traits and frequencies are fluid, open, and not culturally constrained because humans historically have not lived in closed communities (Goodman, 1997). To generate more accurate categories of African vs. non-African, chemical data via diet, pollutant exposure, and focus on geo-landscapes allows for categorization without resorting to outmoded and non-empirical classifications of past populations. Specific information provided from chemical profiling is discussed further in the methods section.

Descendant Community Engagement

A descendant community is made up of individuals whose ancestors were enslaved at a particular site or surrounding region genealogically, socially, or both (National Historic Trust, 2009, 2018). Descendant community engagement works particularly well, and is increasingly viewed as necessary, when dealing with sacred human and artifactual remains., This approach allows a community to take charge of their ancestors' historical narrative. A descendant community-led project has been established by VCU with in collaboration with anthropologists at the College of William and Mary’s Institute for Historical Biology. Descendant-led anthropology places the group being studied at the forefront of our research by working with community members. Rather than the anthropologists guiding the research, descendants are encouraged to take charge while the anthropologists act as mediators between them and the other stakeholders. Using the ethical approach outlined by Blakey (2009) at the NYABG, then later refined as a rubric at Montpelier (NHT/Montpelier, 2018), an engagement methodology focusing on critical theory, public engagement, multiple data sets, within a diasporic scope ensures descendant community empowerment.

Biogeochemistry

You are what you eat takes on new, and literal, meaning from the perspective of the biological anthropologist. The foods we consume and the water we drink are used to construct and repair the tissues that form our bodies and skeletons. The elemental concentrations and isotopes that remain in skeletal tissues are useful in constructing diet, origin, and pollutant exposure of past individuals (Price & Burton, 2011). Figure 2 displays the elemental uptake/deposition model showing how elements in soil and water move from plants to animals to our bodies then finally ending as elemental concentrations in teeth and bones. The reading of chemical signatures flowing from foods being eaten to the consumer allows for past diets to be understood. Commonly misunderstood, these signatures do not represent a reconstruction of diet, but rather, they allow for the understanding of consumption profiles for different foods eaten by past populations (Keegan, 1989).

Dental and bone isotope data are presented below. Originally, for the East Marshall Street Well samples, only bone isotope data was recorded by Smithsonian anthropologists. However, challenges remain in the interpretation of bone chemical data. When bioanthropologists began using isotopes, bone samples were preferred, but researchers quickly realized that the processes of elemental and isotopic incorporation, and turnover of bone was more complicated than initially assumed (Goodman et al., 2003). Now, teeth, and especially enamel tissue, are used to gather isotopic data because enamel forms

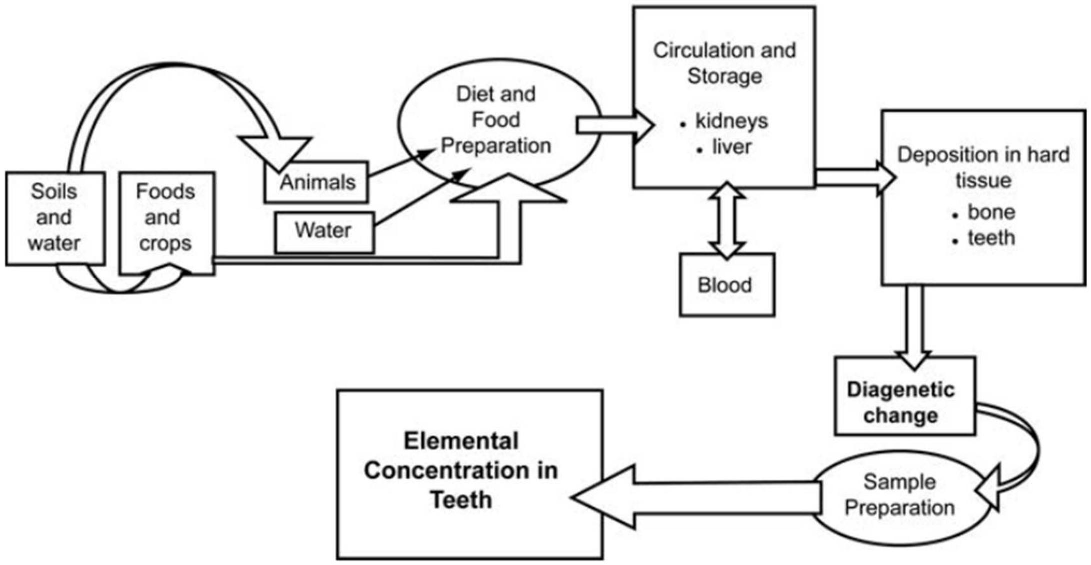

Figure 2: Elemental Uptake/Deposition Model (Goodman et al., 2009, Fig. 40)

in a predictable way, is not subject to remineralization once it erupts from the gums, and is 97% inorganic, meaning it will not be subject to postmortem diagenesis (Kang et al., 2004). Enamel itself is non-cellular and formed by ameloblasts, closely and regularly packed cells within the internal enamel epithelium. The two stages of enamel formation are matrix secretion and maturation. During matrix secretion the enamel matrix is one-third organic and two-thirds mineral. During formation filaments are seeded into the matrix to grow in the shape of a dental crown. Once this process is complete maturation begins, ameloblasts metamorphose and begin to break down the remaining organic components of the matrix creating a mineral structure, allowing for the enamel itself and elemental concentrations to remain preserved under conditions of most burials (Hillson, 1996). The other dental tissues – dentin (the primary tissue found throughout the crown and roots) and cementum (a thin covering on the

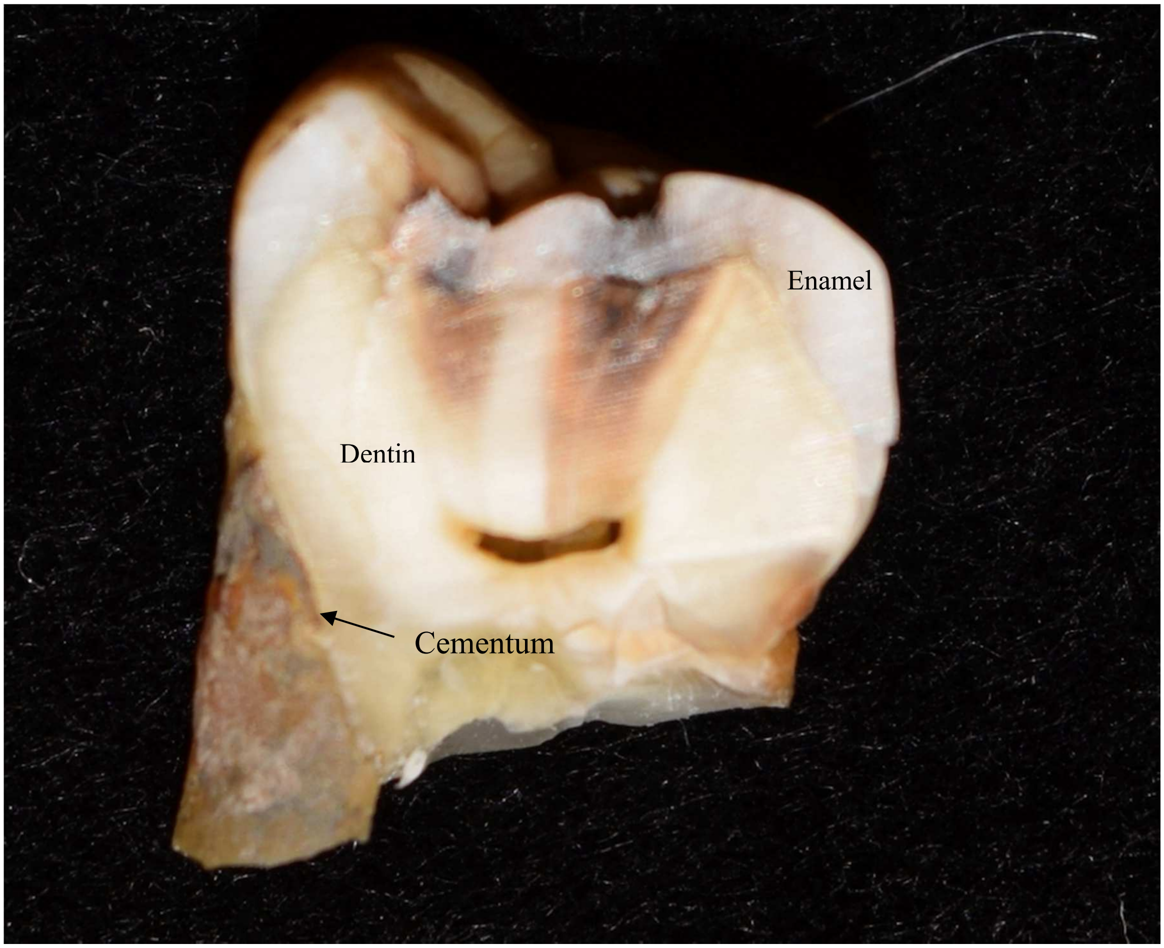

Figure 3: Section of a molar displaying dental tissue components

roots of teeth) are avoided during LA-ICP-MS analysis because their remineralization results in higher organic composition that is comparable to bone tissue. Thus, dentine and cementum typically are avoided in archaeochemistry or the same reasons as bone tissues (i.e., relatively high organic content, diagenesis, reuptake).

This study includes mass spectrometry as a means of characterizing the chemical makeup of tooth samples. Mass spectrometers separate atoms and molecules into a “mass spectrum” according to their weight, then records the number of particles to a specific element or molecule. To accomplish this, mass spectrometers sort particles according to their atomic weight by electrically charging a particle and accelerating it through an electric or magnetic field (Price & Burton, 2011). Most ICP-MS apparatuses use a plasma to ionize the atoms then a collector to generate measurements of different isotopes at the same time. Traditional (nebulization) ICP-MS is destructive, requiring a sample to be dissolved into an aqueous solution to generate a reading.

Laser ablation does not require sample dissolution. This technique allows for solid sampling and helps to minimize the amount of sample destroyed. Here, a laser is attached to the ICP-MS for microspatial analysis. The laser on a LA-ICP-MS apparatus can focus on a small spot of the sample and ablate a specified portion of the material into a gas stream that flows into the plasma (Price & Burton, 2011). This minimally destructive technique allows for sensitive or limited materials to remain intact. In the case of dental laser ablation, it allows for a line to be scanned from early- to late-formed enamel generating a chronological reading of elemental concentrations/isotopes (Jones, 2015).

