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Forgotten Heroes: Design and production of a public engagement and display strategy for a historic skeletal collection.

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Abstract

This project considers multiple concerns and perspectives regarding the design and execution of a structured museum exhibition aimed at bringing a historic skeletal collection to the attention of varied public audiences. The collection comprises of individuals who were likely all Naval seamen excavated from the cemetery of the former Royal Naval Hospital at Plymouth (1762-1995). The burials were discovered due to redevelopment works and were excavated in 2007 by Exeter Archaeology. At the time, approximately 160 articulated and partially articulated skeletons were exhumed. Of these, 151 were sufficiently well preserved to make up the surviving Plymouth assemblage.

The first part of the current research included analysing ninety-one articulated individuals and selecting fifteen out of the sample to construct osteobiographies on the chosen individuals. The chosen individual's range in age, ancestry, and stature, and some have pathological conditions or traumatic injuries, which was the basis for selecting these individuals. The osteobiographies include using a range of non-metric and metric techniques to assess age, sex, stature, ancestry and pathology.

The second part of this project involved planning and organising a temporary museum exhibition open to the general public, which took place in May-July 2021, at the Atrium Gallery at Bournemouth University. The creation of this exhibition included writing simplified versions of the osteobiographies in a form accessible to the general public for when the remains are placed on display. Simplifying the osteobiographies is vital to be readable to the public, and the stories of these forgotten sailors can finally be on display. In the form of the submitted MRes thesis, the written aspects of the project also embed the project within current museological literature to situate the creation of the exhibition within contemporary theory on the management of cultural heritage. This important collection presented an opportunity both to engage the public regarding a specific historical period and also to illustrate the unique contribution human remains can make to our understanding of the past

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Author's Declaration

I am the single author of this thesis, and I declare it to be so. To the best of my knowledge, there is no material in this thesis that has been previously published by anybody else, save when appropriate acknowledgement has been given. Furthermore, there is no material in this thesis that has been accepted as part of the requirements of any other academic degree or non-degree programme in English or any other language.

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1 Introduction

The current study involves analysing ninety-one human skeletal remains recovered from Stonehouse Naval Hospital (Plymouth). The purpose of this research is to explore the potential of osteobiographical approaches for engaging the public in the study of the past. This research involved the creation of osteobiographies of selected individuals from among the collection. Fifteen individuals have been chosen based on unique characteristics, including amputations, pathological conditions, age, and ethnicity. A summary of the Athenaeum Place sailors' whole collection is also discussed and presented within the results section.

Accepted views regarding the eighteenth-century Royal Navy are dominated by information derived from written sources. The overall premise of the current research is to explore the potential of the human skeleton to provide a more direct representation of individual lives than sources produced from the upper echelons of the Navy. What is crucial about this research is the collection itself – these are not the men who worked in the Navy and later retired; they are men who sadly succumbed to their illness or wounds in active service. Therefore, their remains serve as a direct link to the eighteenth-century Navy and are essential for understanding what life was like onboard Nelson's fleet.

The second part of this research involved planning and organising a temporary museum exhibition open to the general public. The exhibition has been designed to be flexible and housed in museums such as the county museum at Dorchester or Poole Museum. The exhibition's presence is likely to benefit local tourism. Due to the nature of these remains, displaying them on the south coast of England, where there is such rich maritime history, is undoubtedly a suitable location. To create this exhibition, it was necessary to create simplified versions of the osteobiographies in a form accessible to the general public when the remains are placed on display, whilst adhering to ethical considerations. Simplifying the osteobiographies was vital to make them comprehendible to the public, and further justifies the excavation and retention of the collection. Making this display accessible to the public is essential; they have a right to know about their ancestors' history and the hardships they endured so that we could be here today. These sailors are of immense value for maritime archaeology. Judging by the success of putting some of the Mary Rose crew on display (The Mary Rose Trust 2020), this exhibition is likely also to prove popular to the public and, as a result, will bring much-wanted attention to the maritime archaeological sector.

The outcome of this research affects how we interpret written sources through osteoarchaeological analysis. It also helps shape the future of museum displays and museological literature. The background section explores other museum exhibitions which have taken place regarding the use of displaying human remains. A further aspect of the research was to consider the potential of such an exhibition to change the way human remains are viewed within a scientific and educational context; therefore, allowing the subject to become more acceptable and less taboo. It is also important to educate about the lives of these people. The exhibition also allows a safe and accepting place for the public to pay their respects to the men and their sacrifices– something that keeping them from the public does not facilitate.

1.1 Aim and Objectives

The current project examines the challenges of constructing a small museum exhibition to educate diverse audiences about a historic human bone collection, in order to illustrate and explore the wider challenges inherent in the presentation of research in human bioarchaeology to the general public. The specific aim is to educate and engage people in regard to the lives of this distinctive and important community of men and what the human skeleton may reveal about them. The project involves selecting and balancing components of osteoarchaeology and maritime archaeology, in order to arrive at an optimal narrative that is stronger and more effective for drawing upon both disciplines. To fulfil this aim, the following objectives were set:

- Assess the wider sample of articulated individuals (n.=91) and choose fifteen to research in the lab. These individuals were selected for their age, sex, pathological, ancestral, or stature characteristics.
- Create osteobiographies which should include stature estimation, sexing, age estimation and any pathological abnormalities. Where feasible, the individual's ancestry will be examined.

- Design a museum exhibition to present the human skeletal collection to the public while adhering to ethical and museology/heritage management requirements. This includes finding a venue, developing the panels and text for the exhibition, exhibiting the remains respectfully, and sourcing related artefacts.
- Create interesting versions of the fifteen osteobiographies for the museum display that the general audience can read and understand easily.
- Collect feedback to evaluate the exhibition's success.

1.2 Rationale

For the first time in Britain, we have access to a vast collection of eighteenth-century sailors who died in active service. This collection of sailors is of tremendous importance for various reasons, including the skeletal remains providing evidence of the physical effects of an eighteenth-century man working in the Royal Navy. The Mary Rose Trust (2020) put the skeletal remains of some individuals from the Tudor ship, the Mary Rose, on display. This has proved to be a valuable, popular, and profitable way of educating the public.

One of the main objectives of this research was to create osteobiographies of some of the individuals recovered; this would not be possible without using the human remains. In terms of the museum exhibition and giving the public a chance to meet their ancestors, arguably, it would not be possible without displaying the human remains. Therefore, it is necessary to create an exhibition for the public to visit safely and respectfully.

The entire project is embedded with osteoarchaeology and maritime archaeology and is the perfect balance between both disciplines. Therefore, this research will not only benefit maritime and osteoarchaeological research, but it will also draw attention to both disciplines, respectively. In addition, this research also helps support the growing trend of putting human remains on display to the public for educational purposes.

2 Background

2.1 Background of the Collection

The individuals analysed within this thesis are likely all Naval seamen who died during active service for their country. The burials were discovered due to redevelopment works taking place at the site of a former car showroom. Thus, the human remains were excavated at Athenaeum Place, Plymouth, in 2007 by Exeter Archaeology (Exeter Archaeology 2008; Hodgins and Salvatore 2009; Boston 2013a).

At the time, around one hundred and sixty articulated and part-articulated skeletons were exhumed from Stray Park; out of these 160, 151 had the best preservation, and therefore they make up the surviving Plymouth assemblage. The remains were buried in a supine position (Boston 2013a). Multiple burials were discovered, which contained up to three bodies in the same grave; this find, as well as a similar weight of disarticulated remains, suggests there was intercutting of successive burials. No gravestones or grave markers were recovered (Hodgins and Salvatore 2009). During the nineteenth and early twentieth centuries, areas including Athenaeum Lane were built upon due to several changes to road systems and sewage works, thus leading to the disturbance of some of the burials at Athenaeum Lane (Boston 2013a).

Additionally, Plymouth was the victim of severe bombing during WWII; this specific area was impacted severely. This led to the rebuilding of the town during the mid-1960s. However, again, this led to further disturbances of the graves (Boston 2013a).

The nationalities of the individuals buried at the site are thought to be predominately from the UK and the Channel Islands; however, some are likely foreign prisoners-of-war such as American, Spanish and French (Boston 2013a and 2013b).

Ceri Boston from Oxford University conducted an unpublished PhD (Boston 2013a) on the remains soon after they were excavated. After Ceri's PhD, the remains stayed stored in a basement at Oxford University. However, in 2014 Dr Martin Smith from Bournemouth University was contacted and asked whether he could house the remains, to which he agreed. Further remains have since been excavated from Athenaeum Place and currently reside at the Universities of Reading and Derby. Bournemouth University is where the original 151 individuals have remained since 2014.

2.2 The Royal Naval Hospital of Plymouth, Stonehouse

Due to the nature of the individuals recovered from Athenaeum Place, it is appropriate to outline a brief history of the Royal Naval Hospital of Plymouth to provide context behind the burials.

On September 15th, 1755, the Navy Board recognised a need for hospitals and thus demonstrated a Memorial to his Majesty in council. The latter proposed the building of three Royal Naval Hospitals in various counties: Portsmouth, Plymouth, and Chatham. The hospitals were to facilitate the reception and cure of sick and wounded seamen sent on shore from His Majesty's ships (Pugh 1972). There was a dire need for a hospital assigned to the wounded in Plymouth, as there were none, except for the hospital ship: *Canterbury*. Pugh (1972) states that before the erection of the hospital, nursing was inadequate where patients were left in lofts and reeked with odours of 'mortification' and a noisy atmosphere due to the bellowing of cattle squealing of pigs and cries of roosters.

A piece of land titled 'No Place Field' was purchased from Henry Tolcher, Esq, by the Commissioners for the sick and wounded Seamen on March 13th, 1756. However, due to its size (0.9 hectare), the land served no useful purpose during the construction of the hospital and stayed vacant for a further sixty-eight years. The latter caused a further delay on the construction until sufficient land was purchased for £2,239 (c. £404,000 today (Webster 2020)), which extended 10.28 hectares on June 14th, 1758. The land was situated between 'No Place Field' and Stonehouse Creek and consisted of five fields (Etherington and Royal Naval Hospital 1962; Pugh 1972). Before the construction of the hospital, it is suggested that an essential ecclesiastical building, 'The Abbey' (possibly relating to Buckland Abbey), inhabited the grounds. However, the remains of the building were demolished to facilitate the new hospital (Bracken 1934).

Construction of the hospital began in 1758, designed with the block system, the earliest example of this type of hospital in the country. This design facilitated a limited number of patients in each block. A London architect was appointed on November 10th, 1756, Alexander Rovehead, who oversaw the construction, and by 1762 basic construction of the hospital was completed. Two physicians were employed at the Hospital: Dr Farr and his junior Dr Walker and two surgeons: Mr Geach and his junior Mr Fuge. There were also two assistants and a dispenser who assisted the Doctors (Pugh 1972; Colvin 2008).

Sometime around 1784, a great philanthropist, John Howard, visited the hospital on numerous occasions. Howard (1784) described how the patients lay in a 'cradle' like bed and provided the measurements of 'fourteen inches from the floor, three feet one inch high at the head and two feet three inches at the feet: six feet two inches long, and three feet one inch wide in clear' (Pugh 1972, 81). Howard (1784) also describes how *"Patients on admission are washed and supplied with hospital dresses, and their own clothes carried to the fumigating house. A nurse is allowed for every 10 men: the greatest attention is paid to cleanliness and keeping the wards always well ventilated"* (Pugh 1972, 84). There were three types of diets at the hospital, and they included the likes of rice gruel, panada, milk porridge, broth, bread and butter, toast and water, half a pound of mutton, bread pudding, some greens and beer (Pugh 1972).

Such observations from John Howard (1784) and John Wesley (1916) portray the hospital (during the first four decades of its opening) as treating the wounded seamen little better than a convicted criminal. The latter is the case for other Royal Naval Hospitals, such as Haslar (Portsmouth) (Pugh 1972). Lloyd and Coulter (1961) accuse the nursing staff (with the odd exception) of having no training, being uneducated and underpaid whilst practising drunkenness, thievery and not above 'soliciting' the seamen. The lack of care is demonstrated in Trotter's (1803) poignant account "*At the beginning of this war a seaman fell from the top of a ship fitting at Plymouth and was wounded dreadfully. He was immediately conveyed on shore, but nobody could be found to open the gate of the hospital. At last access was obtained: but not a surgeon could be found, he was attending a gentleman of great fortune in Cornwall. It is to be added, the man died of a haemorrhage from his wounds"* (Pugh 1972, 86).

Trotter (1803) also criticises the Royal Naval Hospital of Stonehouse for not having an official naval cemetery to bury their deceased in: "*Amidst the deficiencies of Plymouth Hospital a contiguous decent burial ground is much wanted. The present one is a bit of a wasteland belonging to the corporation of Plymouth, where the seamen have such a dislike to be laid, that on dying, if they have any money as will defray the expense of being carried to a churchyard, they leave a will to that effect. The regard of a grateful country ought not to quit the brave men even in death: his cold remains ought to be interred with solemnity and guarded from insult: for these attentions inspire his living companions with the love of their country*" (Pugh 1972, 92). If one were to credit Trotter's writings, it would appear that 'Stray Park' was not a welcome final resting place for any of the men who were buried within the grounds. Finally, and perhaps as a consequence of Trotter's (1803) publication, 'No Place Field', which was purchased sixty-eight years prior (1756), became the official burial ground for the Royal Naval Hospital at Plymouth in 1824 (Pugh 1972). The hospital, despite its deficiencies, was clearly of fundamental importance throughout the Napoleonic Wars and the American Wars of Independence (Hodgins and Salvatore 2009). Stonehouse influenced French hospital plans after Coulomb and Tenon visited in 1787, whilst Florence Nightingale later became an advocate for this hospital style in the nineteenth century (Historic England 1998).

The hospital and its grounds closed in 1995. Since then, it has been converted into numerous uses such as residential houses, offices, and commercial premises; the buildings are all grade II listed buildings and protected under the Planning Act 1990 (PastScape 2012).

2.3 The Royal Navy during the Eighteenth Century

"*Think what thousands fell in vain,*

Wasted with disease and anguish,

Not in glorious battle slain" (Rodger 1986, 98).

Nelson joined the Royal Navy in 1771 and died in 1805. During these thirty years, Britain participated in war for two-thirds of that time. Peace was at last secured ten years after Nelson's death. There are no exact figures available for the number of men serving in the Navy at any particular time. However, in 1771 there were around twenty-six thousand men (including marines); ten years later, in 1781, this rose to approximately ninety-five thousand men (Adkins 2008). British sailors who were recruited for the Navy spent 43 per cent of their time in commission. The latter suggests that the average ship spent more than half her life in port (Rodger 1986). One would be mistaken if they thought men had it easy once their ship was in port. The physical labour of preparing the ship for the sea and hoisting in ballast, stores, and guns, or stripping a ship which was to be docked was substantial. However, there were benefits to time spent at the port, such as a quiet night's sleep, Sundays, and holidays off, except for emergencies (Rodger 1986). Though most men were bound to the sea, sailors were at sea for long periods during the Revolutionary and Napoleonic Wars. Sometimes even several years at once, sailors were rarely allowed shore leave, not even for 24 hours due to fear of desertion (Adkins 2008).

Life at sea for the men of the eighteenth century was harsh and dangerous. It was not time spent engaged in a battle which the men had to fear most; it was the perils of day-to-day life at sea. A lot of the time, men were drowned as a result of falling overboard or capsizing. In addition, deaths occurred from falling of masts and rigging, reports of lightning striking the decks and suffocation from the toxic vapours of the hold killed more men than battle itself. As a result of the staggering dangers ship-life conjured up, very many sailors never returned from service (Rodger 1986). It is regarded that in one case, over one thousand lives were lost in a single storm, far more than in any battle (Adkins 2008).