Methods

Carbon, nitrogen, and oxygen Isotopes

Isotopes were first discovered in 1912 by Scottish chemist Frederick Soddy. He observed stable elements with the same number of protons, but varying numbers of neutrons resulting in the same element having multiple variations with different weights of masses (Price, 2014). Since the 1960s, researchers have used isotopic analysis to address various anthropological questions related to issues of artifact/skeletal dating, origin, diet, and pollution (Brill and Wampler, 1965). In this study, oxygen, carbon, and nitrogen isotopes have been analyzed to reconstruct the lifeway and diets of Ancestors found in the EMSW.

Carbon isotope ratios reflect native plant availability and resources people and animals rely upon to supplement their diet. Carbon in the environment is absorbed as hydroxyapatite carbonate (δ^{13}Ccarbonate), displaying carbohydrate and lipid carbon isotope dietary input, or in the collagen protein found in bone and tooth dentin (δ^{13}Ccollagen) displaying dietary protein input (Fernandes, Nadeau, & Grootes, 2012; Krueger & Sullivan, 1984) Carbon ratios are computed as $\delta^{13}C=[(13C/12Csample-13C/12Cstandard)/13C/12Cstandard]\times 1{,}000$ with variation arriving from differences in the C3 or C4 photosynthetic pathway (France et al., 2018). C3 plants show more negative δ13 ratios (~ -32% to -24%) and are associated with plants like wheat, barley, rice, trees, and shrubs, suggesting temperate/cool-climate grasses. C4 plants show higher δ^{13} ratios than C4 (~ -16% to -10%) and are associated with plants like maize, millet, sorghum, sedges, sugarcane, and imply a warm/dry climate (Heaton, 1999; O'Leary, 1988; Smith & Epstein, 1971). C^{13}carbonate values indicate the type of plants and grains consumed by an individual, while C^{13}collagen values indicate the pant and grain fodder for consumed animals (France et al., 2018).

Nitrogen isotopes (δ^{15}Ncollagen) are absorbed exclusively into the collagen of bone and dentin (France et al., 2018). The results are displayed as a

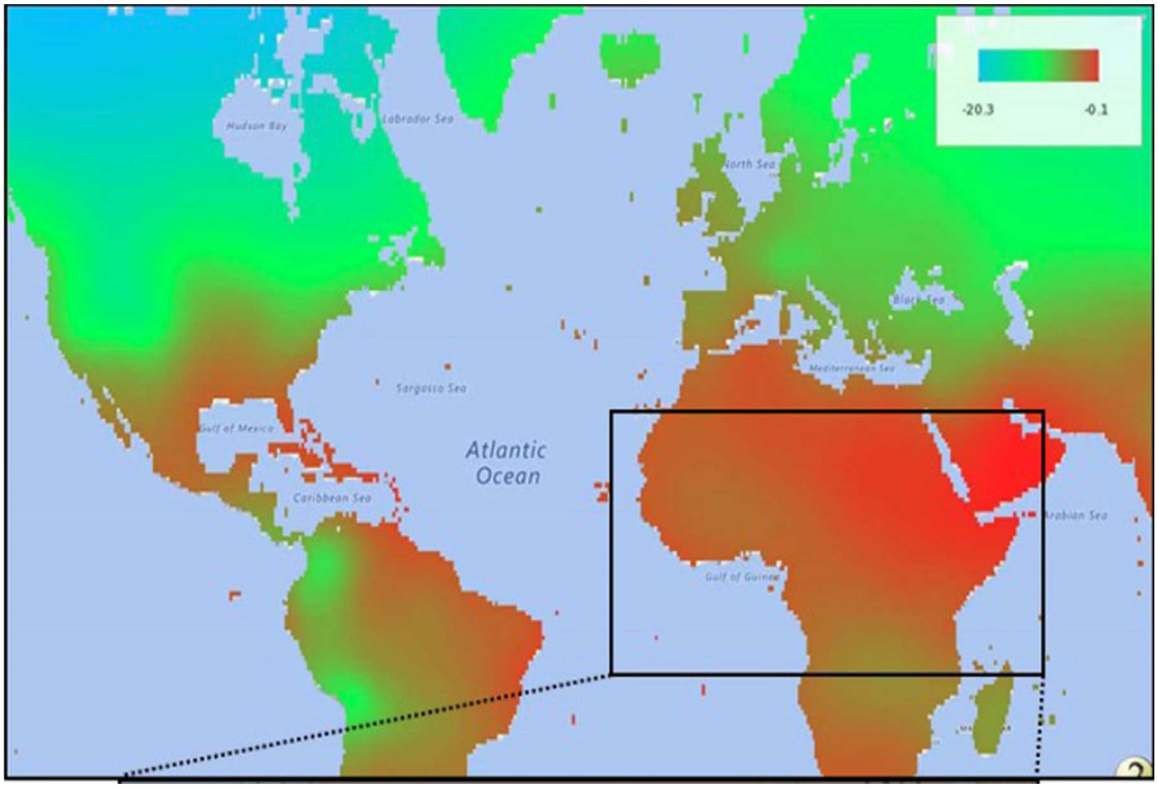

Figure 4: Map showing meteoric water values of the Atlantic area (France et al., 2018; Fig. 1)

calculation of the ratio 15N/14N and represent the amount of marine resources in the diet, with higher δ^{15}Ncollagen typically suggesting more locally available marine resources (Bocherens & Drucker, 2003; DeNiro & Epstein, 1981).

Oxygen isotopes are absorbed in bone, tooth enamel, and tooth dentin in carbonates during the mineralization of body water. Reported as the sum of the ratio 18O/16O (δ^{18}Ocarbonate), skeletal oxygen isotopic composition reflects ratios in drinking water (Daux et al., 2008; Levinson, Luz, & Kolodny, 1987; Luz, Kolodny, & Horowitz, 1984). This method is most effective in determining the region of origin within North America because of significant differences between northern and southern areas (France et al., 2018). Since δ^{18}O meteoric water values are determined by longitude (Figure, 4), some overlap exists between the

southern United States and northern Africa. The $\delta^{18}O$ values for North America range from approximately -21 to +1%
compared to -11 to +4% for Africa. In some instances, this overlap could lead to confusion, mainly when dealing with the Caribbean compared to Africa. This should not be a factor when assessing Mid-Atlantic isotope values (France et al., 2018).

Elemental strontium and barium

In addition to the isotopes mentioned strontium (Sr), barium (Ba), and calcium (Ca) obtained through LA-ICP-MS analysis will be analyzed to further reconstruct lifeway diet. Sr and Ba intensities are studied in relation to Ca intensities to evaluate the trophic level of diets. An enrichment, or fractionation step, occurs as food moves through trophic levels and because of its smaller size, Ca is “favored” or enriched over Ba or Sr (Goodman et al., 2009). For that reason, herbivores have higher Sr/Ca and Ba/Ca ratios than primary carnivores, which have higher Sr/Ca and Ba/Ca ratios than secondary carnivores. As a result, these ratios have become accurate indicators of the relative meat proportions in diets. Breast feeding is at a higher trophic level than weaning, therefore, an increase in Sr/Ca and Ba/Ca ratios in teeth can be used to pinpoint weaning age; something LA-ICP-MS methodology excels at because of the ability to target specific areas (Goodman et al., 2009).

Preliminary Isotope Data

Following the excavation of the EMSW, human remains able to be salvaged were taken to the Smithsonian for preliminary analysis. Following methods of sample preparation and extraction described by France et al. (2014), skeletal isotope data from four analytes: δ^{13}Ccollagen, δ^{15}Ncollagen, δ^{13}Cstructural carbonate, and δ^{18}Ostructural carbonate were collected then compared to 11 sites in America and one in Africa (Table, 1). These data are presented here to begin constructing a chemical paleodietary profile of the EMSW Ancestors.

Statistical analysis

Box plots were created using SPSS 27 for δ^{13}Ccollagen, δ^{15}Ncollagen, δ^{13}Cstructural carbonate, δ^{18}Ostructural carbonate, Sr/Ca, and Ba/Ca within the EMSW data to understand differences within the research group. Due to the small sample size, the isotope data was then cross-compared to control groups using Mann-Whitney tests; $P < .05$ states statistical difference between two data sets.

Dental Isotope Sampling

Study sample selection. The EMSW skeletal sample curated at VCU currently includes a total of 12 skulls, 11 with teeth still embedded within the cranium or mandible granting additional contextual information. From these 11

Table 1. *Experimental and Control Sites*

Site	Site Location	Time Period	Ancestry	Social Status	Total
East Marshall Street Well (EMSW)	Richmond, VA	1848-1860	?	Enslaved, urban	7
A.P. Hill	Fort A.P. Hill, VA	1780-1830	African American	Enslaved, rural	4
Congressional Cemetery	Washington, DC	1850-1899	Caucasian	High status, urban	42
Elmina	Ghana	1600-1899	African	Mostly free residents, a few enslaved	41
First African Baptist Church (FABC)	Philadelphia, PA	1824-1842	African American	Free, Possible former enslaved, urban	9
Foscue Plantation	North Carolina	1800-1849	Caucasian	High Status, rural plantation	6
Glorieta Pass	New Mexico	d. 1862	Caucasian	Confederate Civil War soldier	31
Hilleary Cemetery	Maryland	1850-1899	Caucasian	High status, rural plantation	10
Kincheloe Cemetery	Virginia	1830-1860	Caucasian	Middle-high status, rural	3
Parkway Gravel	Delaware	1780-1830	African American	Enslaved/former enslaved, rural	5
Pettus	Virginia	1700-1799	African American	Enslaved, rural	21

Robinson Cemetery	Virginia	1775-1875	African American	Enslaved, rural	5
Walton Family Cemetery	Connecticut	1750-1830	Caucasian	Farming family, rural	20
Woodville Cemetery	Delaware	1790-1850	Caucasian	Middle class, rural	10

skulls, one tooth was selected from seven skulls as viable for laser ablation. Earlier-formed teeth most likely representing natal conditions are prioritized so that nutritional data may be reassessed in relation to geographic ancestry as part of my dissertation study. Several criteria were considered in selecting the study sample. Permanent first molars were preferred because these are the first teeth to form postnatally capturing early-life chemical exposures that are largely independent of maternal utero input; however, because of breastfeeding input from the mother, her input is inevitable (Kang et al., 2004). However, due to a lack of viable first molars for several individuals, additional tooth types were included in this study. Incisors, which form shortly after the first molar, function as a second option followed by canines, then premolars (V11C), which captures a slightly later development period. This pattern follows the developmental chronology for human permanent dentition. Teeth free of severe caries and calculus were preferred but, because of the overall poor dental health of EMSW ancestors, in some instances this criterion could not be avoided. However, because of the localized, high-resolution sampling capabilities of laser ablation as well as the sectioning method employed, large caries and other defects could be avoided during the sampling process. Initial dental assessment began by reviewing the general Smithsonian Institution (SI) assessment, followed by checking and evaluating the pathologies that they identified. During this initial analysis, additional pathologies not recorded by SI researchers were noted, which will be reported later in my dissertation study. Pathological traits of in-situ teeth to be recorded included presence of hypoplasia, carries, alveolar abscess,