One might find it hard to ponder why a man would devote his life to naval service at all, and indeed a young gentleman blessed with a comfortable upbringing with servants, clean sheets, and good food may have found it hard to adapt to sea life. However, the eighteenth-century Navy offered optimism for those less fortunate, which guaranteed them hot food daily, clothes, some medical attention, lifetime employment with a pay rate, and the possible prospects of a pension. The service was worth it to them, and it was crucial to start them young (as young as six years old), for a boy could be seen as 'young' and 'adaptable' (Rodger 1986). However, there was also a more sinister method for recruiting during this time. An organization called the 'Impress Service' were responsible for recruiting seamen and were staffed by naval offices. The 'bases' of the Impress Service were usually established in a pub; here, men could freely volunteer to join the Navy. However, regular so-called ‘press-gangs’ patrolled the coastal regions and the surrounding countryside, focusing their attention along rivers to inland ports. The Navy was different from the army, which relied on volunteers. Due to the Impress Service, the Navy was able to force men into service. The press-gang was instructed by law that they were only allowed to take seafaring men and those who had experience on the river (such as bargemen and fishermen). The men also had to be aged between eighteen and fifty-five years old; however, that was not always the case. Lovett (1876) describes a frightening account of a young boy who went missing in Portsmouth and turned up several years later in 1812: “*About five years ago, a child of Mr. Sheppard, belonging to one of the coach offices in this town, but who is since dead, was stolen from his parents. Every possible enquiry was made after him, at the time, without success, and he was given up for lost. He has, a few days since, made his appearance in the Hebe frigate, just arrived in England. The boy has not the most distant recollection how he was enticed away; but remembers he was put onboard the Royal William, and afterwards sent to sea in the Laurel. He has been 25 months in a French prison”* (Lovett 1876, 3).

2.3.1 Shipboard Life

A new 74-gun ship is an example of ships being constructed at this time, especially during the seven years’ war (1756–1763). A 74-gun ship of this period was roughly 165 feet long, internally and 45 feet in beam. The main armament was situated on two decks and thus was referred to as a two-decker. However, the ship contained three internal decks spanning the length of the ship. A ship of this type usually had a crew of around six-seven hundred men who spent most of their time on the second deck, often referred to as the gun or lower deck (Rodger 1986). The sailors’ hammocks were slung from the deckhead beams; each hammock had a 14-inch width (according to regulation). The hammocks were, of course, crowded; only the petty officers were allowed extra space. Hammocks were rolled into ‘sausage’ shapes in the day and kept in troughs. Men consumed their meals on the gun deck; tables were hinged from the side or slung from the deckhead between the guns. The gunports had to be kept closed whilst at sea due to them being less than six feet from the waterline; as a result of this, the only light and air came down the main hatch (Rodger 1986).

Damp was one of the worst discomforts at sea. During times of storms: "*the spray of the sea raised by the violence of the wind is dispersed over the whole ship, so that the people breathe, as it were, in water for many weeks together*" (Lind 1753). The severity of the weather meant that the galley fire was not always able to be lit, resulting in no method to dry anything. Consequently, the men often had to sleep and work in wet clothes (Rodger 1986). The Royal Navy employed on-board the ships themselves; virtually no physicians, the Naval Hospitals were the exception. As a result, the surgeons on-board themselves likely knew just as much as the ordinary seamen. One must also acknowledge that amputations were performed on ships under battle conditions by men who were not qualified. Though amputation was usually only reserved for severely injured limbs; as a result, infection such as gangrene was liable to set in. The sooner the operation was undertaken, the lower the mortality rate. Therefore, such operations needed to be performed on the ships (Adkins 2008).

It was relatively common for male children to be on board a battleship; up to fifty boys aged six up to eighteen years old often lived on board. The children did have work to do, especially the older ones, and often received formal instruction – the bigger ships tended to have a schoolmaster on board. However, the children spent a lot of their time on-board in play (Rodger 1986).

At this time, the Navy was primarily dominated by young, single men; those who were married were a relatively small population, and smaller indeed those men who had no interest in a woman at all (Rodger 1986). Therefore, just like in any British organization of this time, the punishment was vital in keeping the men 'in-line'. The most severe crimes were considered mutiny, murder, desertion, and homosexual acts. As a result of such crimes, a man may be flogged through the fleet (which was expected) or even hanged – however, it was mandatory that for both sentences, a court-martial had to judge the case, whilst the accused was held in irons until the trial (Adkins 2008).

One must look past the prejudices; whilst the men of the Royal Navy endured many hardships and were faced with many dangers daily, it was also a society in which men could climb the ladder due to their abilities. Despite the sailors barely being allowed 'leave', their life on-board was not necessarily a constant cycle of working, eating and sleeping; time was allocated for leisure activities – where they could relax. Men also spent their spare time repairing and making clothes, shoes, and other items; this allowed them to implore their skills from previous employment (Adkins 2008). Strangely, there was a sense of freedom from the legal and customary restraints unbeknownst in any other primary European state of the day (Rodger 1986).

2.4 Previous Work on the Individuals

As mentioned in Section 1.1, the skeletal remains of the sailors were first recovered from Stray Park (Athenaeum Place) in 2007 (Exeter Archaeology 2008). Since their discovery, there have been numerous studies on the collection spanning the last decade. Dr Ceri Boston (2013a) was the first to examine the individuals in an academic context, in the form of a PhD. Boston's study analysed the collection and two other collections, including exhumed individuals from Greenwich and Haslar. Boston (2013a) focused heavily on pathology and trauma, in particular; however, stature estimation, sexing, ageing and ancestry were also explored on some of the individuals.

Anna Skaar, a former student at Bournemouth University (2014), paid particular attention to the amputations observed on some of the individuals from the Stray Park collection in the form of an MSc thesis. Skaar (2014) examined all 151 articulated individuals, which involved stereomicroscopic, SEM, radiographic and macroscopic techniques. Results showed that nine out of ten amputees most likely died within the first two weeks after the operation of reasons connected with the surgery. Out of the 151 individuals – eight had suffered limb amputations.

Amanda Wong (2014), a former student at BU, focused on exploring the periosteal new bone formation, which covers most of the individual's limbs. Wong (2014) interpreted some of the new bone formations as cases of treponematosis (yaws, bejel, congenital and venereal syphilis), tuberculosis, leprosy, smallpox as well circulationary diseases, such as scurvy and joint diseases. Trauma was also one of the leading causes of periosteal new bone formation across the collection.

A study regarding isotopic analysis was conducted on various individuals from Plymouth and some of the sailors from Haslar (Roberts et al. 2012). In addition, the analysis included a comparison with some of the sailors recovered from the Mary Rose. The d15N values from across the three populations were strikingly similar and supported the historical information. Therefore, the conclusion proved a relatively high-quality naval diet, with a large protein intake from meat, such as beef and pork, rather than fish, which was supplied in inconsequential quantities.

Therefore, numerous studies have been conducted regarding the Stray Park assemblage; however, complete osteobiographies on the individuals, focusing on this particular assemblage, are lacking (Roberts et al. 2012; Boston 2013a; Skaar 2014 and Wong 2014).

2.5 History of Human Remains within a Museum Context

"*Displaying bodies can serve as connection of the past with the present, and the dead with the living, offering succour, solace, inspiration, or information, but it also renders them ambivalent: both "persons and things*" (Geary 1986, 169).

Human remains within museum exhibitions are a heavily debated subject. When approaching the sensitive subject regarding human remains, the fundamental principle is that they are more than valuable objects for scientific research. Human remains also hold great religious, symbolic, and cultural significance for many people worldwide (Walker 2008). Due to complex and conflicting agendas regarding museums, factors about religion (Cox 1996; Richardson 2000), reburial (Chamberlain 1994; Parker Pearson 1999), validation for retaining human remains, the premise for display (Kirshenblatt-Gimblett 1998; Swain 1998; Vaswani 2001) and consent or non-consent must be considered and confronted daily (Brooks and Rumsey 2008).

The scientific value of human remains has always been prevalent in Western societies. Before museums, there was a great use of human remains to understand the human body; this tremendous scientific study started as early as the first half of the third century BC, in Alexandria by *Herophilus of Chalcedon* and *Erasistratus of' Chios*. The choice of location is essential, as Alexandria had weakened traditional Greek values due to Ptolemaic influences. Likely, the studies involved vivisection on the use of condemned criminals. Scientific research in the Ancient World was not welcomed among many due to the negative impacts it would have had on Greco-Roman, Arabic, and early Judeo-Christian beliefs regarding the afterlife and other religious values (Von Staden 1989 and 1992; Walker 2008).

The opposing view on dissections began to waiver during the Renaissance period (AD fourteenth-seventeenth centuries). During the (AD) sixteenth century, surgeons in heavily Protestant countries, like England, were permitted to take hanged bodies of criminals for anatomical studies. Not only does this turning point seem like a victory for medical enhancement, but it likely served as a deterrent to other criminals (Humphrey 1973; Wilf 1989; Walker 2008). Unfortunately, the gradual acceptance of anatomical studies on the dead led to the high demand for bodies, which ultimately led to illegal practises such as robbing graves and hiring body snatchers to fulfil the demand (Hutchens 1997; Walker 2008). For example, the infamous murders committed by William Burke and William Hare in Edinburgh in the early nineteenth century were motivated by Dr Robert Knox's supply needs to carry out dissections (Walker 2008).

It was not until the middle of the eighteenth century, Europe started to open museums (in a contemporary sense). Before this, huge collections were housed by monarchs and the Catholic Church. However, the Enlightenment era (*c.* AD seventeenth-eighteenth centuries) brought about the need for museums, which could hold and preserve historical artefacts. Museums started in the form of 'cabinets of curiosities', which were collections managed by wealthy aristocrats, often to entertain their guests. Due to their interest in human anatomy, many early collectors were physicians who included human skeletons and various preserved anatomical specimens. For example, Sir Hans Sloane (1660-1753) owned an extensive collection, and he was the personal physician to Queen Anne and King George I. Among Sloane's collection were several human skeletons. After Sloane's death, his collection was entrusted to the care of the British parliament; there, it served as the foundation of the British Museum's Natural History Collection (Walker 2008; Jenkins 2014).

The nineteenth-century saw the construction of large, public, Natural History Museums; their goals were an even balance between popular education and scholarly research. The museums served as an institutional framework, in which extensive skeletal collections were amassed from the smaller private collections of the aristocrats. The museums were able to maintain staff and scientists and secure osteological collections from around the world (Walker 2008).

The twentieth century saw further scientific advancement. Several anatomists realised the importance of having examples of known age, sex, and ethnic background in skeletal collections. The value of known assemblages could aid anthropological and forensic research on the effects of genetic and environmental aspects on factors such as disease, health, and morphological variation. In Britain, World War II disturbed the crypts outside Saint Bride's Church, London. Due to the disturbance, restoration of the church resulted in a detailed collection of skeletal remains dating from the mid-eighteenth century. In addition, comparable collections of people of known age and sex from historic cemeteries have been established across Europe in Portugal, Switzerland, and Austria (Huda and Bowman 1995; Walker 2008).

2.5.1 The Power of Human Remains on Display

The start of the twenty-first century has proved that human remains are popular among the public. Several exhibitions in London displayed human remains, including '*London Bodies: The Changing Shape of Londoners from Prehistoric Times to the Present Day'* and '*Body Worlds: The Anatomical Exhibition of Real Human Bodies'.* The London Bodies exhibition attracted 15,600 visitors, whereas fourteen million people are estimated to have attended the Body Worlds international touring between the mid-1990s and 2004 (Ganiaris and Calver 1999; Walter 2004). During these exhibitions, the British Museum also displayed the likes of '*Ginger*', a late predynastic Egyptian man, '*Pete Marsh*', a retrieved bog body and wrapped Egyptian mummies. In addition, the coffin of the '*The Roman Lady*' situated in the Museum of London was opened in 1999; it was reported there was a dramatic, permanent 70% increase in visitors compared with the previous year (Barham and Lang 2001; Brooks and Rumsey 2008). The Mary Rose Museum is another excellent example of the popularity of putting human remains on display (The Mary Rose Trust 2020).

A survey taken by DCMS (2003) demonstrated that out of the 148 English institutions surveyed, 132 of them held human remains. The museum that holds the most is the Natural History Museum in London; their research collection comprises of 19,950 human remains. The latter collection represents the global human population with a timescale that spans 500,000 years. It is estimated that Britain holds around sixty-one thousand human remains; of those, 15,000 are from overseas, and the rest are from the British Isles. Thirty-five of the institutions surveyed stored most of their collection, whereas eighty-nine had most or all their collections on display. The most common human remains from the period: AD 1500-1945 are organised and exhibited in archaeological, anthropological, anatomical, pathological, and Egyptological contexts. As well as skeletons from excavated burials and cremations, shrunken heads and objects such as drinking vessels constructed from skulls are also on display (Jenkins 2014).

Current campaigns about human remains in museums in Britain do exist. Several practising Pagans have requested that human remains be treated with appropriate care. A Druid, Emma Restall Orr, formed the ‘Honouring the Ancient Dead’ advocacy group in 2004. This group aimed to voice concern about the treatment of pre-Christian remains and campaign for reburial, ritual, and respect (Jenkins 2014). Therefore, it is thus essential for museums to consider that various social and cultural groups have contrasting attitudes. An example of differing opinions comes from English Heritage's small survey of visitors to its Avebury Museum. English Heritage found that despite opposition from the Pagan community, most people approved of keeping a Neolithic child on display. However, a surprising number of those against its continued display were American tourists (Chamberlain and Pearson 2001, 184; Brooks and Rumsey 2008).

Whilst one agrees that the repatriation of human remains in a context of which they have been illegally obtained and where ethical issues are pressing is morally right. However, in some cases, especially in Britain: "*the disturbance of burials and the clearance of graveyards is usually a consequence of property development, and in fact the involvement of archaeologists is normally the best assurance that exposed skeletons will be treated with the maximum respect*" (White and Ganiaris 1998, 19; Brooks and Rumsey 2008). Therefore, in such cases, it can be argued that "*Archaeologists and museums have a responsibility to conserve and preserve archaeological remains and records for future generations.*

It is only in this way that our knowledge of the past can be reconsidered in the light of new techniques and new questions which arise (Hillson 2001, 1; Jenkins 2014).

3 Material and Methods

The project methodology consisted of extensive desk-based research, laboratory analysis and museological studies to achieve the overall research aim.

3.1 Osteological Analysis

3.1.1 Selection of the Individuals

3.1.1.1 Materials

One hundred and seventy-nine individuals from the Athenaeum Place site were labelled with their burial numbers and stored in individual boxes unless the individual was semi-articulated. In the case of semi-articulation, it was common for individuals to share boxes with others to benefit storage space. Some boxes contained disarticulated fragments. The bones were not individually marked with site /burial numbers. Different parts of the skeleton were separated into different plastic bags, such as the ribs, which were kept separate from the vertebrae and innominates. Some of the bags were sided; however, the wrong bones were sometimes in the respective bags. Some of the individuals were recovered with iron nails that were likely coffin nails; a small number of clay pipes were also recovered with some burials. No other items appear to be stored with the individual burials.

There were minor curation issues, such as the bones that had been mistakenly sided, likely due to mixing the bags by a previous researcher. Other issues included the semi-articulated remains, which were kept in separate bags but within the same box, and sometimes crania were crushed by the individual on top.

3.1.1.2 Recording of the Individuals

Bournemouth University's Anthropology recording form was used as a general basis of recording, and then from there, a revised version was used, which was better suited to the collection. A total of ninety-one skeletons were recorded individually. Age, sex, marks of trauma and pathological conditions were recorded from each skeleton, and skulls were also recorded for ancestry (the methods described below). The information was then entered onto a spreadsheet to identify which skeletons had interesting features quickly and why and which individuals were better preserved to display the individual safely. From this spreadsheet, fifteen individuals were chosen.

3.1.2 Preservation

The bones' overall preservation was observed and scored using the scoring system from the Brickley and McKinley (2004) *'Guidelines to the Standards for Recording Human Remains*' published by BABAO (pg. 14-17). Some bones were prone to be heavily fragmented, such as a good percentage of the crania and innominates. However, most individuals were preserved at a grade 2 or 3 level, enabling most of the body to be reconstructed if required.

3.1.3 Age Estimation

There is a difficulty in estimating adult and sub-adult age-at-death. It is an ongoing issue for osteologists because chronological age does not necessarily respond to physiological age due to individual health, nutrition, genetics, mechanical wear, and exposure to environmental stressors (Sherwood et al. 2000; White et al. 2012; Rodgers 2016). Therefore, to combat individual variability, age is estimated within an age range rather than a specific age (Rodgers 2016). In addition, the techniques used to assess sub-adults are different from those applied to adults; therefore, age estimation starts with evaluating the maturational stage to determine the most appropriate methods (Falys and Lewis 2011).

3.1.3.1 Adult Age Estimation

Due to the assemblage's dating and preservation, the most appropriate methods to estimate adult age-at-death was by looking at the auricular surface method by Buckberry and Chamberlain (2002), the pubic symphysis method by Suchey and Brooks (1990) and cranial suture closure by Meindl and Lovejoy (1985).

Whilst Lovejoy's (et al. 1985) auricular surface dating was developed on the Todd collection before the Buckberry and Chamberlain method (2002), the latter method was chosen due to the sample having been developed on UK material, the Spitalfields assemblage, and thus, it is more reliable to be used on this UK assemblage rather than a technique developed on a different geographical sample (Falys et al. 2006). Consideration was given to the issues surrounding auricular surface ageing regarding the Buckberry and Chamberlain (2002) method, which tends to overestimate the age of younger individuals (Rodgers 2016). Buckberry and Chamberlain (2002) conducted a Bayesian analysis to provide posterior probabilities of age to combat the overestimation issue.

I compared the pubic symphyses with the casts in the laboratory at Bournemouth University, which are modelled on the Brooks and Suchey (1990) technique. One issue with this method is that the pubis symphysis is fragile; therefore, this technique could not be used on individuals who did not have a surviving pubis symphysis. As a result, there is a danger of underestimating older individuals (Merritt 2014; Rodgers 2016). A way to combat this risk is to use Hartnett’s (2010) revised method regarding the pubis symphysis when estimating age from a suspected older individual as it is more precise on older individuals.

Table 1 shows the importance of validation studies when applying an aging method to an osteological collection. The various studies reflect that the accuracy of both techniques depends on various factors such as regional variation, the specific body type, and the sex of the individual in some cases (Mulhern and Jones 2004; Wärmländer and Sholts 2011; Millán et al. 2013; Merritt 2017; Rivera-Sandoval et al. 2018; Joubert et al. 2019). The most common outcome of the Suchey-Brooks method (1990) highlights that it is more accurate for younger individuals under sixty. In contrast, the Buckberry-Chamberlain method (2002) was more accurate on individuals over fifty-five years. The UK samples show that both methods apply to UK individuals, as long as variability factors have been acknowledged (Hoppa 2000; Falys et al. 2006).

Table 1: A compilation of validation studies for Suchey and Brooks (1990) and Buckberry and Chamberlain (2002) aging methods (author's own 2021).

Method	*Research*	*Sample*	*No. of Individuals*	***Results***
Pubic Symphysis (Suchey and Brooks 1990).	Hoppa (2000).	Spitalfields (UK).	69	More significant variability in female pubic morphology, often attributed to reproductive changes in hormonal levels. Differences in the timing of age-related changes for osteological criteria may be significant between reference and target samples.
	Millán et al. (2013).	Madrid, modern Spanish sample.	139	More suitable for samples containing a majority of individuals younger than 60 years of age.
	Merritt (2017).	Hamann-Todd and William Bass Collections (USA).	746	Recommended for obese BMI, heavy-bodied, and tall-stature individuals as well as all body types if body size cannot be estimated.
	Rivera-Sandoval et al. (2018).	Medellin, Colombia, modern sample.	277	Suchey–Brooks method proves the most accurate for young individuals.

	Joubert et al. (2019).	White, South African sample.	184	The method performed slightly better in females. Method consistently underestimated age-at-death after 35 and 45 years of age for both males and females. The method is acceptable in a white South African population due to the moderate positive correlation with true age and good repeatability.
Auricular Surface (Buckberry and Chamberlain 2002).	Mulhern and Jones (2004).	Terry and Huntington Collection (USA).	309	Ages younger than 50 years were overestimated, and ages of 60 years and older were underestimated—no bias between sexes or black or white.
	Falys et al. (2006).	St. Bride’s Church (UK).	167	Buckberry and Chamberlain’s (2002) revision of the auricular surface technique proved more useful than Lovejoy’s et al. (1985). However, the study did suggest that even Buckberry and Chamberlain’s (2002) stages were too broad and suggested reducing the number of age ranges. There are only three stages that provide notable changes.
	Millán et al. (2013).	Madrid, modern Spanish sample.	139	The method appears to be more suited to samples containing a more significant percentage of individuals older than 60 years.
	Merritt (2017).	Hamann-Todd and William Bass Collections (USA).	746	Recommended for underweight BMI, light-bodied, and short-stature individuals.

	Rivera-Sandoval et al. (2018).	Medellin, Colombia, modern sample.	277	Buckberry–Chamberlain method adjust the best to Medellin's population and is most appropriate for individuals over 55 years of age.
Cranial Suture Closure (Meindl and Lovejoy 1985).	Wolff et al. (2012).	Hungarian population, Semmelweis University.	239	Ectocranial suture closure had a great degree of variability in the Hungarian population. Individuals over the age of 65 were found to have sutures open or barely closed. Individuals under the age of 50 were also found to have closed sutures. However, there was no accuracy in these results.
	Key et al. (1994).	Europeans, Spitalfields, London.	150	This study found that many people of both sexes, particularly men, have ectocranial sutures that do not close until they are very old, and incomplete closure is normal. In addition, this study found a considerable variation in suture closure.
	Gocha et al. (2015).	Thais, Khon Kaen University.	74	Males were found to have less prejudice and inaccuracy than females. Males' ages were overestimated under 40 years and underestimated above 40 years, though age estimates between 40 and 49 years were reasonable. Age was overestimated in females under 30 years and underestimated in females over 30 years. However, age estimates were near to known age between 30 and 49 years.

Ectocranial suture closure analysis was conducted on some completely intact skulls, and inter-decile ranges were reached from the composite score (Meindl and Lovejoy 1985). This technique was employed as the only option when individuals were only represented by skulls. Cranial sutures have been said to have a poor correlation with age (see Table 1), though they can be helpful on the older individuals where the age range is smaller and within this study, they were used broadly to establish old age in correlation with other techniques (Rodgers 2016; Maaranen and Buckberry 2018; Adserias-Garriga 2019).

3.1.3.2 Sub-Adult Age Estimation

There is a challenge in separating non-adults from young adult skeletons due to sexual and individual developmental variation. An adult skeleton is classified, in a physical sense, as one in which the growth process has been completed. However, the epiphyseal union is a slow process that appears primarily throughout the teenage years (for the case of long bones) but extends into the mid-twenties and early-thirties in regard to the iliac crest (Webb and Suchey 1985) and sternal clavicle (Webb and Suchey 1985; Bassed et al. 2011; Rodgers 2016). In comparing published studies Falys and Lewis (2011) found inconsistencies for the minimum age a skeleton is classed as an adult, ranging from f14-25 years of age (Rodgers 2016). The concept of 'adulthood' is subjective and dependent on social norms (Sofaer 2006 and 2011).

Teeth are less impressionable than bone to environmental factors. Generally, they are ideal for estimating sub-adult age (Roberts 2016) but lose informative value in older sub-adults. There is much debate around at what age the third permanent molar erupts (Schaefer et al. 2009). Table 2 shows that the age at which an individual's third permanent molar erupts varies depending on the population and the sex of the individual. Therefore, when one uses this technique, it is essential first to establish the ancestry and the sex of the individual; however, this can be problematic as establishing the sex in a sub-adult from skeletal morphology is not recommended due to the unreliability (Wilson et al. 2011). Nelson and Ash (2010) discuss that in Caucasian males, the third permanent molar erupts between seventeen and twenty-one years of age. Olze et al. (2005) conducted a validation study, and out of the following methods: Gleiser and Hunt (1955), Demirjian et al. (1973), Gustafson and Koch (1974), Harris and Nortjé (1984) and Kullman et al.

(1992); Demirjian et al. (1973) proved to be the most reliable. However, dental formation is favoured over tooth eruption because tooth eruption rates vary by population and are negatively affected by poor nutrition and disease (Saunders 2008; Cunningham et al. 2016; Roberts 2016). The third molar eruption was only used loosely in this research, and the primary method used to assess the age and maturation of the sub-adults was epiphyseal fusion.

Table 2: Different studies of the 3rd molar eruption based on Demirjian's (et al. 1973) schematic stages (author's own 2021).

Method	*Study*	*Mandibular (Stage H) Eruption Mean Age (M)*	*Maxillary (Stage H) Eruption Mean Age (M)*	*Mandibular (Stage H) Eruption Mean Age (F)*	*Maxillary (Stage H) Eruption Mean Age (F)*
Radiological	Priyadharshini et al. (2015) - South Indian sample, 14-30 yrs.	22	22.88	22.53	23.35
Orthopantomograms	Tuteja et al. (2012) - Indian sample, 12-26 yrs.	22.52	22.5	22.41	22.67
Radiological	Kasper et al. (2009) - Hispanic sample, 12-22 yrs.	<21	<20	<22	<21
Radiological	Caldas et al. (2011) - Portuguese sample, 6-22 yrs.	21.9	22.1	22.5	22.5

The epiphyseal union was the primary method used when estimating the age of sub-adults. Table 3 shows a list of compiled methods for estimating age from the epiphyseal union in sub-adults. Schaefer's work (2008) is often considered the most reliable method when estimating age using epiphyseal union (Schaefer et al. 2009; Cunningham et al. 2016). An issue with this method is evident when looking at Table 3; none of the samples used within the epiphyseal studies was from the UK; therefore, one must be aware that the method may not be as effective on a British collection. The samples include a mix of different cultures, including Portuguese, American, Bosnian, and Indian (McKern and Stewart 1957; Jit and Singh 1971; Jit and Kulkarni 1976; Webb and Suchey 1985; Coqueugniot and Weaver 2007; Cardoso 2008; Schaefer 2008).

Table 3: Compiled methods and sources for the epiphyseal union in male sub-adults (author’s own 2021).

Bone	*Area*	*Method*	*Study/ Reference*	*Open fusion (yrs)*	*Partial fusion (yrs)*	*Complete fusion (yrs)*
Humerus	Proximal	Dry Bone	Schaefer (2008) - Bosnian Sample.	<20	16-21	>18
			McKern and Stewart (1957) - American Sample.	<20	? -23	-
			Coqueugniot and Weaver (2007) - Portuguese Sample.	<20	19-23	>20
		Radiographic	Jit and Singh (1971) - Indian Sample; Cunningham et al. (2016).	<18	14-19	>16
	Medial	Dry Bone	Schaefer (2008) - Bosnian Sample.	<18	16-18	>16
			Coqueugniot and Weaver (2007) - Portuguese Sample.	<19	16-20	>16
	Distal	Dry Bone	Schaefer (2008) - Bosnian Sample.	<14	15-18	>15
			Coqueugniot and Weaver (2007) - Portuguese Sample.	<15	-	>16
Radius	Proximal	Dry Bone	Schaefer (2008) - Bosnian Sample.	<18	15-18	>16
			Coqueugniot and Weaver (2007) - Portuguese Sample.	<16	17-20	>16
	Distal	Dry Bone	Schaefer (2008) - Bosnian Sample.	<19	16-20	>17

			McKern and Stewart (1957) - American Sample.	<20	? -22	-
			Coqueugniot and Weaver (2007) - Portuguese Sample.	<21	19-21	>20
Ulna	Proximal	Dry Bone	Schaefer (2008) - Bosnian Sample.	<14	15-18	>15
			Coqueugniot and Weaver (2007) - Portuguese Sample.	<16	16-20	>16
	Distal	Dry Bone	Schaefer (2008) - Bosnian Sample.	<20	17-20	>17
			McKern and Stewart (1957) - American Sample.	<20	? -22	-
			Coqueugniot and Weaver (2007) - Portuguese Sample.	<21	19-21	>20
Femur	Proximal	Dry Bone	Schaefer (2008) - Bosnian Sample.	<18	16-20	>16
			Coqueugniot and Weaver (2007) - Portuguese Sample.	<20	16-24	>16
			Cardoso (2008) - Portuguese Sample.	<16	15-18	>16
		Radiographic	Jit and Singh (1971) - Indian Sample; Cunningham et al. (2016)	<15	13-17	>14
	Greater and Lesser Trochanter	Dry Bone	Schaefer (2008) - Bosnian Sample.	<18	16-20	>16

			Coqueugniot and Weaver (2007) - Portuguese Sample.	<20	16-21	>16
			Cardoso (2008) - Portuguese Sample.	<16	15-18	>16
	Distal	Dry Bone	Schaefer (2008) - Bosnian Sample.	<19	16-20	>17
			McKern and Stewart (1957) - American Sample.	<19	? -21	-
			Coqueugniot and Weaver (2007) - Portuguese Sample.	<20	16-21	>19
			Cardoso (2008) - Portuguese Sample.	<18	16-18	>16
Tibia	Proximal	Dry Bone	Schaefer (2008) - Bosnian Sample.	<18	16-20	>17
			McKern and Stewart (1957) - American Sample.	<19	? -22	-
			Coqueugniot and Weaver (2007) - Portuguese Sample.	<20	16-21	>19
			Cardoso (2008) - Portuguese Sample.	<18	16-19	>17
	Distal	Dry Bone	Schaefer (2008) - Bosnian Sample.	<18	16-18	>16
			Coqueugniot and Weaver (2007) - Portuguese Sample.	<19	16-20	>16
			Cardoso (2008) - Portuguese Sample.	<18	15-18	>16
		Radiographic	Crowder (pooled sample); Cunningham et al. (2016).	<16	12-18	>14
Fibula	Proximal	Dry Bone	Schaefer (2008) - Bosnian Sample.	<20	16-20	>17

			McKern and Stewart (1957) - American Sample.	<19	? -21	-
			Coqueugniot and Weaver (2007) - Portuguese Sample.	<20	16-21	>19
			Cardoso (2008) - Portuguese Sample.	<18	16-18	>16
	Distal	Dry Bone	Schaefer (2008) - Bosnian Sample.	<18	16-20	>17
			Coqueugniot and Weaver (2007) - Portuguese Sample.	<20	16-21	>16
			Cardoso (2008) - Portuguese Sample.	<16	15-18	>17
		Radiographic	Crowder (pooled sample); Cunningham et al. (2016).	<17	12-18	>14
Vertebrae	Annular Rings	Dry Bone	Cardoso and Ríos (2011): Modern Portuguese Sample.	<21	14-23	>18
Clavicle	Medial	Dry Bone	Schaefer (2008) - Bosnian Sample.	<23	17-29	>21
			McKern and Stewart (1957) - American Sample.	<22	18-30	>23
			Webb and Suchey (1985) - Modern American Sample.	<21	16-30	>21
			Coqueugniot and Weaver (2007) - Portuguese Sample.	<24	19-29+	>25
		Radiographic	Jit and Kulkarni (1976); Cunningham et al. (2016).	<21	18-24	>22

Sternum	Mesosternum	Dry Bone	Cunningham et al. (2016); Schaefer et al. (2009).	-	-	>25+

3.1.4 Sex Estimation in Adults

Sex estimation of these individuals is essential. Although one would expect most of this collection to be male due to the link to the eighteenth-century Royal Navy, one cannot merely rest on an assumption. Therefore, it was necessary to estimate the sex of as many individuals as possible. If females were present, this would pose questions to how we interpret the eighteenth-century Royal Navy or the extent to which we can assume that all those buried at Athenaeum Place were in naval service instead of other occupations.

The pelvic girdle is considered the most sexually dimorphic region in the body; therefore, the pelvis was crucial in determining the sex in these individuals. In addition, the ventral arc, subpubic concavity, medial aspect of the ischiopubic ramus and greater sciatic notch were all accessed and scored similarly to the skull from 1-5 (Phenice 1969; Walker 1994). There are increasingly new studies published that support the theory that female pelvic girdles have more global variation than was previously assumed. There is evolutionary evidence to support the idea that variable pelvic girdles result from factors such as genetic drift, differential migration, higher calorific diets, sedentary lifestyles, and climatic variation (Betti et al. 2013; Betti 2017; Betti and Manica 2018). A higher degree of pelvic variation produces methodological implications, and one must acknowledge this factor when relying on the pelvis to estimate the sex of an individual. Although Table 4 shows the reliability of both the Phenice (1969) and Walker (2004) methods, these studies show that the method's reliability appears to be population specific. For example, there seems to be higher reliability of the Phenice method in a Native American population than in a European sample; however, the accuracies are also biased between sexes (Kelley 1978; Lovell 1989; MacLaughlin and Bruce 1990). Despite the accuracy issues, Table 4 does demonstrate that Phenice's pelvic method (1969) achieves a higher accuracy at estimating sex than using Walker's (1994) skull scoring technique.

Table 4: Validation studies of the Phenice method (1969) and the Walker method (1994) (author's own 2021).