Table 2. Dental sample

EMSW Ancestors	Tooth
V01CA	LI^1
V02C	RI^2
V03C	LI^2
V06C	LI_1
V09C	RM^1
V11C	LP^1
V12C	RM_1

and calculus. Next, mesiodistal, buccolingual, and crown height measurements were taken for each tooth using a GPM Martian type sliding caliper. Finally, general photographs were taken from the occlusal, mesial, distal, buccal, and lingual surfaces of in-situ teeth with focused, close-up shots of pathology when present using a Nikon D3500 with a Nikon DX VR AF-S NIKKOR 18-55mm lens. Table 2 lists the LA-ICP-MS study sample. Teeth selected include permanent first molars (M1s), permanent first incisors (I1s), permanent second incisors (I2s), and one permanent first premolar (PM1). M1 crowns begin formation at birth and complete around the age of three, positioning M1s as the best tooth for analysis because of their ability to record early-life chemical exposures (Figure, 5). For individuals whose molars were either absent or unsatisfactory for testing, I1s then I2s were sampled. I1s and I2s, like M1s capture early life exposure despite a slightly later developmental period (Figure, 6). Lastly, one PM1 was selected

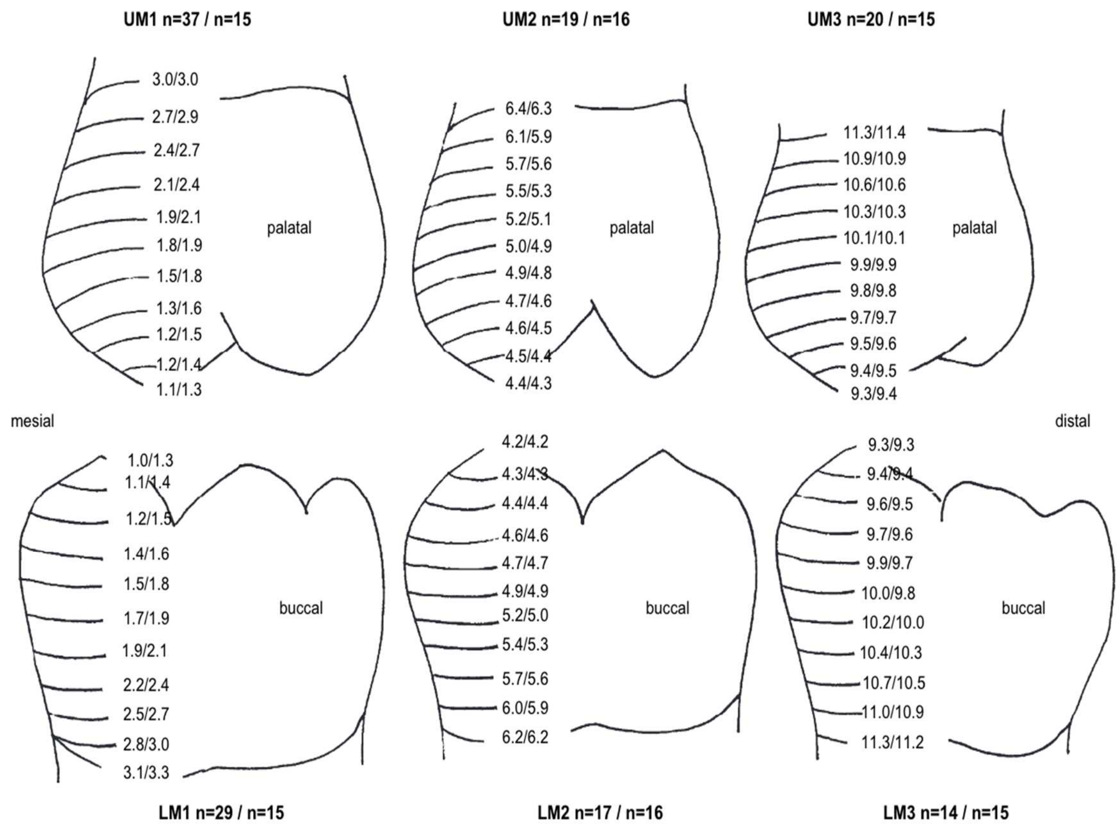

Figure 5: Chronological age estimates of human enamel formation for permanent molars by decile of crown growth. Numbers on the left are mean estimates of the southern African sample, numbers on the right are mean estimates for the northern European sample (Reid & Dean, 2006)

even though this tooth forms much later than the other teeth sampled (Reid and Dean, 2006).

Study sample preparation. Teeth were extracted using Crosstex dental extraction forceps, 70% ethanol was used when necessary to dissolve glue holding teeth in the alveolar process. Extracted teeth were once again photographed from all directions.

Dental sectioning involved a novel methodology developed by archaeologist Christopher Stevenson. Two parallel cuts 1mm apart, capturing the longest amount of the crown possible, were made along the buccal-/labio-lingual

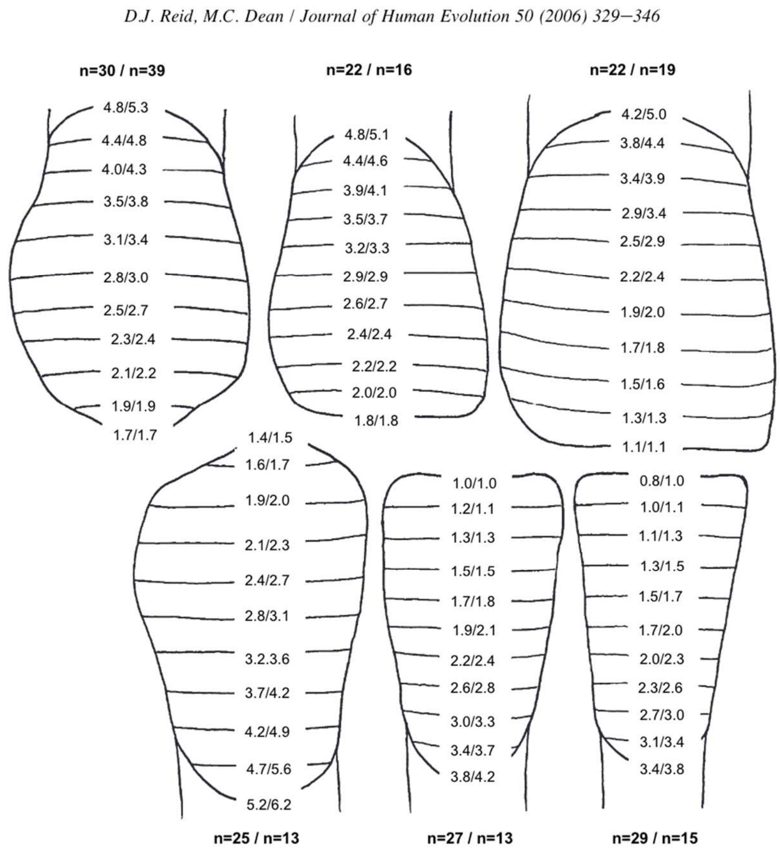

Figure 6:Chronological age estimates of human enamel formation for permanent anterior teeth (incisors and canines) by decile of crown growth. Numbers on the left are mean estimates of the southern African sample, numbers on the right are mean estimates for the northern European sample (Reid & Dean, 2006)

axis using a diamond bladed circular saw with deionized water baths between each sample. A razor blade was then inserted between one of the cuts with pressure applied to remove the 1-mm tooth sample. General inventory photographs were taken of each resulting section and sampled tooth using a Nikon 33300 with a Nikon DX VR AF-S NIKKOR 18-55mm lens.

The removal of organic and inorganic containments before LA-ICP-MS analysis is crucial for laser focus during ablation (Pollard et al. 2007). Teeth were cleaned with nitric acid. Sectioned teeth and tooth samples were placed in separate 14 ML test tubes and filled with 2% HNO_3 fully to prevent material rising to the surface during sonication. Test tubes were then placed in a Fisher Scientific FS20 Ultrasonic Cleaner and sonicated for 10 minutes. Following decantation of the 2% HNO_3, the sample and tooth were washed once with deionized water. Test tubes were then refilled fully with deionized water and sonicated a second time for 10 minutes. They were then decanted and placed in a fume hood on Kimtech wipes overnight to air-dry.

LA-ICP-MS analysis. LA-ICP-MS measurement was conducted using an Agilent 8900 Triple Quadrupole ICP-MS coupled to an ESI NWR 193 Laser Ablation System following instrumental parameters for teeth established by Palmer et al. (2022). Up to eight tooth samples were positioned within the ablation apparatus at once in a manner that a single line scan would track elemental intensities chronologically, from early- to late-formed lateral enamel (Jones, 2015). Linear 600-micron line scans were run in the buccal or labial enamel unless defective, then lingual enamel was sampled. To avoid elevated trace metal levels possibly due to post developmental incorporation into the enamel matrix, care was taken to avoid the enamel-dentine junction (EDJ) (Kang et al. 2004) and the outside surface of the tooth. Data was collected using Mass Hunter 4.6 software for the following isotopes: ^{24}Mg, ^{25}Mg, ^{26}Mg, ^{43}Ca, ^{44}Ca, ^{50}Cr, ^{52}Cr, ^{53}Cr, ^{54}Cr, ^{57}Fe, ^{58}Ni, ^{60}Ni, ^{61}Ni, ^{62}Ni, ^{64}Zn, ^{66}Zn, ^{67}Zn, ^{68}Zn, ^{70}Zn, ^{74}Se, ^{76}Se, ^{77}Se, ^{78}Se, ^{80}Se, ^{82}Se, ^{84}Sr, ^{86}Sr, ^{87}Sr, ^{88}Sr, ^{130}Ba, ^{132}Ba,^{133}Ba, ^{134}Ba, ^{135}Ba, ^{136}Ba, ^{137}Ba,^{138}Ba, ^{204}Pb, ^{206}Pb, ^{207}Pb, and ^{208}Pb.