Method	Study	Population	No. Individuals	Classification accuracy (%)
Phenice Method (1969)	Kelley (1978)	Native American	362	90
	Lovell (1989)	Presumed Caucasian	36	83
	MacLaughlin and Bruce (1990)	European	Three separate collections	59–83
	McBride et al. (2001)	Terry Collection (USA)	115	89
	Ubelaker and Volk (2002)	Terry Collection (USA)	198	88
Walker Method (1994)	Walker (2008)	European American; African American; English ancestry	304	88
	Garvin et al. (2014)	U.S. Whites; US Blacks; medieval Nubians; Arikara Native Americans	499	74-94
	Lewis and Garvin (2016)	U.S White and Black	135	76.8-86.4

The skull can be a helpful sex indicator when present. Male skulls tend to have larger, more robust, and prominent skull morphology (White and Folkens 2005). The skull has been proven to become less reliable with age; males become more gracile, whilst females become more robust; therefore, post-cranial methods are more reliable (Meindl et al. 1985; Spradley and Jantz 2011). The skull was only used for sexing on those individuals who did not have an entire pelvic girdle, and a comparison technique was used alongside the sexing of the pelvis. The following sexual dimorphic traits were analysed and then scored out of 5, 5 being masculine and 1 being feminine: nuchal crest, mastoid process, supraorbital margin, supraorbital ridge, and the mental eminence (Walker 1994; Mays 1998; White and Folkens 2005). Table 4 shows there is a high degree of variation of accuracy when estimating sex using Walker's (1994) scoring of the skull. Similar to Phenice's method, geographical factors and a bias between females and males produce a less reliable accuracy.

3.1.5 Ancestry Estimation

A mix of non-metric cranial traits and craniometric techniques were used to estimate ancestry in the individuals that stood visually apart from the others. Table 4 shows the non-metric traits analysed following Hefner's (2009) score-based method. This method was only possible if the skull was present. Although metric techniques for ancestry estimation have been scientifically standardised, non-metric techniques are often favoured because they can be applied to fragmented assemblages (Hefner et al. 2012). Hefner (2009) highlights the issues with non-metric techniques in ancestry estimation, describing a "lack of a methodological approach" used within these methods. There are no error rates associated with ancestry prediction, and therefore he suggests such techniques have not been investigated with scientific and legal considerations. There is also the existence of extensive overlaps between many traits (Işcan and Steyn 2013). Another issue is that experience is vital in examining these traits, as an experienced observer is more likely to classify the traits more accurately (Brettell 2013).

Craniometric data for biodistance analyses could be collected from four complete skulls of the selected fifteen individuals. First, craniometric measurements (Table 5) were recorded using sliding and spreading callipers and then analysed using the database Fordisc3.1 (Jantz and Ousley 2005), with the help of Dr Sam Rennie (Bournemouth University). One must be aware that the accuracy of using Fordisc3.1 is higher in the US; this is because it was developed in the US, and therefore the database is mainly made up of forensic cases from North America, it performs better there than in other geographical regions (Dudzik and Kolatorowicz 2016; Cunha and Ubelaker 2019).

Fordisc3.1 uses a Discriminant Function Analysis (DFA), a set of statistical algorithms for determining the best way to separate groups and classify unknowns based on measurements (Jantz and Ousley 2005). Reference groups with known membership in some category, such as language family, ethnicity, sex, or tribe, are involved in all DFAs. In general, discriminant analyses should be done using all feasible groups that an unknown could be classified into at first, which may mean numerous groups in some circumstances (Jantz and Ousley 2005). The most dissimilar groupings should then be eliminated after several runs. The classification accuracy of a DFA is the best indicator of its quality. Leave-One-Out Cross-Validation (LOOCV) (Lachenbruch and Mickey 1968) is the most commonly recommended method for estimating classification accuracy (Jantz and Ousley 2005). In LOOCV, the first person in each of the reference groups is removed from that group. The parameters are recalculated using the remaining N-1 people. That person is then categorised into one of the reference groups using DFA. That person is then re-added to his or her original group, and the next person is removed from his or her original group and categorised, and so on. When all individuals have been classified in this way, the predicted unbiased classification accuracy is the total number of correctly classified persons (Jantz and Ousley 2005). Two statistics provide information about the unknown being classified once the classification accuracy is evaluated. The chance of membership for the unknown in each group based on the relative distances to each group is called posterior probabilities (PPs), and they sum to one. PPs are calculated in the same way as in the two-group instance but with additional distances between groups (Jantz and Ousley 2005). Fordisc3.1 presents three probabilities of typicality: Typ F represents the probability based on the F and Hotelling's T distributions (Hawkins 1981); Typ Chi represents the probability based on the Chi-square distribution, and Typ R represents the ranked probability. Depending on the number of variables utilised, the number of groups included, and the sample size of each group, each computation has advantages and disadvantages (Jantz and Ousley 2005).

Table 5 shows the landmarks which were measured on each individual for craniometric analysis. Table 6 shows the validation studies conducted using Fordisc3.0 and Fordisc3.1.

Table 5: Cranial landmarks measured for craniometric analysis (author's own 2021).

Abbreviation	Definition	Description of measurements
GOL	Glabella-occipital length	Distance between glabella (g) and opisthocranion (op)
BNL	Basion-nasion length	Distance between basion (ba) and nasion (n)
BBH	Basion-bregma height	Distance between basion (ba) and bregma (b)
XCB	Maximum cranial breadth	Max. width of the skull from euryon (eu) to eury (eu)
WFB	Minimum frontal breadth	Distance between the two frontotemporale (ft)
ZYB	Bizygomatic breadth	Distance between zygion (zy) and zygion (zy)
AUB	Biauricular breadth	Distance between both auriculare (au)
OBH	Orbital height	Distance between the superior and inferior orbital margins
OBB	Orbital breadth	Distance between dacryon (d) and ectoconchion (ec)
DKB	Interorbital breadth	Distance between both dacryon (d)
EKB	Biorbital breadth	Distance between both ectoconchion (ec)
FRC	Frontal cord	Distance between nasion (n) to bregma (b)
PAC	Parietal cord	Distance between bregma (b) and lambda (l)
OCC	Occipital cord	Distance between lambda (l) and opisthion (o)
NLH	Nasal height	Distance between nasion (n) to nasospinale (ns)
NLB	Nasal breadth	Distance between both alare (al)

Table 6: Validation studies regarding the use of Fordisc3.0 and Fordisc3.1 for ancestry estimation (author's own 2021).

Study	Fordisc Version	Population	No. Individuals	Classification Accuracy (%)	Notes
Elliott and Collard (2009)	3.0	Berg (Europe); Hokkaido Japanese (Asia); Santa Cruz (Americas); Tasmanians (Australia and Pacific); Zulus (Africa).	200	>70 if source population was included in reference sample; <40 if source population was not included in the reference sample.	Only when an unidentified specimen is more or less complete and belongs to one of the populations represented in FORDISC's reference samples is it likely to be beneficial.
Urbanová et al. (2014)	3.1	Japanese Brazilian, Afro-Brazilian, European Brazilian and admixed (mostly Afro-European admixture) ancestry.	174	44.5	Inconsistent findings amongst software applications were discovered when classifying Brazilians of mixed ancestry, most likely due to a lack of a suitable sample in the reference database. As a result, Fordisc3.1 is prone to misclassify the

					Brazilian samples as Hispanic or South Americans.
Dudzik and Jantz (2016)	3.1	Hispanic (Mexican; Guatemala; El Salvador; Nicaragua; Panama, *n=334);* Asian (Korea; Thailand; Japan, *n=319).*	653	49-53	When ancestral groups such as Whites and Native Americans are included in the analysis, the results suggest that Hispanics classify badly. The findings also back with reports that Hispanics are more likely to be misclassified as Asian.
Kranioti et al. (2018)	3.1	Mediterranean (Greek, Greek-Cypriot and Turkish)	677	74.1-97.9	Bias due to the potential lack of the target specimen's source population in the reference sample.

Ancestry is not the same as race. Işcan and Steyn (2013) describe race as a social construct rather than a biological one; however, they recognise that the social construct of race does have biological consequences such as selective mating, genetic drift, and institutional racism. However, if the region where an individual came from is established, it is argued that it does not equate to race, more geographical patterning (Brace 1995).

Table 7: The morphoscopic traits assessed for Hefner's (2009) non-metric technique (author's own 2021).

Morphoscopic Trait	References
Anterior nasal spine	Rhine (1990); Gill (1998); Hefner (2003).
Inferior nasal aperture	Krogman and Işcan (1986); Rhine (1990); Gill (1998); Hefner (2003).
Interorbital breadth	Bass (1987); Gill and Rhine (1990); Rhine (1990); Gill (1998); Hefner (2003).
Malar tubercle	Hauser and De Stefano (1989); Rhine (1990); Hefner (2003).
Nasal aperture width	Stewart (1979); Bass (1987); Rhine (1990); Hefner (2003).
Nasal bone contour	Gill (1998); Hefner (2003).
Nasal overgrowth	Rhine (1990); Hefner (2003).
Postbregmatic depression	Krogman and Işcan (1986); Bass (1987); Rhine (1990); Hefner (2003).
Supranasal suture	Hauser and De Stefano (1989); Hefner (2003).
Transverse palatine suture	Hauser and De Stefano (1989); Rhine (1990); Gill (1998); Hefner (2003).
Zygomaticomaxillary suture	Hauser and De Stefano (1989); Rhine (1990); Gill (1998); Hefner (2003).

The use of a visual non-metric technique like Hefner's (2009) (Table 7) should be limited to adult remains with comparative material available (White and Folkens 2005). The issue surrounding using a trait-based non-metric technique is the lack of geographical samples the traits represent. This is because only 'European', 'African', 'American-Indian' and 'Asian' are accounted for (within Hefner's 2009 study) while the rest of the geographical diversity of the world is not represented (White and Folkens 2005; Hefner 2014). Therefore, craniometric analysis was favoured for this research due to the broader variable samples available in Fordisc3.1's database. The morphoscopic analysis was used in conjunction with the results given by Fordisc3.1.

3.1.6 Stature Estimation

Stature was estimated by employing Trotter's (1970) metric technique. Callipers and an osteometric board were used to take the measurements of the humerus, ulna, radius, femur, tibia, and fibula. Due to Trotter's consistent mismeasurement of the tibia, the malleolus was not included in the measurements (Jantz et al. 1995). Once the measurements were taken, Trotter's (1970) equation was applied to work out stature estimations for the individuals. It is crucial when using this technique that the individual's ancestry is known; therefore, ancestry estimation was conducted first to use the correct formula. It was not always possible to measure each bone for each individual; however, the present bones were measured, and an average was taken.

3.1.7 Pathology

Pathological features were identified by analysing the bones and noting specific pathological indicators such as a change in shape, texture, or colour that was not the result of taphonomy (Işcan and Steyn 2013; Grauer 2012).

Some individuals' pathologies were highlighted by previous work (Boston 2013a; Skaar 2014; Wong 2014). In those cases, an analysis was conducted further upon whether one agreed with the author's verdict. Diagnosing pathology required consulting many resources (Lloyd 1965; Ortner 2003; Mann and Hunt 2005; Roberts and Manchester 2010; Grauer 2012; Horvai and Link 2012; White et al. 2012; Işcan and Steyn 2013; Lamb 2017) and discussing with supervisors for a different opinion in some cases. Differential diagnosis was also an essential factor to consider. Therefore, having a good understanding of how post-mortem changes such as taphonomy may have impacted the human remains, thus distinguishing between pathological and pseudopathological patterns (Fulcheri et al. 1986). Appleby et al. (2015) modified the *Istanbul Protocol* (UN 2004) to keep differential diagnosis consistent and established a diagnostic criterion with fixed terminology that best describes the trauma.

3.1.8 Identifying Trauma

Trauma was examined with a hands-on approach. For small lesions, a microscope was required, where pictures were also taken. Boston had previously highlighted some trauma (2013a); therefore, in those cases, an analytical approach was drawn upon whether one agreed on Boston's previous diagnosis or not. Trauma was also heavily researched by consulting peer-reviewed books and journals to understand each individual wound (Stirland 2005; White et al. 2012; Martin and Frayer 2014; Browner et al. 2015; Smith 2017).

3.2 Exhibition Building

3.2.1 Interpretive Master Plan

The theoretical framework underpinning the construction of the planned exhibition was drawn from recent museological publications dealing specifically with the presentation of human remains. The interpretive master plan was modelled from the Smithsonian's 'a guide to exhibit development' (2018). It can be viewed as a triangle split into three parts that flow fluidly into one another (Figure 1). The interpretive master plan underpins and holds the museum exhibition together.

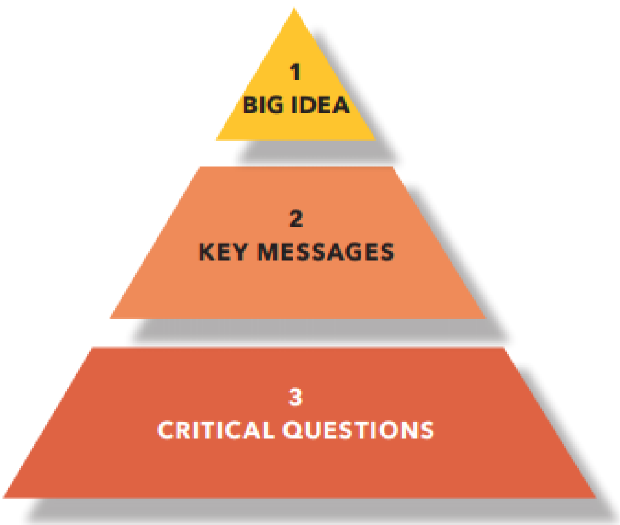

Figure 1: Interpretative master plan represented as a diagram (Smithsonian Exhibits 2018, pg. 7).

The interpretive master plan achieved a solid foundation to build the museum exhibition. The overall plan stemmed from the 'big idea', which pinpointed the ‘key messages’ that this exhibition answered and the critical questions that the exhibition needed to answer. These models are used to help promote and optimise learning and understanding. For example, suppose the ‘big idea’ is clear. In that case, the ‘key messages’ can be formed around that to maximise engagement and thus, the ‘critical questions’ can then be formed around the ‘key messages’ to ensure fluidity in the exhibition.

It was crucial to plan out the exhibition script to ensure it was readable and understandable for the general public. Therefore, the approach involved consulting the Smithsonian exhibit guide (2018) and focusing on script formatting and writing. The script formatting involved creating a draft script on excel for each panel and planning out which words to use to be understandable and easy to read for the public. The text was the optimal length for a visitor standing and visiting the exhibition reading the panels. It is vital to get the text right because it is the primary tool that will educate the public.

3.2.2 Human remains on display

Displaying human remains will always draw attention from the public because we are fascinated by bodies. Bodies offer windows into the past that other archaeological finds do not. They are the personification of the past. They bring us face to face with history because they are the mortal remnants of the exact individuals who created and lived in the past (Sofaer 2006b). Because of the power of human remains, these remains were displayed to teach the public.

Brooks and Rumsey (2008) highlighted the point that it is necessary to evaluate not just the display of human remains but also the accompanying narrative and interpretation. Therefore, the information accompanying the individuals on display needed to be factual, truthful, and informative. This was a fundamental principle when planning the exhibition. Brooks and Rumsey (2006) claim that practises regarding the display of human remains are constantly changing; relevant guidelines such as the Department for Digital, Culture, Media and Sport’s (DCMS) guidance for the care of human remains in museums’ (2005) were consulted throughout the process of displaying human remains.

The creation of the ‘Forgotten Heroes’ exhibition has led to the careful consideration of how the public views the human remains whilst maintaining creative and ethical standards, allowing the viewers the space to voice their opinion in the form of feedback ensures their concerns or debate are heard (Brooks and Rumsey 2007). Visitors' ideas of what a museum should present are crucial in determining what society finds acceptable in displaying – therefore, the public must be given a voice to benefit the future of the heritage sector (Swain 2002; Kilminster 2003). The following resources were the principles that were followed in creating the exhibition and displaying the human remains: The Vermillion Accord (1989); DCMS' guidance of care (2005); Museum's Association code of ethics (2015), and BABAO's code of ethics (2019).

3.2.3 Description of Feedback Statistical Analysis

Cronbach (1970) alpha is one of the most frequently reported internal consistency estimates. It gives a good under-estimate (that is, a conservative or safe estimate) of a set of test results' reliability. Cronbach alpha is used to calculate the amount of variance in a set of test scores that is systematic or consistent. It can be anywhere between 00.0 (if no variance is consistent) and 1.00 (if all variance is consistent), with any value in between (Cronbach 1970). Cronbach alpha was used for testing the reliability of feedback statistics. Means and percentile were used for the rest of the feedback statistics.