Table 3. *Laser ablation and ICP-Ms optimized operating conditions*

Laser ablation operation parameters	
Laser type	Ar:F Eximer 193 nm
Repetition rate/Hz	30 Hz
Laser energy/mJ	4 J/cm^2
Sampling scheme	Lines
Scanning speed/μm s^{-1}	30 um/sec
ICP-MS operation parameters	
Forward power/kW	1550 kW
Coolant	H_2O at 19°C
Nebulizer gas	Argon
Measurement Conditions	
Dwell time (ms)	100 ms
Readings/replicates	3
Isotopes/measured	^{24}Mg, ^{25}Mg, ^{26}Mg, ^{43}Ca, ^{44}Ca, ^{50}Cr, ^{52}Cr, ^{53}Cr, ^{54}Cr, ^{57}Fe, ^{58}Ni, ^{60}Ni, ^{61}Ni, ^{62}Ni, ^{64}Zn, ^{66}Zn, ^{67}Zn, ^{68}Zn, ^{70}Zn, ^{74}Se, ^{76}Se, ^{77}Se, ^{78}Se, ^{80}Se, ^{82}Se, ^{84}Sr, ^{86}Sr, ^{87}Sr, ^{88}Sr, ^{130}Ba, ^{132}Ba,^{133}Ba, ^{134}Ba, ^{135}Ba, ^{136}Ba, ^{137}Ba,^{138}Ba, ^{204}Pb, ^{206}Pb, ^{207}Pb, and ^{208}Pb
Internal standard	^{43}Ca

Figure 7: Customized tray for LA-ICP-MS analysis allowing for multiple samples to be scanned during each run.

Figure 8: LA-ICP-MS instrumentation.

To establish argon background, intensity counts per second (CPS) were measured approximately 30 seconds prior to and following each ablation scan. Free from isobaric and polyatomic interfaces ^{43}Ca serves as an internal normalization standard, or signal correction against ablation variations or instrumental drift (Jones, 2015). Analytes of primary interest for this study of dietary and nutritional status include ^{43}Ca, ^{88}Sr, and ^{137}Ba.

Results

Isotopic variability of the EMSW bone sample

δ^{15}Ncollagen of the EMSW data set has a median of 10.65 ppm. The lower quartile is at 9.94 ppm and the upper quartile is at 11.00 ppm. The interquartile range is 1.06 ppm (Figure 9).

δ^{13}Ccollagen of the EMSW data set has a median of -11.27 ppm, the lower quartile is at -12.59 ppm, the upper quartile is at -10.35. The interquartile range is 2.24 (Figure, 10). The box plot reveals two outliers: one at -16.6 ppm and another at -18.28 ppm.

δ^{13}Ccarbonate of the EMSW data set has a median of -5.15 ppm, the lower quartile is at -5.65 ppm, the upper quartile is at -3.79 ppm. The interquartile range is 1.86 (Figure, 11). The box plot reveals two outliers one: at -11.30 ppm and another at -12.03 ppm. The two outliers on the δ^{13}Ccollagen and δ^{13}Ccarbonate belong to the same sample.

δ^{18}Ocarbonate of the EMSW data set has a median of 24.86 ppm, the lower quartile is at 24.25 ppm, the upper quartile is at 25.25. The interquartile range is 1.00 (Figure, 12). The box plot reveals three outliers at 27.65, 22.53, and 20.13 ppm.

Cross comparison of EMSW to other Mid-Atlantic isotopic signatures

The δ^{13}Ccarbonate values from the East Marshall Street Well show an average of -5.2 ppm (±2.2, 1σ) with a range of -12.0 to -1.2 ppm (Figure, 13). The values of the African Elmina site show a slightly lower trend with an average of -5.9 ppm range of -11.5 to -2.8 ppm. The Euro-American sites show the most negative numbers at -8.9 ppm (±2.1, 1σ) with a wide range at -14.0 to -4.4 ppm range of -11.5 to -2.8 ppm.

The δ ^{13}Ccollagen values reveal the same trends as δ ^{13}Ccarbonate. The values from the East Marshall Street Well average at -11.62 (±2.1 ppm, 1σ) with almost the widest range of -18.3 to -8.3 ppm (Figure, 14). The average of the Elmina site is slightly higher at -10.3 ppm (±1.6, 1σ) with the tightest range at -13.5 to -7.7 ppm. The average for the African American sites is similar to that of the EMSW at -12.0 ppm (±2.6, 1σ) albeit with a smaller range of -17.0 to -8.2 ppm. The Euro the EMSW at -12.0 ppm (±2.6, 1σ) with a smaller range of -17.0 to -8.2 ppm. The Euro-American sites boast the lowest average at -14.2 ppm (±2.0, 1σ) and the widest range at -19.7 to -9.2 ppm.

The δ ^{15}Ncollagen values show the least amount of variation between groups. The East Marshall Street Well average is 10.52 ppm (±0.6, 1σ) with a range of 9.11 to 11.39 ppm (Figure, 14). The average of the Elmina site is the highest at 11.9% (±1.1, 1σ) with the largest range of 8.3 to 14.1 ppm. The African American sites show similar stats to the EMSW with an average of 10.4 ppm (±0.7, 1σ) and a range of 8.8 to 11.9 ppm. The Euro-American sites are also similar to the EMSW data, showing an average of 10.7 ppm (±0.9, 1σ) and a range of 8.1 to 13.2.

δ^{18}Ocarbonate values from the East Marshall Street Well show an average of 24.5 ppm (±1.3, 1σ) with a range of 20.1 to 27.7 ppm. The average of the Elmina site is 27.6 ppm (±1.0, 1σ) with a range of 23.3 to 28.9 ppm. Yet,