4 Results

Firstly, desk-based research was undertaken regarding the archaeological excavation of the Athenaeum Place collection in 2007. Further to accessing published articles regarding the excavation, some original excavators were contacted, which helped provide further insights. At the same time, additional supporting information was obtained from the Plymouth archive office, '*The Box*'.

Attention was then focused upon the former Royal Naval Hospital, Stonehouse, where histories of the hospital were consulted (Howard 1784; Etherington 1962; Pugh 1972). Numerous guides were consulted regarding the museum exhibition when designing the exhibition, such as the Smithsonian exhibit guide (2018). The use of human remains in other exhibitions was also explored. The history of skeletal remains on display to the public through books and journals has been discussed in the background chapter.

Laboratory analysis started in October 2020 and continued until May 2021; due to the third national lockdown regarding Covid-19, lab time was lost in January and February. Therefore, more time was spent in the lab in March-May 2021 to compensate for the lockdown.

4.1 Skeletal analysis

4.1.1 Age Estimation

The fifteen individuals selected for osteobiographies range from sub-adult to young adult, middle adult, and older adult and were analysed by the author. Table 8 shows that two out of the fifteen individuals' age could not be estimated; one skeleton only has its skull present (Sk. 100). The other individual did not have an intact enough pelvis for ageing (Sk. 547).

Table 8: The fifteen individuals selected for the creation of osteobiographies and their estimated age (author's own 2021).

Skeleton	Estimated Age (yrs)	Age Category	Method
Sk. 100	N/A	N/A	N/A
Sk. 523	16-19	Sub-Adult	Epiphyseal Fusion (Schaefer et al. 2009; Cunningham et al. 2016); Auricular Surface (Buckberry and Chamberlain 2002).
Sk. 547	Older than 21	Adult	Epiphyseal Fusion (Schaefer et al. 2009; Cunningham et al. 2016).
Sk. 551	40	Old Adult	Pubis Symphysis (Brooks and Suchey 1990); Auricular Surface (Buckberry and Chamberlain 2002).
Sk. 581	20-30	Young Adult	Auricular Surface (Buckberry and Chamberlain 2002).
Sk. 605	20-30	Young Adult	Cranial Suture (Meindl and Lovejoy 1985); Auricular Surface (Buckberry and Chamberlain 2002).
Sk. 617	40-50	Old Adult	Pubis Symphysis (Brooks and Suchey 1990); Auricular Surface (Buckberry and Chamberlain 2002).
Sk. 624	11-13	Sub-Adult	Epiphyseal Fusion (Schaefer et al. 2009; Cunningham et al. 2016); Pubis Symphysis (Brooks and Suchey 1990); Auricular Surface (Buckberry and Chamberlain 2002).
Sk. 633	20-30	Young Adult	Pubis Symphysis (Brooks and Suchey 1990); Auricular Surface (Buckberry and Chamberlain 2002).
Sk. 648	16-18	Sub-Adult	Epiphyseal Fusion (Schaefer et al. 2009; Cunningham et al. 2016); Auricular Surface (Buckberry and Chamberlain 2002).
Sk. 651	18-20	Sub-Adult	Epiphyseal Fusion (Schaefer et al. 2009; Cunningham et al. 2016); Pubis Symphysis (Brooks and Suchey 1990); Auricular

			Surface (Buckberry and Chamberlain 2002).
Sk. 677	8-14	Sub-Adult	Epiphyseal Fusion (Schaefer et al. 2009; Cunningham et al. 2016); Diaphyseal Length (Maresh 1970; Gindhart 1973).
Sk. 757	40-65	Old Adult	Pubis Symphysis (Brooks and Suchey 1990); Auricular Surface (Buckberry and Chamberlain 2002).
Sk. 844	26-38	Middle Adult	Pubis Symphysis (Brooks and Suchey 1990); Auricular Surface (Buckberry and Chamberlain 2002).
Sk. 875	30-40	Middle Adult	Pubis Symphysis (Brooks and Suchey 1990); Auricular Surface (Buckberry and Chamberlain 2002).

Figure 2 shows that thirteen of the individuals chosen (that could be aged) are likely to be sub-adults at the time of their death. There were equally as many older adults (40+ years) as there were young adults (20-30 years), and middle adults (30-40 years) made up the least of the thirteen.

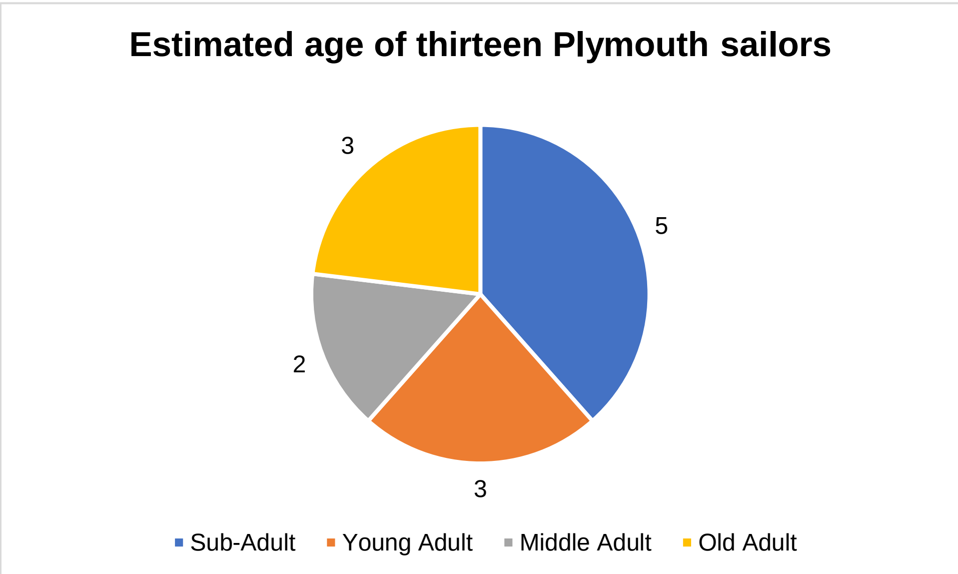

Figure 2: Graph representing the estimated age of thirteen Plymouth sailors (author's own 2021).

Figure 3 shows the estimated age (represented as a number of individuals) of all individuals from the ninety-one individuals recorded in the lab. These results reflect only the individuals where age could be estimated from the pelvic region or through epiphyseal fusion. Therefore, out of the ninety-one initially examined (including the chosen fifteen individuals), fifty-two were estimated an age.

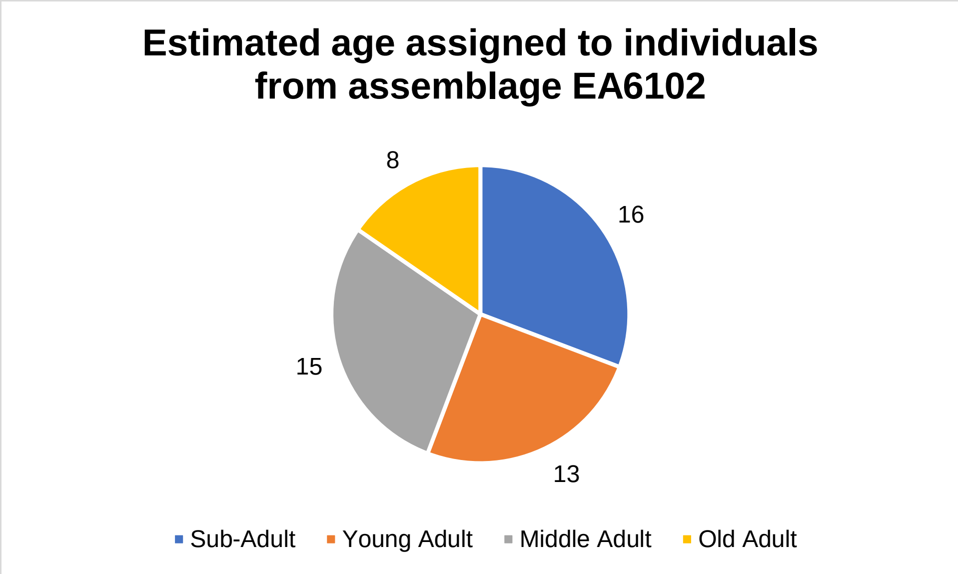

Figure 3: Pie graph representing the estimated age assigned to individuals from the Plymouth assemblage (author's own 2021).

In comparison to Figure 2, this graph shows that the overall assemblage (represented as a number and not a percentage) has an equal age range represented overall. There are fewer older individuals in the assemblage, so sub-adults and middle adults dominate the assemblage. However, young adults are also represented well among this assemblage.

4.1.2 Sex Estimation

Table 9 shows the results of the sex estimation of the fifteen individuals selected for the osteobiographies. All of the sex estimates that could be assigned were all likely male; they all seemed to have relatively robust and masculine features. The sex for individuals Sk. 523, 624, 648, 651 and 677 could not be estimated due to those being sub-adults (Schaefer et al. 2009; Cunningham et al. 2016).

Table 9: Sex estimation of the fifteen individuals selected for the creation of osteobiographies (author's own 2021).

Skeleton	Sex Estimation	Method
Sk. 100	Likely Male	Cranial traits (Walker 1994; Mays 1998; White and Folkens 2005). No post-cranial elements present.
Sk. 523	N/A	N/A
Sk. 547	Likely Male	Cranial traits (Walker 1994; Mays 1998; White and Folkens 2005).
Sk. 551	Likely Male	Cranial traits (Walker 1994; Mays 1998; White and Folkens 2005); Pelvic traits (Phenice 1969; Mays 1998; White and Folkens 2005).
Sk. 581	Likely Male	Pelvic traits (Phenice 1969; Mays 1998; White and Folkens 2005).
Sk. 605	Likely Male	Cranial traits (Walker 1994; Mays 1998; White and Folkens 2005); Pelvic traits (Phenice 1969; Mays 1998; White and Folkens 2005).
Sk. 617	Likely Male	Cranial traits (Walker 1994; Mays 1998; White and Folkens 2005); Pelvic traits (Phenice 1969; Mays 1998; White and Folkens 2005).
Sk. 624	N/A	N/A
Sk. 633	Likely Male	Cranial traits (Walker 1994; Mays 1998; White and Folkens 2005); Pelvic traits (Phenice 1969; Mays 1998; White and Folkens 2005).
Sk. 648	N/A	N/A
Sk. 651	N/A	N/A
Sk. 677	N/A	N/A
Sk. 757	Likely Male	Cranial traits (Walker 1994; Mays 1998; White and Folkens 2005); Pelvic traits (Phenice 1969; Mays 1998; White and Folkens 2005).
Sk. 844	Likely Male	Cranial traits (Walker 1994; Mays 1998; White and Folkens 2005); Pelvic traits (Phenice 1969; Mays 1998; White and Folkens 2005).
Sk. 875	Likely Male	Cranial traits (Walker 1994; Mays 1998; White and Folkens 2005); Pelvic traits (Phenice 1969; Mays 1998; White and Folkens 2005).

Figure 4 shows that most of the fifteen individuals chosen were likely male, and five of the individuals could not be estimated a sex due to the immaturity of the bones. These results are what one would expect from a Royal Naval assemblage from the eighteenth century.

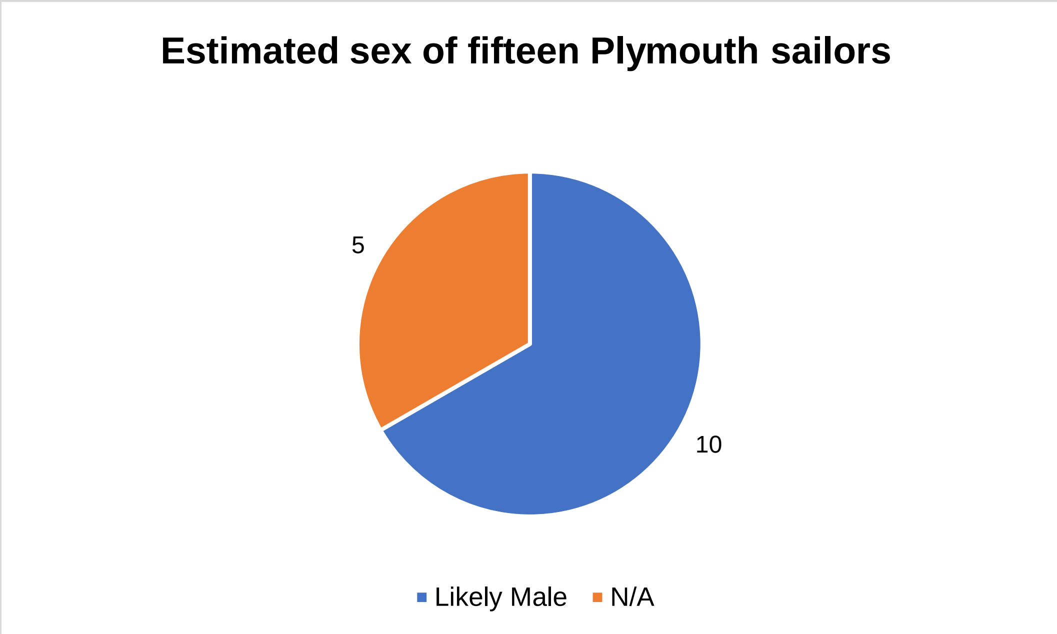

Figure 5: Pie graph representing the estimated sex of the selected fifteen individuals from the assemblage (author's own 2021).

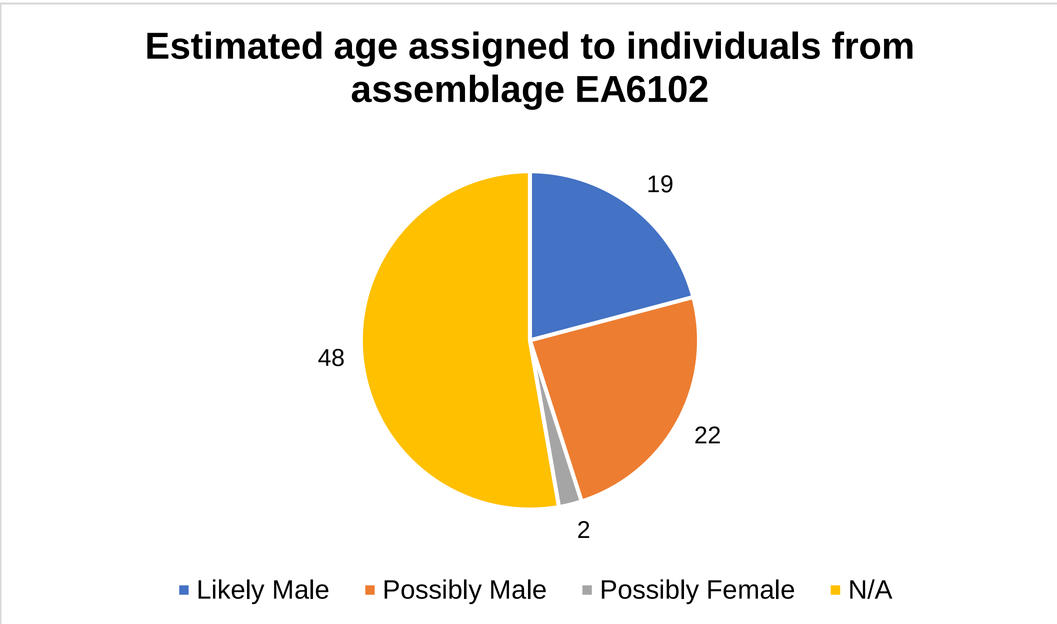

Figure 4: Pie graph summarising the age estimation of individuals from the Plymouth assemblage (author's own 2021).

Figure 5 shows the estimated sex of all individuals from the ninety-one individuals recorded in the lab. These results show that most of the assemblage could not be assigned a sex due to sub-adult age and high fragmentation to the pelvic and cranial regions. However, these results show that likely and possible males dominate the assemblage; only two skeletons showed feminine traits.

4.1.3 Ancestry

4.1.3.1 Results from Fordisc3.1 (Forensic Databank sample – 20th Century sample)

Four skulls were intact enough for craniometric analysis. The craniometric data was first run on the Fordisc3.1 programme, using the forensic database sample. Table 10 summarises the results from Appendix I. This table depicts the posterior probability of the individual being from a particular sample base. Fordisc3.1 results from the forensic database suggest that the four individuals were most likely either of African, Asian or South American descent.

Table 10: Ancestry results from Fordisc3.1 (Forensic database sample) summarised (author's own 2021).