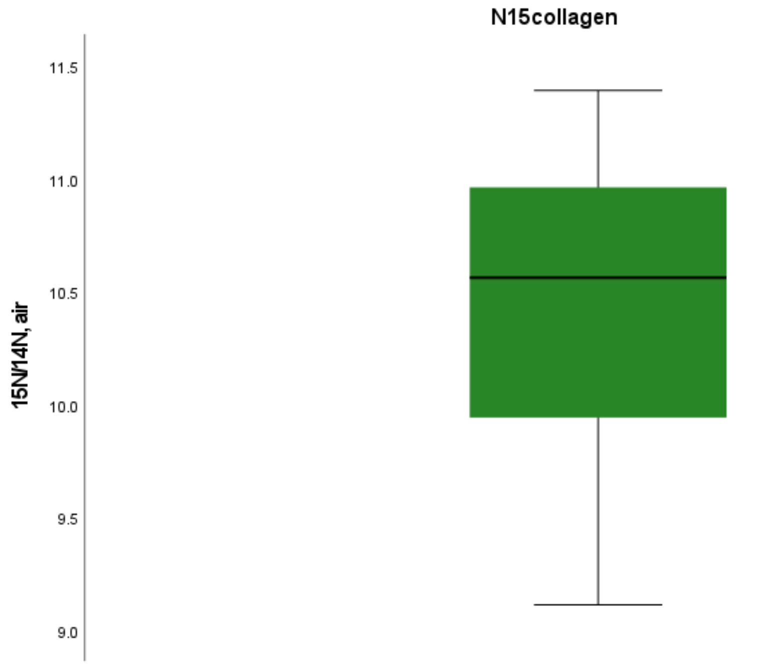

Figure 9: EMSW δ15Ncollagen box plot

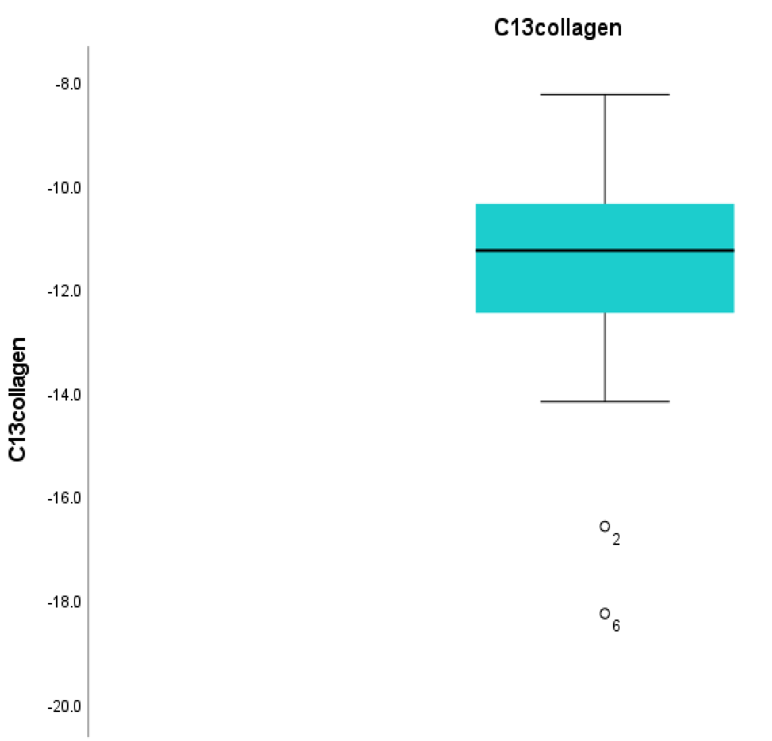

Figure 10: EMSW δ13Ccollagen box plot

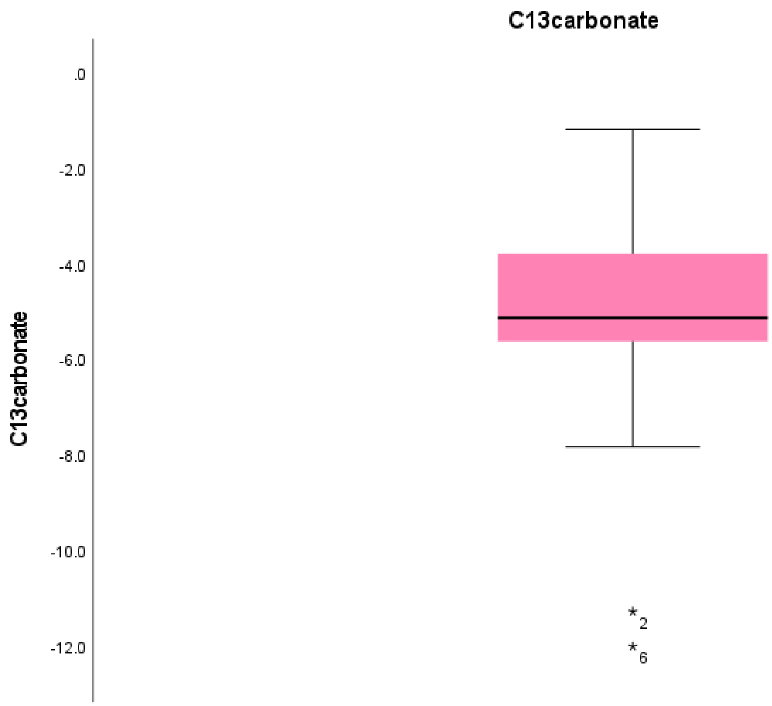

Figure 11: EMSW δ13Ccarbonate box plot

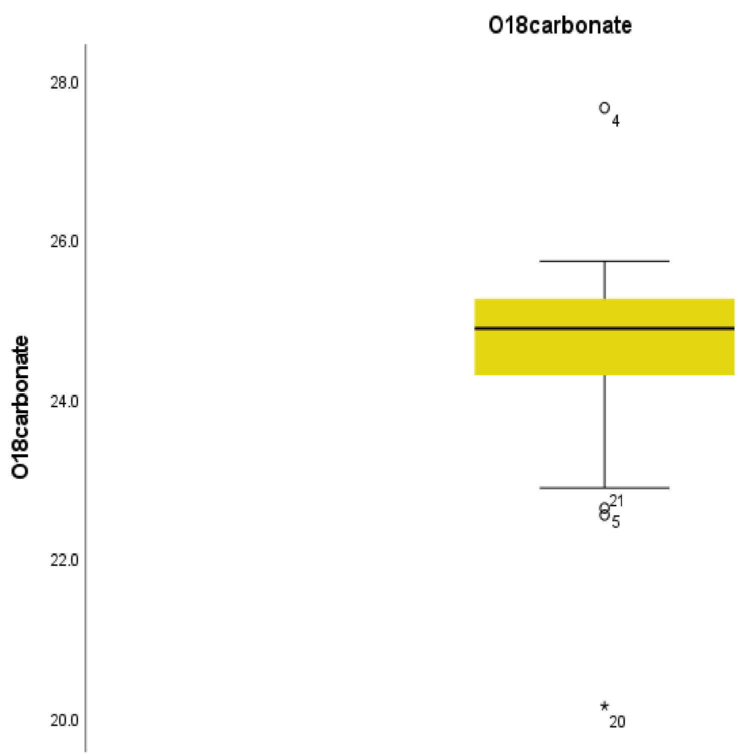

Figure 12: EMSW δ18OCarbonate box plot

most values fall in the 26.1 to 28.9 ppm range. The δ^{18}Ocarbonate average of the African American sites is 25.3 ppm (±1.2, 1σ), the closet to the EMSW data, with a range of 22.0 to 27.7 ppm. The Euro-American site data has an average of 26.0 ppm (±2.6, 1σ) with the greatest range of 15.9 to 34.0 ppm (Figure, 13).

The Mann-Whitney test displays significant differences in average isotopic values across sites or populations (Table, 3). The EMSW values are statistically different from Elmina, the only African site, in all categories (δ^{13}Ccollagen, δ^{13}Ccarbonate, δ^{18}Ocarbonate, and δ^{15}Ncollagen). The EMSW values are statistically similar in all isotope categories to those of African American individuals excavated from a site located at Fort A.P. Hill in Virginia.

The δ^{13}Ccollagen values for the EMSW sample are similar to three of the seven Euro-American sites (Foscue Plantation, Kincheloe Cemetery, and Woodville Cemetery) and similar to four of the five African American sites (A.P. Hill, Parkway Gravel, Pettus, and Robinson Cemetery). The δ^{13}Ccarbonate values for the EMSW sample are similar to only one of the seven Euro-American sites (Kincheloe Cemetery) and similar to three of the five African American sites (A.P. Hill, Parkway Gravel, and Robinson Cemetery).

The δ^{15}Ncollagen values for the EMSW sample are similar to three of the seven Euro-American sites (Glorieta Pass, Hilleary Cemetery, and Woodville Cemetery) and similar to three of the five African American sites (A.P. Hill, FABC, and Parkway Gravel). The δ^{18}Ocarbonate values for the EMSW sample are similar to five of the seven Euro-American sites (Congressional Cemetery,

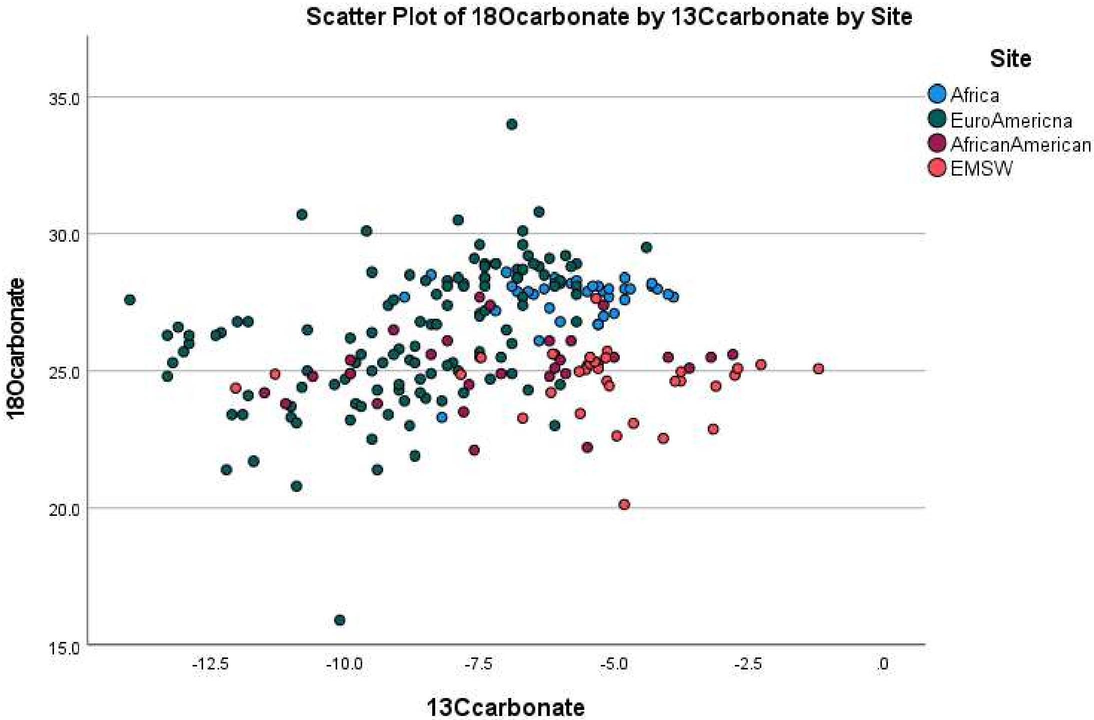

Figure 13: Scatter Plot of 18Ocarbonate compared to 13Ccarbonate differentiated by ethnicity

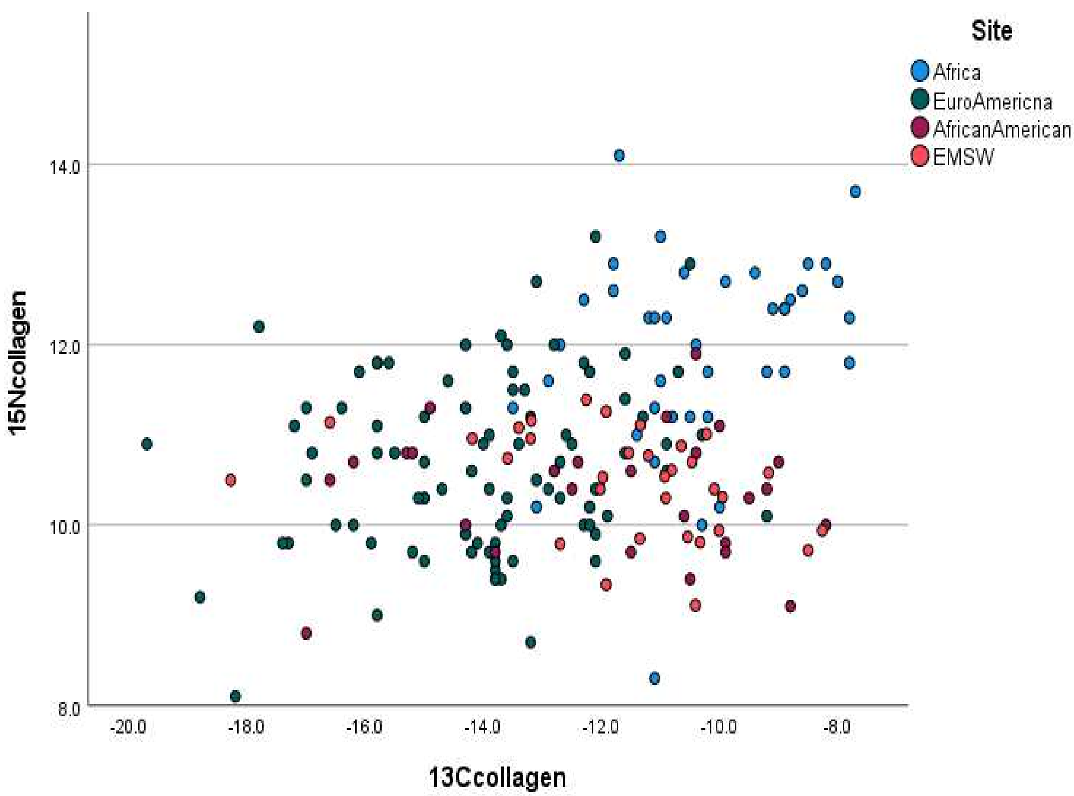

Figure 14: Scatter Plot of 15Ncollagen compared to 13Ccollagen differentiated by ethnicity

Table 4. Mann-Whitney U test results comparing (EMSW and sites from France et al. (2018). EMSW data are highlighted in red. Salmon = (δ 15Ncollagen), Yellow = (δ 13Ccollagen), Blue = (δ 18Ocarbonate), and Green = (δ 13Ccarbonate).

	Elmina	Walton	Woodville	Congressional	Hilleary	Kincheloe	Foscue	Glorieta	FABC	Parkway	Robinson	Pettus	AP Hill	EMSW
Elmina		**<0.001**	**0.021**	**<0.001**	**<0.001**	**0.048**	0.159	**<0.001**	**0.007**	**0.003**	**0.038**	**<0.001**	**0.012**	**<0.001**
Walton	**<0.001**		**<0.001**	**<0.001**	**0.022**	**0.029**	**0.003**	**<0.001**	0.119	**0.012**	**0.001**	0.232	**0.021**	**<0.001**
Woodville	**0.008**	**0.014**		0.835	0.108	0.071	0.476	0.284	0.257	0.126	0.931	**0.005**	0.257	0.089
Congressional	**<0.001**	**0.002**	**<0.001**		0.07	**0.021**	0.405	0.162	0.134	0.074	0.599	**0.001**	0.175	**0.005**
Hilleary	**<0.001**	0.603	**0.043**	**0.016**		**0.044**	**0.048**	0.386	0.808	1	0.065	0.279	1	0.612
Kincheloe	0.392	**0.029**	0.429	**0.021**	**0.044**		0.133	**0.022**	0.133	0.095	0.095	**0.044**	0.133	**0.019**
Foscue	**0.005**	0.065	0.257	**0.007**	0.109	0.133		0.116	0.2	0.111	0.73	**0.008**	0.057	**0.025**
Glorieta	**<0.001**	**0.009**	0.347	**<0.001**	**0.037**	0.137	0.804		0.456	0.285	0.158	**0.014**	0.6	0.423
FABC	**0.002**	0.143	**0.038**	0.757	0.214	0.133	0.114	0.082		1	**0.032**	0.461	0.886	0.497
Parkway	**0.004**	0.265	0.537	**0.008**	0.354	0.381	0.905	0.961	0.111		**0.016**	0.354	0.905	0.549
Robinson	0.843	**0.023**	0.126	**0.001**	0.065	0.381	0.19	**0.032**	**0.032**	0.095		**0.003**	0.111	**0.026**
Pettus	1	**0.003**	0.081	**<0.001**	**0.007**	0.533	0.109	**0.007**	**0.016**	**0.045**	0.943		0.368	**0.021**
AP Hill	0.698	**0.026**	0.257	**0.003**	**0.016**	0.8	0.2	0.082	0.057	0.111	1	0.933		0.597
EMSW	**0.008**	**<0.001**	0.173	**<0.001**	**<0.001**	0.942	0.056	**0.001**	**0.010**	0.069	0.213	0.128	0.421	