	Sk. 100	Sk. 605	Sk. 617	Sk. 757
Black Male	-	-	38.80%	**47.30%**
Chinese Male	-	**53.70%**	-	-
Guatemalan Male	**69.70%**	-	**61.20%**	-
Hispanic Male	30.30%	-	-	15.80%
Japanese Male	-	24.30%	-	-
Vietnamese Male	-	22%	-	-
White Male	-	-	-	36.90%

4.1.3.2 Results from Fordisc3.1 (Howells Dataset – Historical & Archaeological sample)

The craniometric measurements were then run through the Howells database on Fordisc3.1, where the samples are made up of archaeological and historical content. Table 11 reflects the posterior probability of the individual being from a specific sample base. This table shows that the Fordisc3.1 results from the historical and archaeological database suggest that the four individuals were most likely either of African, Asian or South American descent.

Table 11: Results from Fordisc3.1 (Howells's dataset) summarised (author's own 2021).

	Sk. 100	Sk. 605	Sk. 617	Sk. 757
Andaman Island Male	-	-	8.00%	-
Black male (19th century)	-	-	**86.30%**	38.00%
Black Male (20th century)	-	-	-	**62.00%**
Dogon (Mali) Male	-	-	3.30%	-
Egyptian Male	-	**62.20%**	-	-
Guatemalan Male	32.50%	-	1.10%	-
Hainan (Chinese) Male	23.00%	-	-	-
Hispanic Male	-	-	-	-
Peru Male	-	-	-	-
Teita (Kenya) Male	**44.50%**	-	0.70%	-
White male (19th century)	-	-	0.10%	-
Zalavar (Hungary Male)	-	37.80%	-	-
Zulu Male	-	-	0.50%	-

4.1.3.3 Results from craniomorphological analysis using HefneR

Hefner's (2009) definitions were used to score the skull, which was then analysed using the HefneR web interface (www.osteomics.com/hefnerR/). A Simple Bayesian Classifier model with Conditional Independence was built after rating 11 morphological characteristics of the cranium. Table 12 summarises the craniomorphological analysis of the six individuals who were able to be assessed. The craniomorphological results suggest that neither individual has the skull morphology of a European.

Table 12: Results summarised from the HefneR analysis (author's own 2021).

	African	American Indian	Asian	European
Sk. 100	**48.32%**	12.67%	38.56%	0.44%
Sk. 523	**44.62%**	22.58%	31.86%	0.93%
Sk. 605	9.00%	21.37%	**69.15%**	0.46%
Sk. 617	34.71%	10.76%	**52.60%**	1.92%
Sk. 633	**72.67%**	11.79%	12.66%	2.86%
Sk. 757	**85.26%**	2.02%	12.08%	0.63%

4.1.4 Stature Estimation

The fifteen individuals selected for osteobiographies were given stature estimations. However, Table 13 shows that out of the fifteen, five individuals could not have their stature estimated due to their young age.

Table 13: Stature estimation summarised of the ten individuals who could be assessed (author's own 2021).

Skeleton	Height (ft)	Height (cm)
Sk. 547	5ft 5"	167.49
Sk. 551	5ft 8"	176.61
Sk. 581	5ft 7"	175.98
Sk. 605	5ft 4"	164.44
Sk. 617	5ft 4"	163.41
Sk. 633	5ft 3"	162.47
Sk. 651	5ft 8"	176.07
Sk. 757	5ft 3"	160.60
Sk. 844	5ft 6"	171.30
Sk. 875	5ft 3"	162.32

Figure 6 shows the variability among the rest of the assemblage's stature and where the ten individuals fit into the graph; the tallest individual is 176.61cm tall, whereas the shortest individual is 160.60cm tall. Some of these results correspond with the British stature of the eighteenth-century in males, where the average stature of a military man for this time was 167.5 cm to 169.5cm

(Steegmann 1985). However, Steegmann (1985) proposes that men were selectively recruited depending on their height, and this could be why the height range for military men of this time is narrow compared to the sailors who seem to vary in height. Steegmann (1985) also suggests that height may be impacted by variable factors such as environmental temperature, available diet, and genetics. These results conclude that taller men were selected for the Navy just as likely as shorter men were, despite the ships being constructed for shorter stature. As many sailors began their careers as children, their adult stature cannot be estimated.

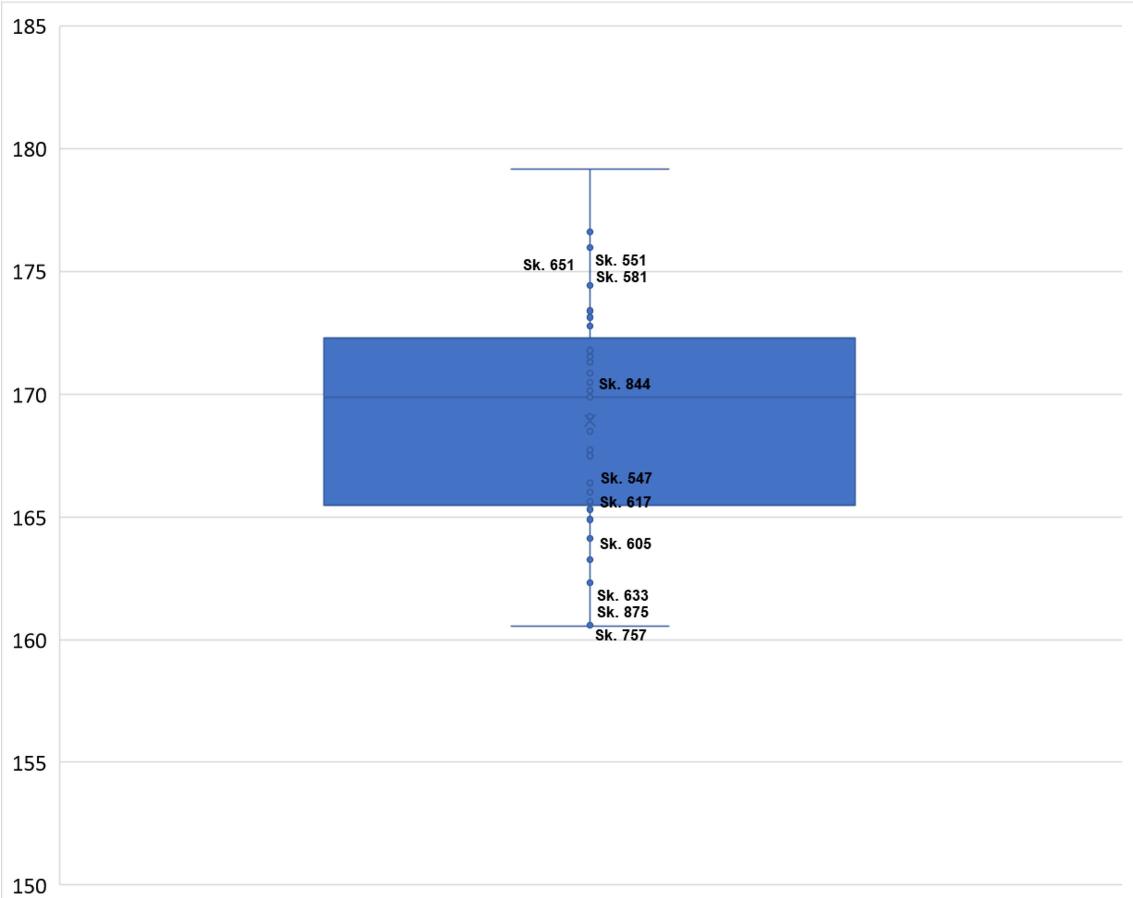

Figure 6: Stature variability among the Plymouth assemblage (author's own 2021). **Please note this diagram was created before the ancestry analysis was carried out on three of the individuals and therefore the points of individuals Sk. 605, 617 and 757 are now incorrect.**

As it was impossible to estimate ancestry for most of the assemblage due to poor cranial preservation, the stature formula for White Europeans was used. Population-specific formulae were applied on three of the individuals with non-European ancestry who, oddly enough, were also the only individuals with intact enough crania for Fordisc3.1 ancestry estimation. The differences in mean stature are concluded in Table 14. The dramatic difference in the stature of Sk. 617 between the European-American and African-American formulas highlight the importance of knowing the provenance of the individual where possible; if the ancestry analysis is correct in this case, this individual is much shorter than previously thought. Instead of being around 5ft 4-5inches, this individual was actually around 5ft 3inches. To increase the accuracy in stature estimations, ancestry analysis is crucial.

Table 14: Re-estimation of stature due to the results of ancestry analysis (author's own 2021).

	Height (cm) EU-AM Formula	**Height (cm) AF-AM Formula**	**Height (cm) EA Formula**
Sk. 605	164.27	-	164.44
Sk. 617	166.37	163.41	-
Sk. 757	160.60	160.60	-

4.1.5 Trauma and Pathology

The fifteen individuals selected for osteobiographies were analysed in the lab regarding trauma and pathology. Table 15 summarises all the pathological conditions and trauma detected on these individuals. The most common pathological condition evident in seven individuals was the ‘orange-peel’ like porosity to the ectocranial surface. For a complete analysis of the pathology for these individuals, see the full osteobiographies in Appendix I.

Table 15: The trauma and pathology of the selected fifteen individuals summarised (author's own 2021).

	Trauma	**Pathology**
Sk. 100	• Healed depressed fracture to the frontal bone, 1cm.	• Asymmetrical cranium, enlarged mastoid processes and 'twisted' and asymmetrical C1 and C2 vertebrae, likely Muscular Torticollis.

Sk. 523	• Healed depressed fracture to the right parietal bone, 2cm.	• Remodelled bone growth to maxillary sinuses. • Orange-peel like porosity to the ectocranial surface. • Active periostitis to the right rib.
Sk. 547	• Healed amputation to the right femur, midshaft. • Healed crush fracture to the first metatarsal on the left foot.	• Orange-peel like porosity on the ectocranial surface. • Porous texture to the right maxillary sinus. • Healed periostitis to the left tibia.
Sk. 551	• Soft tissue lesion to the first metacarpal on the right hand. • Healed fracture to the right patella.	• Orange-peel like porosity to the ectocranial surface. • Holes in sacrum and vertebrae spanning T10-L3, likely tuberculosis. • Healed periostitis to the right tibia and fibula.
Sk. 581	• Fine cutmarks to C5 consistent with decapitation. • Fine cutmarks to the manubrium, x3 rib shafts and right scapula, possible radical forequarter resection. • Healing Bennett fracture to the first metacarpal of the right hand. • Healed impaction fracture to the right acetabulum. • Unhealed fracture to the first proximal phalanx on the right foot.	• Porous lesions to the anterior aspect of the femoral neck, likely Cribra femoris (both femurs).
Sk. 605	-	• Orange-peel like porosity to the ectocranial surface. • New bone growth on the posterior of the maxilla. • Healed periostitis on the left and right tibia.

Sk. 617	• Healed fracture to an unsided rib. • L1 healed wedge fracture.	• Orange-peel like porosity to the ectocranial surface. • Healed periostitis to the tibiae. • Lumbarisation of the lumbar vertebrae. • Os acromiale to the right scapula.
Sk. 624	• Small bones for the estimated age of the individual, possible stunted growth. • Unhealed amputation to the proximal left tibia.	• Remodelled bone on the maxillary sinuses. • Active periostitis on the left tibia and fibula.
Sk. 633	• Healed fracture to the right side of the mandible and left parietal bone. • Healed compound fracture to the right humerus. • Healed fracture to the third metacarpal and distal phalanx on the right hand. • An unhealed potential projectile fracture to the right ilium. • Fine cutmarks on the left ilium. • Unhealed amputation to the right femur, midshaft.	• Osteomyelitis on the right side of the mandible. • Abscess on the right side of the hard palate. • Orange-peel like porosity to the ectocranial surface.
Sk. 648	-	• New bone growth on both frontal orbits, likely Cribra orbitalia. • Osteochondritis dissecans to the left humerus' capitulum. • Lesions to both glenoid cavities on the scapulae show possible osteochondritis dissecans. • Slight bowing of the left tibia.
Sk. 651	• Perimortem projectile trauma to the occipital bone, 1cm.	• Healed periostitis to both femora and right tibia.
Sk. 677	-	-

Sk. 757	• Healed fractures to both nasal bones. • Depressed lesion in the frontal bone, 0.5cm. • Healed fracture to the left acetabulum rim, 1cm. • Unhealed shepherd's fracture to right talus.	-
Sk. 844	• Healed sharp force trauma in the right temporal bone. • Healed crush-like fracture to the first distal phalanx on the right foot.	• Multiple active periostitis elements on the cranium, such as new bone growth on the left orbit, known as Cribra orbitalia and on the endocranial surface. • Thickened skull. • Active periostitis in the left rib. • Mild bowing in the tibiae and fibulae.
Sk. 875	• Unhealed amputation to the left femur, midshaft.	• Orange-peel like porosity to the ectocranial surface. • Abscess in the frontal diploe and sinuses. • New bone growth on the mandible. • Active periostitis on the right rib. • The left and right tibiae show signs of healed periostitis.

Figure 7 shows the prevalence of ‘orange-peel’ porosity (porotic hyperostosis) among the ninety-one individuals that were analysed. The graph shows that despite the porosity being shared among the fifteen selected individuals, most of the sample size did not have porotic hyperostosis on the crania.

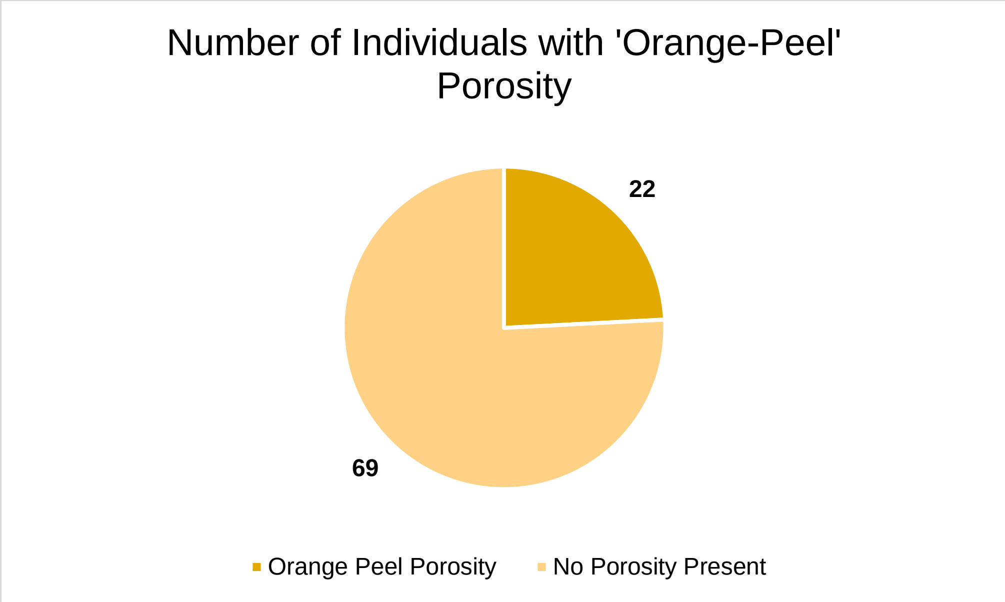

Figure 7: Pie graph depicting the number of individuals with 'orange-peel' porosity (author's own 2021).

Diagnosing the prevalent porotic hyperostosis is summarised in Table 16 (Ortner 2003). The table shows that the likely cause of the lesions present on the Plymouth assemblage is either an iron deficiency anaemia or scurvy, which can occur in cases where anaemia is present.

Table 16: Summary of diagnosing Porotic Hyperostosis based on Ortner (2003) (author's own 2021).

Lesion	Potential Cause	Present	Not Present
Porotic Hyperostosis	Scurvy	• It can occur in cases where anaemia is present, similar lesions to that of marrow hyperplasia. • Subperiosteal haemorrhages are common on the frontal bone and particularly on the portion that forms the orbital roof.	-

	Sickle-cell Anaemia	• Lesions on the cranial vault.	• Marrow enlargement of the diploe.
	Iron Deficiency Anaemia.	• Lesions on the skull vault, primarily parietal and the orbital roof. It consists of porous, periosteal bone formation in these areas of the skull. • Long bones are not affected.	-
	Thalassemia	• Lesions on the cranial vault.	• The genetic presence at the time in Europe. • Bone, skull and post-cranial bone abnormalities.
	Rickets	• Lesions on the cranial vault.	• Bowing of long bones.
	Marrow Hyperplasia	• The affected area involves the frontals, including the orbital roofs, but predominantly involves the outer table of the parietal bones; the inner table is not affected.	• Deformation of occipital patterning. Labyrinth-like lesions. • Long bones are affected by the porosity.