	Elmina	Walton	Woodville	Congressional	Hilleary	Kincheloe	Foscue	Glorieta	FABC	Parkway	Robinson	Pettus	AP Hill	EMSW
Elmina		**<0.001**	**<0.001**	**<0.001**	**<0.001**	**0.027**	**0.022**	0.51	**0.002**	**<0.001**	**0.001**	**<0.001**	**0.011**	**<0.001**
Walton	**<0.001**		0.285	0.334	0.147	0.725	**0.023**	**<0.001**	0.277	0.836	**0.043**	**0.002**	0.143	0.827
Woodville	**0.014**	**0.001**		0.155	0.074	0.643	0.177	**<0.001**	**0.038**	0.329	0.662	**0.043**	0.257	0.400
Congressional	**<0.001**	**0.002**	**<0.001**		0.409	0.972	**0.022**	**<0.001**	0.651	0.303	**0.016**	**<0.001**	0.101	0.625
Hilleary	**<0.001**	0.617	**0.034**	**0.032**		0.914	**0.032**	**<0.001**	0.525	0.198	0.098	**0.015**	0.179	0.231
Kincheloe	0.184	0.106	1	0.067	0.237		0.19	**0.022**	1	1	0.19	**0.044**	0.533	0.826
Foscue	**0.002**	0.052	0.052	**0.008**	0.159	0.857		0.077	0.063	0.095	0.151	0.435	0.556	**0.006**
Glorieta	**<0.001**	**0.011**	0.815	**<0.001**	0.059	0.907	0.409		**0.001**	**<0.001**	**<0.001**	**0.003**	**0.023**	**<0.001**
FABC	**0.002**	0.119	0.067	0.905	0.104	0.267	0.19	0.073		0.19	**0.016**	**0.004**	0.343	0.144
Parkway	0.164	0.231	0.931	**0.011**	0.245	0.857	0.841	0.724	0.063		0.056	**0.002**	0.286	0.779
Robinson	0.176	**0.003**	0.126	**<0.001**	**0.008**	0.19	0.056	**0.02**	**0.032**	0.151		0.622	0.286	0.073
Pettus	**0.009**	**0.025**	0.755	**<0.001**	0.1	1	0.435	1	**0.032**	0.943	0.065		1	**<0.001**
AP Hill	1	**0.003**	0.019	**0.002**	**0.006**	0.267	**0.016**	**0.013**	**0.029**	0.19	0.556	0.073		0.131
EMSW	**0.026**	**<0.001**	**0.003**	**<0.001**	**<0.001**	0.092	**0.001**	**<0.001**	**0.005**	0.298	0.554	**0.004**	0.174	

Hilleary Cemetery, Kincheloe Cemetery, Walton Family Cemetery, and Woodville Cemetery) and four of the five African American sites (A.P. Hill, FABC, Parkway Gravel, and Robinson Cemetery).

EMSW elemental intensities

Sr/Ca ratios of the EMSW dental data set have a median of 0.984 counts per second. ,The lower quartile is at 0.947 counts and the upper quartile is at 1.010 counts. The interquartile range is 0.0063 (Figure, 15).

Ba/Ca ratios of the EMSW dental data set have a median of 0.598 counts, the lower quartile is at 0.560 counts, the upper quartile is at 0.607 counts. The inter quartile range is 0.047 counts (Figure, 16). The box plot reveals one outlier at 0.884.

A scatter plot was created with Ba/Ca elemental counts on the x axis and Sr/Ca elemental counts on the y axis (Figure, 17). The green oval captures the general cluster of EMSW samples and indicates that most of the EMSW Ancestors had diets at similar trophic levels. The red circle corresponds to the single outlier and reveals the same individual is also outside the cluster on the Sr/Ca axis, something the box plot did not reveal.

Discussion

To contextualize these results, I compared this study's findings to those of France et al.'s (2018) study of 11 archaeological sites across the Mid-Atlantic

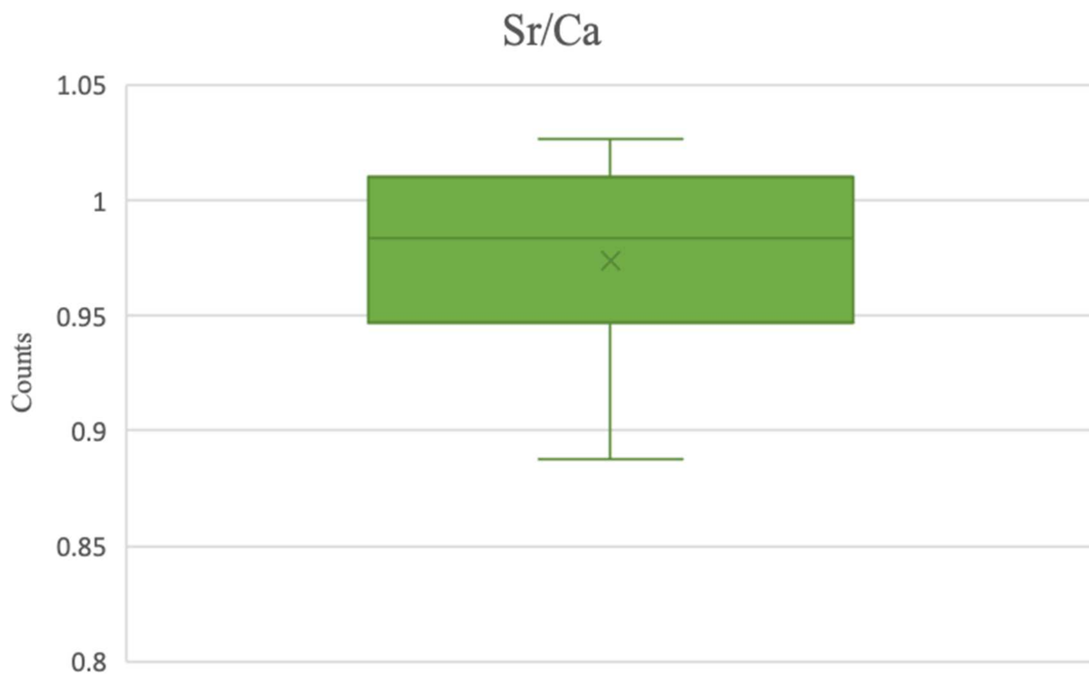

Figure 15: Box plot of EMSW Sr/Ca ratios

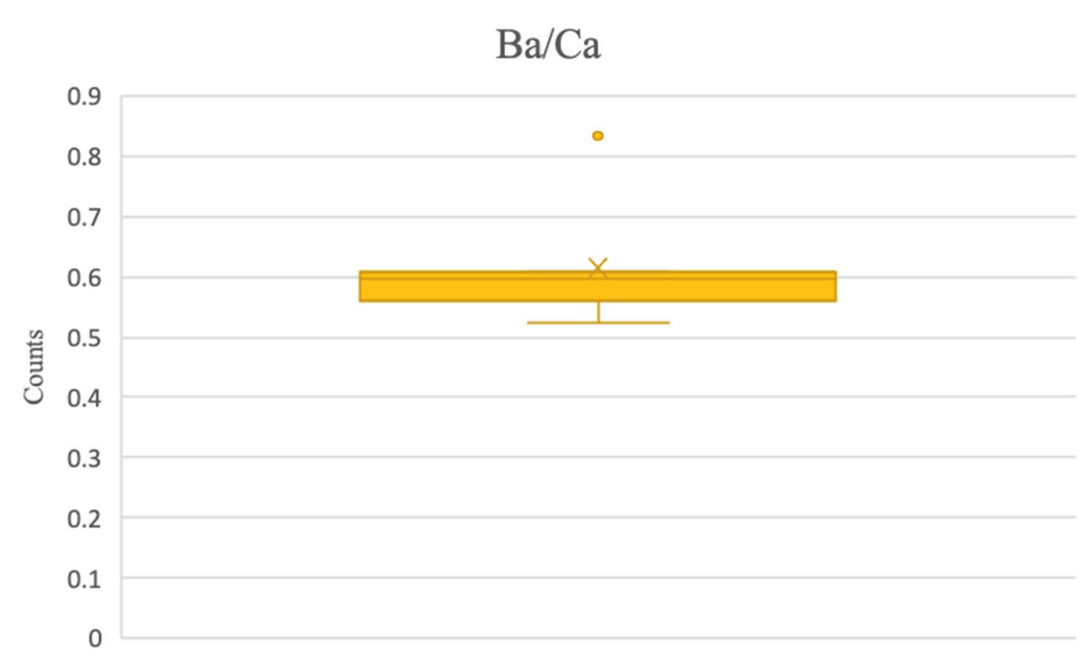

Figure 16: Box plot of EMSW Ba/Ca ratios

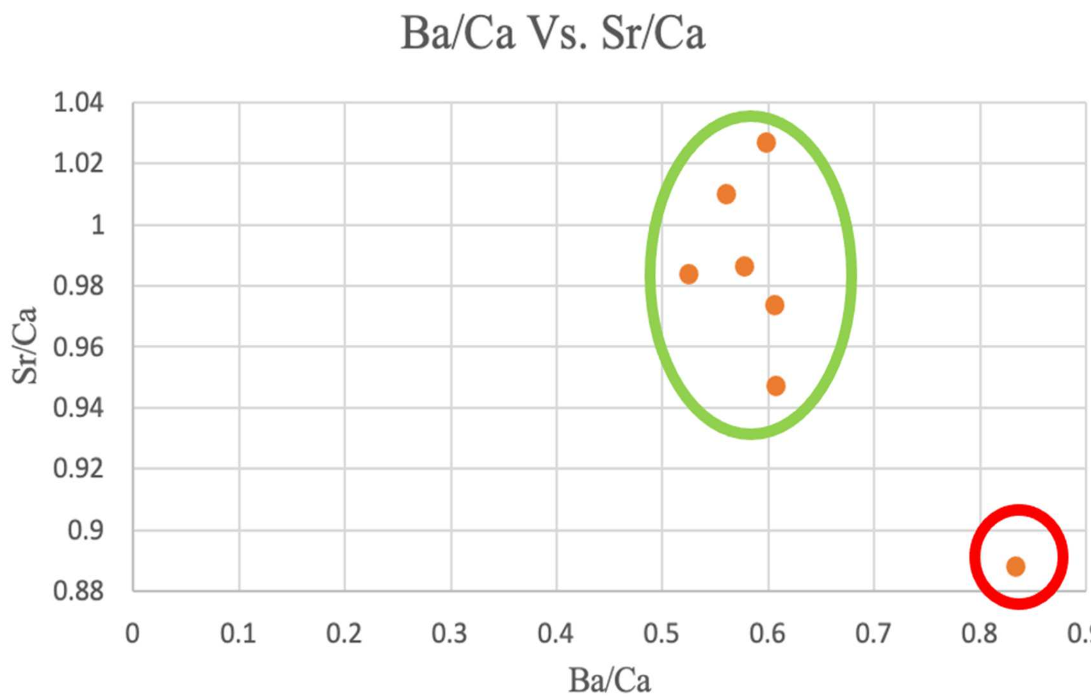

Figure 17: Scatter plot comparing Ba/Ca to Sr/Ca ratios.