The most likely cause of porotic hyperostosis is a diagnosis of scurvy (Table 17). Not only do the lesions resemble that of a scurvy diagnosis, but due to circumstantial evidence, it is well documented that scurvy was rampant in the Royal Navy before the commissioning of lemon juice in 1805 (Lind 1753; Rodger 1986). However, differential diagnoses include iron deficiency anaemia, marrow hyperplasia and in some cases (Sk. 648; 844), where bowed long bones are involved, the porotic hyperostosis is likely attributed to rickets rather than scurvy, or both (Ortner 2003; Waldron 2009).

Table 17: Characteristic signs of a scurvy diagnosis based on Waldron (2009) (author's own 2021).

	Characteristic signs
Scurvy (Waldron 2009).	• Radiological signs at the epiphyses sometimes with enlarged, porous epiphyses.
	• Deposits of periosteal new bone on the skull.

Periostitis was also common among the fifteen individuals selected, and Figure 8 shows that it was common among the ninety-one-sample size. Healed periostitis was more prevalent than active periostitis; however, they are represented almost evenly.

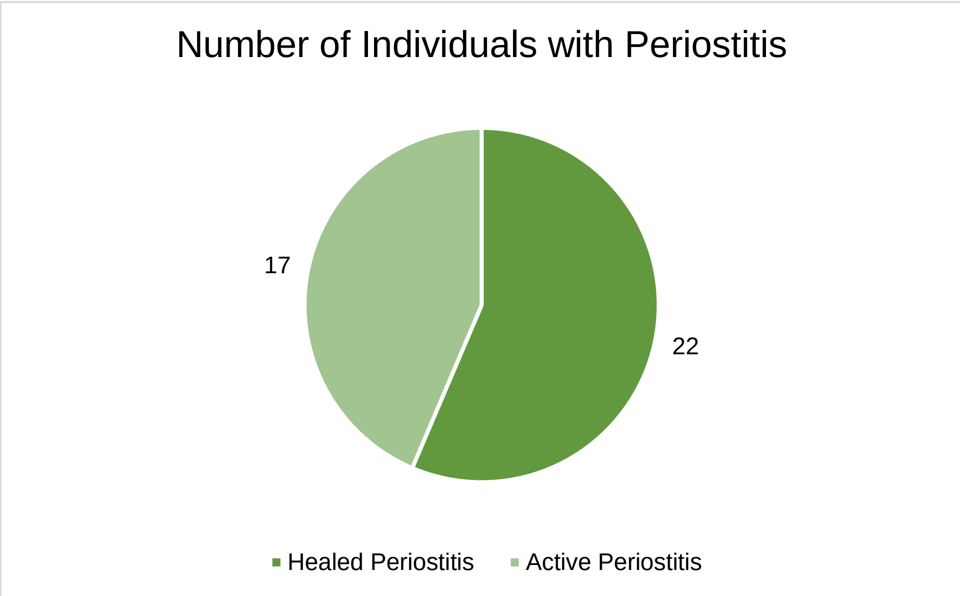

Figure 8: Pie graph depicting the number of healed and unhealed periostitis cases in the assemblage (author's own 2021).

The causes of periostitis could be a variety of things; Table 18 summarises the potential causes. Comparing the causes of periostitis with that of the causes of porotic hyperostosis in the skull, immediately scurvy and rickets stand out as the symptoms for these are present in both cases. Therefore, scurvy could be a plausible diagnosis for the periosteum new bone growth, and rickets, tuberculosis and syphilis could be differential diagnoses. However, the cause is unlikely to have been a tumour due to 39 individuals displaying similar periosteal patterning. In osteomyelitis (Waldron 2009), the patterning does not seem to reflect the symptom. Therefore, due to the number of individuals with similar lesions, it is far more likely to be attributed to a vitamin deficiency because they had the same diet. As mentioned before, circumstantial evidence with this assemblage points to a vitamin-C deficiency, scurvy.

Table 18: A summary of diagnosing periostitis causes (author's own 2021).

Lesion	Potential Cause	Symptom
Periostitis	Osteomyelitis	The bone may grow in size, and drainage channels form. Pus drains from the bone to the outside via sinuses created in the soft tissues overlying the bone. In addition, the presence of organisms beneath the periosteum drives the production of new bone, which can be highly vigorous, generating a thick sheath of new bone around the infected bone's shaft.
	Syphilis	A common symptom of syphilis and can present early on. It is most noticeable on bones at the surface, such as the tibia, frontal bone, ribs, and sternum; however other bones may also be affected. Lesions are most evident on the frontal bone.
	Scurvy	A line of new bone may be visible around the subperiosteal haemorrhage. In addition, the exterior surface of the skull can also become bossed due to periosteal new bone deposits.
	Rickets	Periosteal new bone formation can appear in rickets alongside the bowing of long bones such as the tibia.

	Malignant Tumours	As the tumour grows in size, the thickness of the periosteal layer will thicken. A quickly developing tumour, such as an osteosarcoma, may lift the periosteum, resulting in a triangular elevation (Codman's triangle) and the creation of new bone beneath the elevated periosteum. Typically affects the long bones.
	Tuberculosis	New bone growth on the inner surface of the ribs.

The number of individuals who sustained fractures, healed or unhealed, is presented in Figure 9. Again, these results represent the ninety-one individual sample size. A surprising number of unhealed fractures compares to healed fractures which may be likely due to the individual succumbing to death before the fracture could heal.

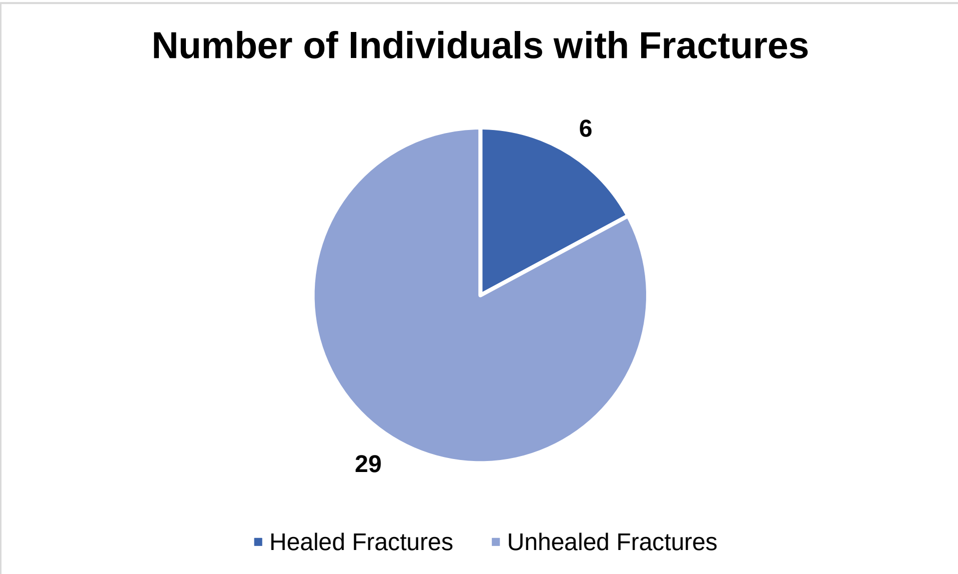

Figure 9: Pie graph depicting the number of individuals with healed and unhealed fractures in the assemblage (author's own 2021).

Figure 10 shows the representation of other types of trauma and lesions evident among the ninety-one individuals. These lesions are not as common as those previously mentioned; however, at least twelve individuals had evident orbital lesions.

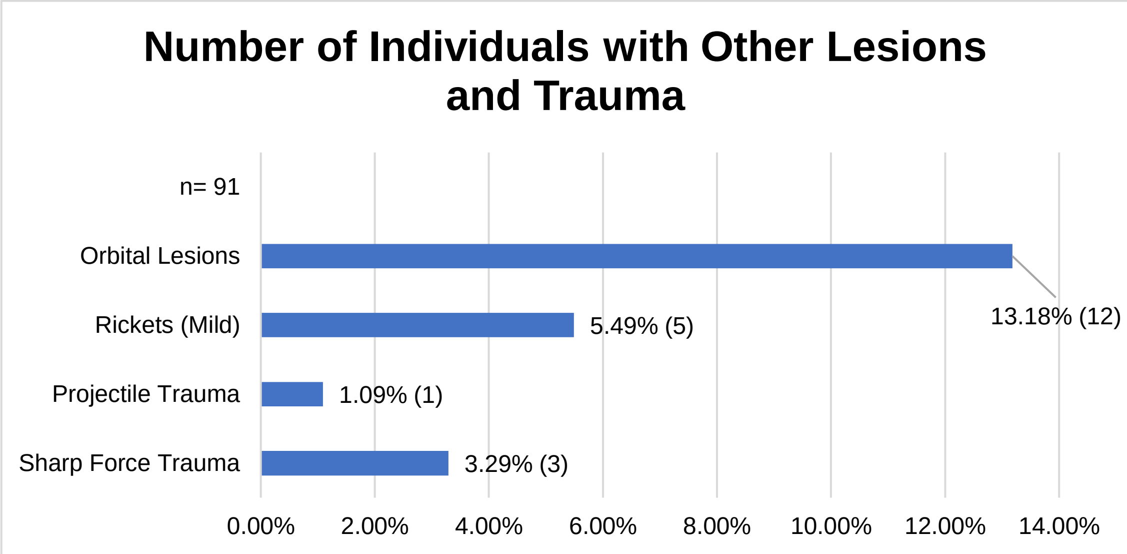

Figure 10: Graph representing the other types of trauma and lesions diagnosed in the assemblage (author's own 2021).

4.2 The Creation of an Exhibition at the Atrium, BU

The interpretative master plan (Table 19) was the foundation from which the museum exhibition was created. It stayed at the pivotal point of the planning stage. Having a master plan helped keep the focus in place. It made sure that the exhibition answered the critical questions and covered the purpose of why it was created in the first place, to present this valuable collection to the public and to educate the public whilst doing so.

Table 19: The interpretive master plan (author's own 2021).

1. Big Idea	What do we know about eighteenth-century sailors? This exhibition aims to highlight what a vital and taxing role sailors in the past did and offer the public an insight into maritime archaeology from the remains of those who served in the British Navy. Without using these human remains on display and creating osteobiographies, the exhibition would not have been the same.
2. Key Messages	• The importance of osteobiographies to be included with historical accounts and documents; bones do not lie, but they can be misdiagnosed.
	• The use of human remains causes emotive responses; therefore, it is far more beneficial to create an exhibition with the skeletal remains on show than with written accounts about the Navy. In addition, it will grab the public's attention.
	• The remains of sailors who died in active service are rare; therefore, this exhibition is important.
3. Critical Questions	• Where were the sailors excavated, and why were they buried there?
	• How do these sailors relate to Lord Admiral Nelson?
	• Why were the individuals on display chosen?
	• Who were the sailors?
	• Does the analysis of their bodies support the historical accounts of the eighteenth-century Navy?

Throughout March and April 2021, the planning for the exhibition at the BU Atrium gallery took place once it was given the go-ahead in March. The process of how the exhibition was assembled is summarised in the flowchart in Figure 11. The flowchart expands on the six crucial steps which were expanded up to create the exhibition. These steps included: location approval (1), selection of contents (2), exhibition script (3), design content (4), source artefacts (5) and assembling the exhibition (6).

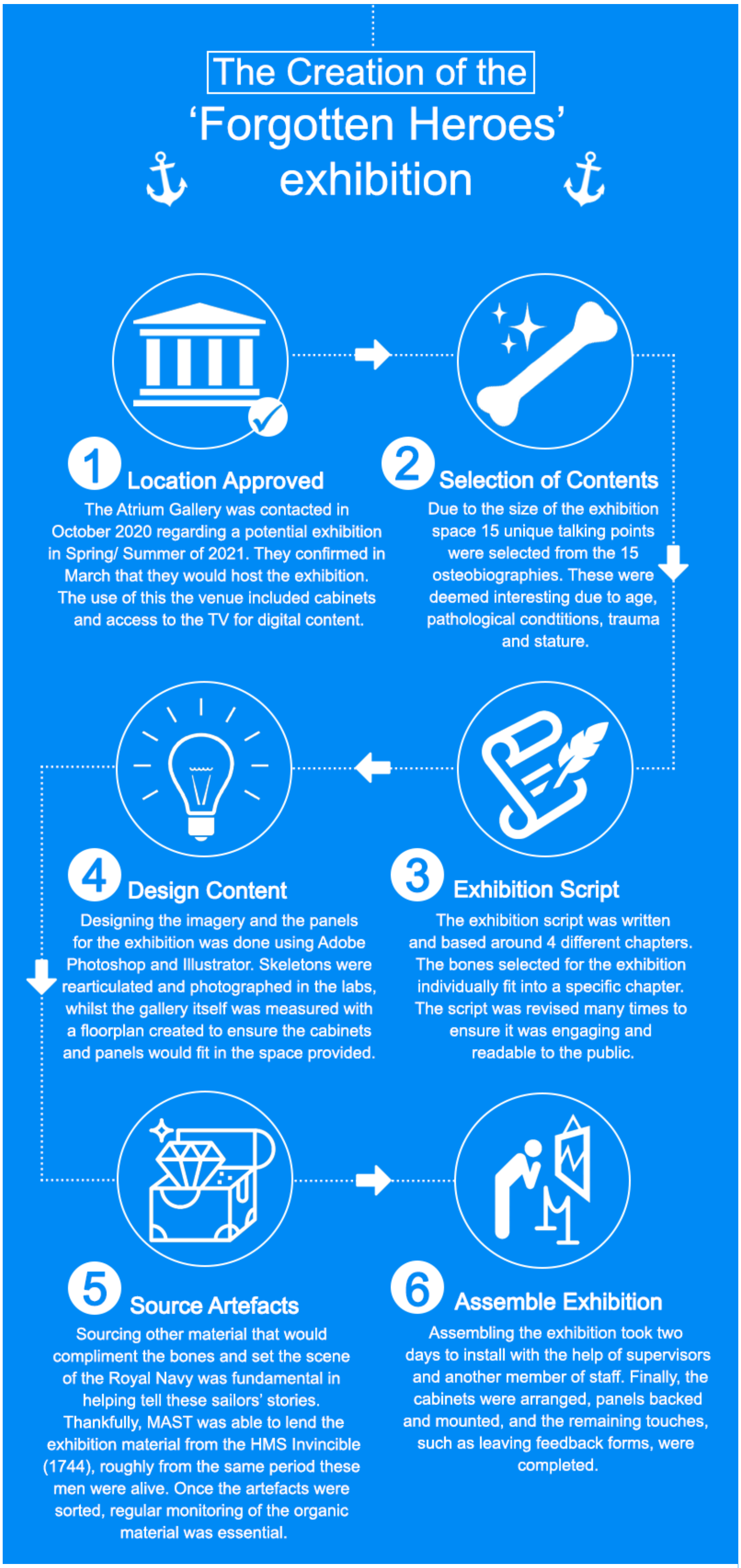

Figure 11: Flowchart depicting the process of designing and assembling the exhibition (author's own 2021).

4.2.1 Location Approval and Cabinets

The choice of venue for the theoretical exhibition seemed, in one instance, obvious. The ideal location would be a museum close to the university, such as Dorchester Museum, or somewhere close to Plymouth, such as The Box in Plymouth. However, due to the national importance of these human remains, venues such as the National Maritime Museum in Greenwich or the National Museum of the Royal Navy were also a good possibility.

The exhibition at Bournemouth University's Atrium Gallery is not only a good test for the broader, theoretical one, but if it captures the public's interest, there is no reason why it could not be loaned out to several locations rather than becoming a fixed exhibition at a single place, maximising public participation. The Atrium was contacted in October 2020 and was booked and finalised with a booking confirmation and an approved risk assessment in April 2021.

Cabinets are an essential consideration for any exhibition which is displaying artefacts and archaeological material. Before the venue was established, the decision of cabinets was subjective. Firstly, the possibility of renting cabinets for an exhibition was explored; this led to numerous private correspondence with companies that hire out cabinets. However, to ascertain how many cabinets were required for such an exhibition, the question of how much material would be on display and how big the venue was. Although, theoretically, planning to rent cabinets proved to be difficult if a venue was not first established, the cost of renting the cabinets also came into question. Most rentals quoted prices such as £90-150 per cabinet, not to mention the added VAT and export costs on top of that. It was clear that the cost of renting cabinets would not be sustainable for this exhibition.