and one site from western Africa (Ghana). The EMSW isotope data reveal higher δ ^{13}Ccarbonate and δ ^{13}Ccollagen values than Mid-Atlantic Euro-Americans. The results show overlap with other African American sites and African sites possibly due to the prevalence of C4 vegetation in southern North America, where maize was a staple food for enslaved individuals (Bowes, 2011; Bowes & Trigg, 2012). High C4 values can be explained by the limited food available to enslaved individuals, forcing reliance on cheap, hearty grains and scraps for survival. Two outliers are clustered deeply within Euro-American values in both scatter plots suggesting diets similar to other Euro-Americans sampled. A consideration of dietary practices, which often reflect cultural affiliation, suggests the possibility that those two samples could be of Native American or Euro-American ancestry. For example, if a poor Euro-American was working within the factories with Africans and eating similar meals provided by their employer, how varied would their chemical signatures be to Africans eating the same thing? However, the bioarcheological literature suggests both groups would have also had high C4 in diet leading to the conclusion that further historical research is necessary to understand how much of the diet is varied or similar for antebellum industrial workers based on race (Dew, 1994).

It is important to consider, also, that enslaved Richmonders living in an industrial context would have been hired out from the surrounding plantations to work in town at factories (Takagi, 1999). This suggests a range of dietary and other environmental exposures potentially extending beyond the city of Richmond. Alternatively, therefore, these findings may reflect internal dietary variation (e.g., occupational) within the broader African American community from which the EMSW sample derived.

EMSW nitrogen isotope values cluster amongst other Mid-Atlantic Euro and African American sites. These results are somewhat surprising because of marine food source abundance in the local area, at the James River, Chesapeake Bay, and the Atlantic Ocean. In the control sample, sites were inland and far from the ocean, but for Ancestors of the EMSW, ample shellfish would have been available and used for centuries by native groups (Jenkins & Gallivan, 2020). However, the lack of marine resources in diet could be controlled by the low social class that enslaved individuals lived within (France et al., 2014) or a reliance on riverine resources rather than marine.

The δ18Ocarbonate analysis is especially interesting because oxygen isotopes reveal aspects of diet (in the form of water intake) but also are used to infer geographic origin and migration. EMSW δ18Ocarbonate values cluster near those of the other Mid-Atlantic African American sites and many of the Euro-American sites, which is expected because of the similar longitudes. However, there are several interesting outliers. One of the EMSW individuals is clustered deeply within the Elmina population, possibly suggesting an African origin for an individual who died within a decade or so of arriving in Richmond (or elsewhere in the region). Another outlier of the EMSW data is lower than almost all other data points suggesting they possibly originated in a more northern area. Given the small dental sample, Sr/Ca and Br/Ca intensities reveal a limited amount about the diet of EMSW ancestors. However, this study has yielded several interesting cases. For example, one individual is an outlier in both elemental intensity box plots. With respect to Sr/Ca, they are below the curve of data and in the Ba/Ca box plot they are an extreme outlier about the data. Ba and Sr to Ca ratios should follow the same trend whether the numbers are the same. This warrants further investigation to identify, if possible, the source of this unique observation or, possibly, human error during the sampling process.. For my dissertation research I will re-ablate the sample to see if concentrations change. Future research will also include an expanded sample of considerably more individuals and teeth. Ongoing DNA analysis may also allow for matching dental and bone samples for discrete individuals, which would greatly enhance the ability to construct chronological profiles.

Conclusion

This preliminary stable isotope study of the EMSW has shed light on individuals who suffered postmortem atrocities associated with the cadaver trade conducted by past anatomists working MDHSC. The data presented allows for a deeper understanding of African diasporic culture based around diet. Ultimately, this research may help to identify early conditions that gave rise to contemporary health disparities. For example, modern day African Americans have some of the highest rates of heart disease and type two diabetes. Both diseases are caused by poor eating habits, often within conditions and structures of poverty. These structural conditions, like eating habits, are generally shared intergenerationally and may track back to the period of enslavement.

Through comparison of Mid-Atlantic isotope values (France et al., 2018), I have begun to construct the EMSW biogeochemical profile. Using LA-ICP-MS, I have identified foci for my dissertation research. The next steps include expanding my dental sample as well as the list of analytes to construct EMSW Ancestorial origins, diets, and environmental health conditions (e.g., pollutant exposure).; This research will contribute to a fuller, more human and holistic image of enslaved urban industrial lifeways. Once a standard profile or chemical baseline for enslaved Richmonders has been generated, isotope data — alongside DNA analysis – may help us to identify discrete individuals from a commingled assemblage of human remains for reburial and memorialization. Future research will seek to further reveal how enslaved laborers in urban industrialized settings differ from those living in plantation contexts with respect to diet, origin, and pollutant exposure.

At the beginning of the paper, I described the context of industrialized slavery unique to Richmond, VA. I then explained the development of the EMSWP, an interdisciplinary and inter-institutional effort to research, memorialize, and inter the Ancestral Remains. The theory section describes the capabilities of biogeochemistry, then the questions and interpretations a biocultural approach allows you to understand when working with descendant-communities. Then, from recommendations by the FRC, VCU's role of assembling complete burials from a commingled deposit is described. My methods section introduces a new dental section methodology and describes how laser ablation of teeth allows for chronological isotopic interpretations. I evaluate the bone isotope data collected, by the using box plots to find intra-variability and then compare values to a larger Mid-Atlantic isotope data set established by France et al. (2018). Next, I look at the elemental dental intensity data using boxplots to explore elements for future dissertation research. Finally, my discussion explains what new insights are to be understood from statistical analysis and where more research is necessary.

The hidden history of the East Marshall Street Well is slowly being shared. As such, is this project is part of a larger process of bringing to public awareness important debates over skeletal research, racism and ethic throughout the country. At the University of Pennsylvania remains of Delisha and Katrica “Tree” Africa were unethically retained and handled by Penn Museum without the consent of their family member following the 1985 Philadelphia police MOVE bombing (PPRSS, 2021). In Canada, the remains of over 751 indigenous children, once thought to be lost forever, were found at the site of a former boarding school in unmarked graves (Austen & Bilefsky, 2021). Today, the stories and struggles of many black Richmonders are still being rendered invisible through “colorblind” ideology and policies that produce modern problems like food deserts, gentrification, and unequal access to health care (Smedley & Smedley, 2012). Modern problems like these and the stories of UPenn and the native boarding school are direct results of the carelessness towards human life and until we illuminate the problems of the past, we have no chance of shining light on the problems of today.

Bibliography

Austen, I., & Bilefsky, D. (2021, June 24). *Hundreds more unmarked graves found at former residential school in Canada*. The New York Times. Retrieved May 15, 2022, from https://www.nytimes.com/2021/06/24/world/canada/indigenous-children-graves-saskatchewan-canada.html

Bentley, R. A. (2006). Strontium isotopes from the earth to the archaeological skeleton: A review. In *Journal of Archaeological Method and Theory* (Vol. 13, Issue 3, pp. 135–187). https://doi.org/10.1007/s10816-006-9009-x(201Best

Berry, D. R. (2017). *The Price for Their Pound of Flesh: The Value of the Enslaved from Womb to Grave, in the Building of a Nation*. Beacon Press.

Blakey, M. L. (2009). Theory: An Ethical Epistemology of Publicly Engaged Biocultural Research. *In Skeletal Biology of the New York African Burial Ground Part I* (Vol. 1, Ser. The New York African Burial Ground: unearthing the African Presence in colonial New York, pp. 1–342). essay, Howard University Press.

Blakey, M. L. (2020). Archaeology under the blinding light of race. *Current Anthropology*, *61*(S22), 183–197. https://doi.org/10.1086/710357

Blakey, M. L., & Rankin-Hill, L. M. (2016). *Political economy of African forced migration and enslavement in colonial New York: an historical biology perspective*. http://ebookcentral.proquest.com/lib/cwm/detail.action?docID=4653430.

Bocherens, H., & Drucker, D. (2003). Trophic level isotopic enrichment of carbon and nitrogen in bone collagen: Case studies from recent and ancient terrestrial ecosystems. *International Journal of Osteoarchaeology*, 13, 46–53.

Brooke Thomas Book, R., Editor, B., Goodman, A. H., & Leatherman, T. L. (1998). *The Evolution of Human Adaptability Paradigms: Toward a Biology of Poverty. Building a New Biocultural Synthesis Book Subtitle: Political-Economic Perspectives on Human Biology*. https://doi.org/10.3998/mpub.10398.8

Bowes, J. (2011). Provisioned, produced, procured: Slave subsistence strategies and social relations at Thomas Jefferson's poplar forest. *Journal of Ethnobiology,* 31, 89–109.

Bowes, J., & Trigg, H. (2012). Social dimensions of eighteenth and nineteenth-century slaves' uses of plants at poplar forest. *In B. J. Heath & J. Gary (Eds.), Jefferson's poplar forest: Unearthing a Virginian plantation* (pp. 155–171). Gainesville, FL: University Press of Florida.

Castro, W., Hoogewerff, J., Latkoczy, C., & Almirall, J. R. (2010). Application of laser ablation (LA-ICP-SF-MS) for the elemental analysis of bone and teeth samples for discrimination purposes. *Forensic Science International*, *195*(1–3), 17–27. https://doi.org/10.1016/j.forsciint.2009.10.029

Copeland, C. (1788-1822). [*Diary belonging to Charles Copeland*]. Library of Virginia. Richmond, VA

Daux, V., Lécuyer, C., Héron, M., Amiot, R., Simon, L., Fourel, F., Escarguel, G. (2008). Oxygen isotope fractionation between human phosphate and water revisited. *Journal of Human Evolution*, 55, 1138–1147.

DeNiro, M. J., & Epstein, S. (1981). Influence of diet on the distribution of nitrogen isotopes in animals. *Geochimica et Cosmochimica Acta*, 45, 341–351.

Dew, C. (1966*). Ironmaker to the Confederacy: Joseph R. Anderson and the Tredegar Iron Works.* Yale University Press.

Dew, C. (1994). *Bond of Iron: Master and Slave at Buffalo Forge* (1st ed.). W.W. Norton.

Douglas Price, T., Burton, J. H., Cucina, A., Zabala, P., Frei, R., Tykot, R. H., & Tiesler, V. (2012). Isotopic studies of human skeletal remains from a sixteenth to seventeenth century AD churchyard in Campeche, Mexico: Diet, place of origin, and age. *Current Anthropology*, *53*(4), 396–433. https://doi.org/10.1086/666492

Fernandes, R., Nadeau, M., & Grootes, P. M. (2012). Macronutrient-based model for dietary carbon routing in bone collagen and bioapatite. *Archaeological and Anthropological Sciences*, 4, 291–301.

Fleskes, R. E., Ofunniyin, A. A., Gilmore, J. K., Poplin, E., Abel, S. M., Bueschgen, W. D., Juarez, C., Butler, N., Mishoe, G., Oubré, L., Cabana, G. S., & Schurr, T. G. (2021). Ancestry, health, and lived experiences of enslaved Africans in 18th century Charleston: An osteobiographical analysis. *American Journal of Physical Anthropology*, *175*(1), 3–24. https://doi.org/10.1002/ajpa.24149

France, C. A. M., Owsley, D. W., Bruwelheide, K. S., Renschler, E. S., Barca, K. G., & DeCorse, C. R. (2020). Stable isotopes from the African site of Elmina, Ghana and their usefulness in tracking the provenance of enslaved individuals in 18th- and 19th-century North American populations. *American Journal of Physical Anthropology*, *171*(2), 298–318. https://doi.org/10.1002/ajpa.23946

France, C. A. M., Owsley, D. W., & Hayek, L. A. C. (2014). Stable isotope indicators of provenance and demographics in 18th and 19th century North Americans. *Journal of Archaeological Science*, *42*(1), 356–366. https://doi.org/10.1016/j.jas.2013.10.037

Goldfield, D. R. (1989). *Cotton Fields and Skyscrapers: Southern City and Region.* Johns Hopkins University Press.

Goodman, A. H., Leatherman, T. L., & Editor, B. (1998). *Traversing the Chasm between Biology and Culture: An Introduction Book Title: Building a New Biocultural Synthesis Book Subtitle: Political-Economic Perspectives on Human Biology*. https://doi.org/10.3998/mpub.10398.7

Goodman, A. H. (1997) Bred in the Bone? *The Sciences* 37 (March/April):20–25.

Goodman, A. H., Leatherman, T. L., & Editor, B. (1998). Traversing the Chasm between Biology and Culture: An Introduction. *Building a New Biocultural Synthesis Book Subtitle: Political-Economic Perspectives on Human Biology*. https://doi.org/10.3998/mpub.10398.7

Goodman, A. H., A. E. Dolphin, R. Klein, J. R. Backstrand, D. Amarasiriwardena, J. Reid, and P. Outridge (2003) Tooth Rings: Dental Enamel as a Chronological Biomonitor of Elemental Absorption from Pregnancy to Adolescence. *Journal of Children's Health* 1:203–214

Heaton, T. H. E. (1999). Spatial, species, and temporal variations in the $^{13}C/^{12}C$ ratios of C_3 plants: Implications for paleodiet studies. *Journal of Archaeological Science,* 26, 637–649.

Hillson, S. (1996). *Dental Anthropology*. Cambridge University Press.

Horine, E. F., Bay, J. C. (2016). *Daniel Drake (1785-1852): Pioneer Physician of the Midwest* (Reprint 2016). University of Pennsylvania Press. https://doi.org/10.9783/9781512802702

Humphrey, L. T., Jeffries T.E., Dean M. C. (2008). Micro spatial distributions of lead and zinc in human deciduous tooth enamel. In: Irish J, Nelson G, editors. *Technique and application in dental anthropology*. New York: Cambridge University Press. p 87-110

Jenkins, J., & Gallivan, M. D. (2020). Shell on Earth: Oyster Harvesting, Consumption, and Deposition Practices in the Powhatan Chesapeake. *Journal of Island and Coastal Archaeology*, 15(3), 384–406. https://doi.org/10.1080/15564894.2019.1643430

Jones, M. E. (2014). *Trace element analysis of human tooth enamel by laser ablation-inductively coupled plasma-mass spectrometry for estimation of region of origin* (dissertation). Boston University ProQuest Dissertations Publishing.

Kang, D., Amarasiriwardena, D., & Goodman, A. H. (2004). Application of laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) to investigate trace metal spatial distributions in human tooth enamel and dentine growth layers and pulp. *Analytical and Bioanalytical Chemistry*, *378*(6), 1608–1615. https://doi.org/10.1007/s00216-004-2504-6

Keegan, W. F. (1989). Stable isotope Analysis of Prehistoric Diet. In *Reconstruction of Life from the skeleton*, ed. M.Y. Iscan & K.A. R. Kennedy, pp. 223-36. New York: Alan R. Liss.

Koste, J. L. (2012.). Artifacts and Commingled Skeletal Remains from a Well on the Medical College of Virginia Campus: Anatomical and Surgical Training in Nineteenth-Century Richmond. In *Office of the President Documents VCU University Archives* (Vol. 6). http://scholarscompass.vcu.edu/arch001/2

Krueger, H. W., & Sullivan, C. H. (1984). Models for carbon isotope fractionation between diet and bone. In Stable isotopes in nutrition. ACS symposium series (Vol. 258, pp. 205–220). Washington, DC: American Chemical Society.

Larsen, C. S. (1997). *Bioarchaeology: Interpreting Behavior from the Human Skeleton*. Cambridge University Press.

Leatherman, T., & Goodman, A. (2019). Building on the Biocultural Syntheses: 20 years and still expanding. *American Journal of Human Biology*, *32*(4). https://doi.org/10.1002/ajhb.23360

Levinson, A. A., Luz, B., & Kolodny, Y. (1987). Variations in oxygen isotopic compositions of human teeth and urinary stones. *Applied Geochemistry*, 2, 367–371.

Luz, B., Kolodny, Y., & Horowitz, M. (1984). Fractionation of oxygen isotopes between mammalian bone-phosphate and environmental drinking water. *Geochimica et Cosmochimica Acta*, 48, 1689–1693.

National Historic Trust/Montpelier. *(2018). Engaging descendant communities engaging in the interpretation of slavery at museums and historic sites.* https://savingplaces.org/african-american-cultural-heritage#.

O'Leary, M. H. (1988). Carbon Isotopes in Photosynthesis. *BioScience*, 38, 328–336.

Osterholtz, A. J., (2019). Advances in Documentation of Commingled and Fragmentary Remains. *Advances in Archaeological Practice: a Journal of the Society of American Archaeology*, *7*(1), 77–86. https://doi.org/10.1017/aap.2018.35

Perry, W. R., Howson, Jean., Bianco, B. A., Howard University., & United States. General Services Administration. (2009a). *The archaeology of the New York African Burial Ground*. Howard University Press.

Price, T. D. (2014). An Introduction to the Isotopic Studies of Ancient Human Remains. *Journal of the North Atlantic*, *7*(sp7), 71–87. https://doi.org/10.3721/037.002.sp708

Price, & Burton, J. H. (2011). *An Introduction to Archaeological Chemistry*. Springer

Rabinowitz, H. N., (1996). *Race relations in the Urban South*, 1865-1890. Oxford University Press.

Rankin-Hill, L. M. (1997). *A biohistory of 19th-century Afro-Americans: The Burial Remains of a Philadelphia Cemetery*. Bergin & Garvey.

Rankin-Hill, L. M. (2016). *Identifying the First African Baptist Church: Searching for Historically Invisible People*. http://ebookcentral.proquest.com/lib/cwm/detail.action?docID=4653430.

Recommendations for Research, Memorialization and Interment of the East Marshall Street Well Ancestral Remains Report Prepared by VCU East Marshall Street Well Family Representative Council. (2018).

Reid, & Dean, M. (2006). Variation in modern human enamel formation times. *Journal of Human Evolution*, 50(3), 329–346. https://doi.org/10.1016/j.jhevol.2005.09.003

Richmond City Council. (1859). *The Charters and Ordinances of the City of Richmond with the Declaration of Rights and Constitution of Virginia*. Library of Virginia. Richmond, VA.

Roberts, D. E. (2020). *Response to retention and use of move bombing victims' remains by the Penn Museum*. Response to Retention and Use of MOVE Bombing Victims' Remains by the Penn Museum | Penn Program on Race, Science, & Society. Retrieved May 15, 2022, from https://prss.sas.upenn.edu/news/response-retention-and-use-move-bombing-victims%E2%80%99-remains-penn-museum

Schroeder, H., O'Connell, T. C., Evans, J. A., Shuler, K. A., & Hedges, R. E. M. (2009b). Trans-atlantic slavery: Isotopic evidence for forced migration to Barbados. *American Journal of Physical Anthropology*, *139*(4), 547–557. https://doi.org/10.1002/ajpa.21019

Simonetti, A., Buzon, M. R., & Creaser, R. A. (2008). In-situ elemental and sr isotope investigation of human tooth enamel by laser ablation-(mc)-icp-ms: Successes and pitfalls. *Archaeometry*, *50*(2), 371–385. https://doi.org/10.1111/j.1475-4754.2007.00351.x

Smedley, & Smedley, B. D. (2012). *Race in North America: Origin and Evolution of a Worldview (4th ed.).* New York, London: Routledge.

Smith, B. N., & Epstein, S. (1971). Two categories of $^{13}C/^{12}C$ ratios for higher plants. *Plant Physiology*, 47, 380–384.

Takagi, M. (1999*). Rearing Wolves to Our Own Destruction: Slavery in Richmond, Virginia, 1782-1865.* Charlottesville: University Press of Virginia.

Utsey, S. O., & Shabazz, I. (2011). *Until the Well Runs Dry: Medicine and the Exploitation of Black Bodies*. Privately Published.

Washington, H. A., (2006). *Medical apartheid: The Dark History of Medical Experimentation on Black Americans from Colonial Times to the Present*. Doubleday.

Wilder, C. S. (2013). *Ebony & Ivy: Race, Slavery, and the Troubled History of America's Universities* (First U.S. edition.). Bloomsbury Press.