Building the cabinets themselves were a cheaper alternative when retailers such as IKEA sold cabinets for £25. Plinths for the cabinets to stand on could be built purposely for the exhibition – this allowed the plinths to fit the cabinets and the desired height. Extras such as spotlights installed within the cabinets and locks fixed to the glass doors were also considered when designing these cabinets. Building the cabinets were undoubtedly the most feasible and cost-effective solution for a theoretical museum exhibition for this assemblage.

However, there was a solution to sourcing cabinets due to the location being at the Atrium Gallery in Poole House, Bournemouth University. Due to the size of the venue, it meant a scaled-down exhibition; however, they already had plenty of cabinets with plinths and locks that were included in hiring the space, which was free; thus, this was the ideal outcome for sourcing cabinets and trialling the exhibition itself.

4.2.2 Exhibition Script

An Excel spreadsheet was used to plan out each panel for the exhibition, which included a general introduction and then four separate chapters: (1) Becoming a sailor, (2) Daily life of a sailor on board Nelson's fleet, (3) Physical injuries at sea and (4) Life and death at Stonehouse Royal Naval Hospital. The word count for each section was included in the spreadsheet, so it was easy to determine if the text was too long. Deciding how long the scripts were was crucial because too much would mean half of the text is left unread, and too little would leave things unexplained and unfinished. The scripts were written to flow into one another and were written formally yet understandable; therefore, you did not have to study the subject to understand the text. Specific measures were imposed in the scripts to ensure they were easy to read and understand, such as colloquial terms for the bones would be written first. In addition, the scientific term for the bone would be placed next to the word in brackets – this worked well because it was easy to understand. However, it was also subconsciously informative and would teach the public what the scientific words for the specific bones were.

4.2.3 Selection of Contents

The selection of the individuals was crucial as these are the chosen few who get to be viewed by the public. The fifteen individuals selected for creating osteobiographies were put in a table along with the possible reason for why they would be displayed – what would they teach the public? Table 20 shows the list. Unfortunately, due to the size of the venue, it was not possible to display all of the individuals, nor was it possible to display entire articulated bodies. As a result, the selection of a few exciting features was the main focal point.

Table 20: The selection of individuals for the exhibition and why (author's own 2021).

Individual	Reason	Location	Further Detail	Display	Chapter
SK. 651	Trauma	Occipital	Possible gunshot wound to head.	Occipital	Physical injuries at Sea
SK. 100	Ancestry	Skull	Morphological traits suggest African heritage.	Skull	Becoming a Sailor
SK. 551	Pathology	Lumbar Vertebrae	Lesions in Vertebrae from TB.	Lumbar Vertebrae	Daily life of a Sailor on board Nelson's fleet
SK. 581	Trauma	Cervical 5 (C5)	Decapitation, surgical cut marks present on C5 vertebrae.	C5	Life and death at Stonehouse Royal Naval Hospital
SK. 617	Age/ Ancestry	Skull	Older individual aged 40-50 years and skull is showing morphological Caucasian traits.	Skull	Becoming a Sailor
SK. 624	Age/ Trauma	Left Tibia	Amputation to the left tibia, aged 11-13 years.	Left Tibia	Life and death at Stonehouse Royal Naval Hospital
SK. 624	Age/ Stunted Growth	Long Bones	Long Bones suggest stunted growth; bones measure the length of a nine/ ten-year-old.	Right Femur	Becoming a Sailor
SK. 844	Trauma	Temporal	Healed sharp force trauma on	Right Temporal	Physical injuries at Sea

			the right temporal bone.		
SK. 581	Trauma	Metacarpal 1	Healing Bennett fracture.	Right Metacarpal 1	Physical injuries at Sea
SK. 605	Pathology	Tibiae	Ectocranial orange-peel porosity and new bone growth on posterior to the maxilla, periostitis to tibiae - likely scurvy.	Tibiae	Daily life of a Sailor on board Nelson's fleet
SK. 633	Trauma	Right Femur	Amputation to right femur.	Right Femur	Life and death at Stonehouse Royal Naval Hospital
SK. 648	Stature	Left Femur	Left femur measured 495mm; the individual was aged 16-18 years - very tall for his age!	Left Femur	Becoming a Sailor
SK. 547	Trauma	Right Femur	Healed amputation to right femur.	Right Femur	Daily life of a Sailor on board Nelson's fleet? (Because it has healed, the op may have happened onboard?)

SK. 581	Pathology	Left and Right Femur	Cribra Femora	Femora (both)	Daily life of a Sailor on board Nelson's fleet
SK. 844	Pathology	Tibiae	Mild bowing of tibiae - mild rickets.	Tibiae	Daily life of a Sailor on board Nelson's fleet

Due to the limited cabinets, Sk. 617's skull, Sk. 581's metacarpal and Sk. 844's temporal bone was not featured in the exhibition; this was decided on the day of assembling the exhibition, and the decision was made to not overcrowd the cabinets by not featuring these three; there was plenty of space to layout the other contents nicely. The features chosen were selected on the basis that they would fit into the chapters that had already been created and tie into the panels nicely due to these – each chapter was represented fairly.

4.2.4 Design Content

Throughout this process, ethical consideration was consistently consulted, as well as open access to all. As a result, open accessibility was incorporated throughout the design concept and in the floor plan, which allowed enough room for wheelchair access within the gallery and the design work being created to allow easy reading for individuals who may be colour-blind or autistic.

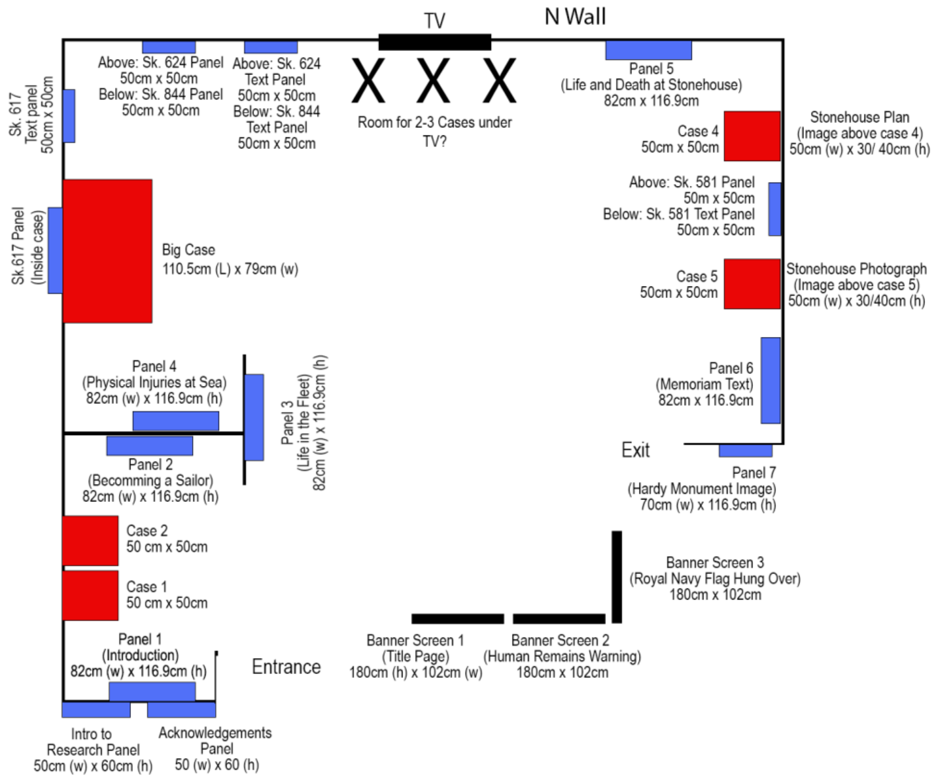

Figure 12: Designed floor plan for the exhibition (author's own 2021).

Above (Figure 12) is the floorplan design, which was consulted when installing the exhibition. It was crucial to plan the exhibition out in advance to ensure the content would fit safely and work well. For example, space was observed between panels and cabinets to ensure there was enough room for somebody to read a panel and then to be able to move onto the next one with plenty of space. The plan also shows that the cabinets were measured out in advance to ensure an easy instalment. Pop up banners have also been scheduled in the plan to ensure appropriate screening of the human remains before one enters the exhibition itself.

Figures 13 and 14 shows some of the panels and design content, from signs to TV screen slides and the feedback form, all implemented in the exhibition. To see all the panels and content, please navigate to Appendix II.

Journey back with us to the 18th century when Admiral Horatio Nelson commanded the British fleet. Britain was frequently at war during this period, including the seven years war (1756-1763), the American war of independence (1775-1783), the war with the French republic (1783-1801), the Napoleonic wars (1805-1815) and the Anglo-American war (1812-1815). It was arguably the time when the Royal Navy held the greatest importance in British national history.

In 2007, over 150 graves were discovered in the grounds of Athenaeum Place, then a former car showroom in Plymouth, Devon. The site had previously been a graveyard for the 18th century Royal Naval hospital Stonehouse.

This exhibition presents the remains of selected individuals from the naval hospital graveyard, giving us insights into the lives of these men and boys who ultimately died serving their country.

"Fifteen uniformed men, each of different rank in the Royal Navy, on the deck of a ship. Coloured lithograph, c. 1859", by London (25 Berners St., Oxford St.) ; Paris (8 Rue de Bruxelles) : E. Gambart & Co., 1 June 1859 (M & N Hanhart lith. impt), licensed under CC BY 4.0

Figure 13: The introduction panel for the exhibition (author's own 2021).

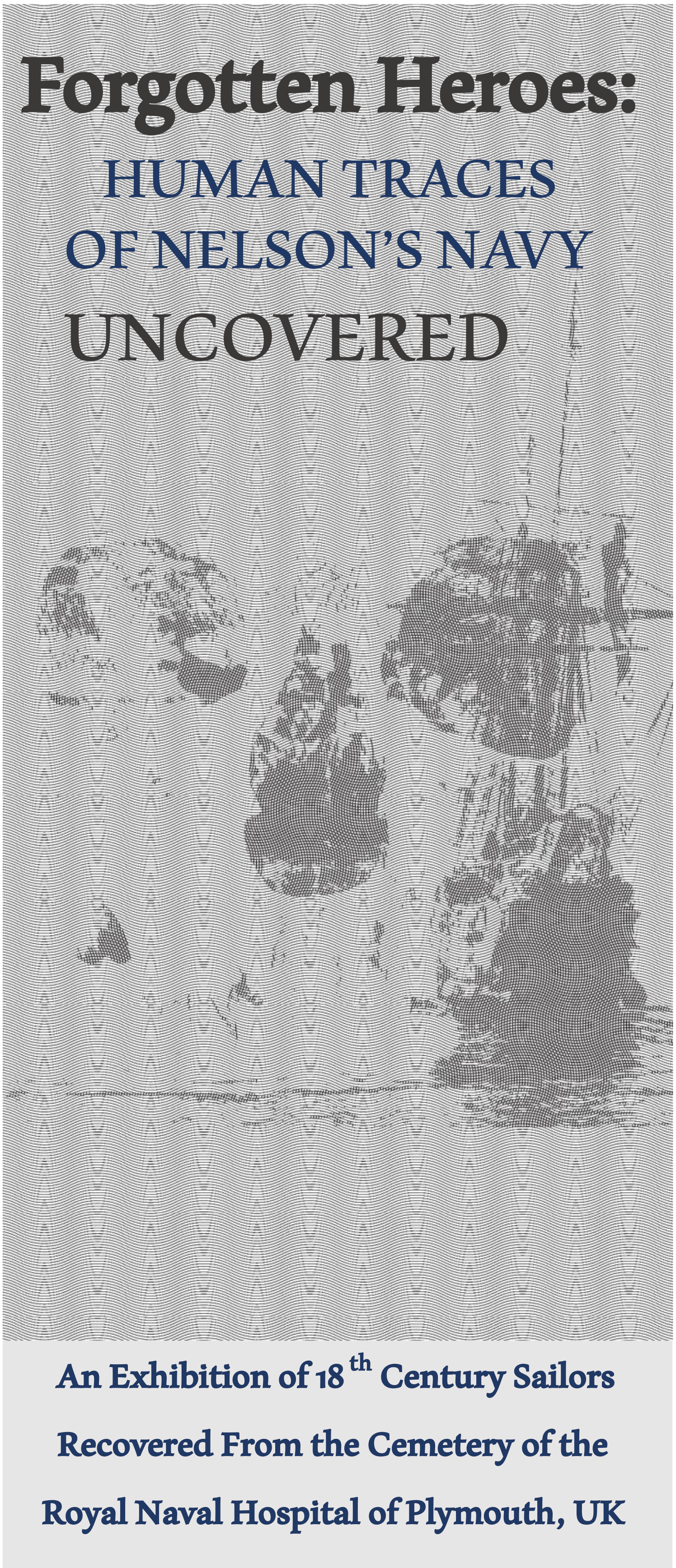

Figure 14: The title page panel for the exhibition (author's own 2021).

4.2.5 Source Artefacts

It was decided that displaying relevant artefacts alongside the human remains will set the scene for the story of these men and put them into context, thus creating an emotive response. The Maritime Archaeological Survey Team (MAST) was contacted since they were responsible for diving to the HMS Invincible (1744) and conserving the artefacts found on such dives. Numerous trips were taken to the unit to pick out some artefacts, and a contract was drawn up between myself and MAST to agree to a loan and be responsible for looking after the artefacts whilst they are displayed in the exhibition.

4.2.5.1 Inorganic Material

The inorganic material selected for the exhibition included a box of 16mm lead shots where two were placed on display. The rest of the box has been stored safely until the exhibition has finished and thus can be returned to MAST. Gun flints were also selected to be displayed alongside the lead shots to help demonstrate warfare in the Royal Navy. The other inorganic material chosen for display alongside the human remains were shoe buckles; these were highly personal and helped bring the human remains to life. The shoe buckles were made from metal, and despite the corrosion, their decorative detail was still visible. Finally, a rum jug with an eighteenth-century influence was loaned by a private collector – despite the jug not being from the eighteenth century; it was an excellent tool for talking about the rum rations in the eighteenth century.

4.2.5.2 Organic Material

Before the organic material was selected, there would be a cabinet to help monitor the humidity of the organic material and therefore would not try out the artefacts and cause damage to them. It was agreed with MAST that the cabinet would be kept between 45 and 60% relative humidity; luckily, the Atrium already facilitated these conditions – it just required the cabinet to be monitored every week.

Two-gun wads were selected as an individual (Sk. 651) had suffered a projectile injury to the head; therefore, the gun wads, lead shots and gun flints were complimentary of one another and would help imitate how the individual may have sustained the injury. A wooden sheave was selected to help illustrate how the rigging on an eighteenth-century ship worked – this also served as a visual tool due to the instant nautical link of the item. Shoe fragments were chosen carefully due to the condition of the leather – these items needed to be well monitored to avoid damage to the material. The shoe fragments were the most critical artefact besides the human remains. They are so relatable and recognisable to the public because everyone wears shoes, which resonated with the public. Also selected was a wooden writers kit and a wooden bowl fragment to help illustrate how everyday tasks were performed, such as keeping the ship's paperwork in order and simply eating your daily meals. Not all the organic material could fit into one cabinet; therefore, humidity strips were included in all cabinets, which would help monitor the humid conditions.

4.2.5.3 Replica Material

One of the most critical aspects of the sailors from the eighteenth century is the number of amputations conducted. Therefore, a replica company that specialised in the eighteenth and nineteenth century was contacted in March/ April 2021, recommended by the Hunterian Museum (London). Shipping and product availability was checked with the company before the order was confirmed. Despite being assured there would be minimal risk of these items being delayed, they had not arrived in time for the start of the exhibition in May 2021. Therefore, a plan B was implemented where a life-size, high-quality print of eighteenth-century amputation tools was used as a stand-in until the tools arrived in late June 2021.

A replica eighteenth-century Napoleonic Flintlock pistol was also loaned to the exhibition from a private collector. This pistol is a replica of Napoleon Bonaparte's 1806 pistol. Therefore, it was a treat to display this alongside the lead shots, flints, wads, and Sk. 651's occipital bone, where the projectile injury was located.

4.2.6 Assembling the Exhibition

The exhibition was assembled on May 7th, 2021; the entire day involved moving the cabinets into place, putting the panels up, displaying all the material in the relevant cabinets, placing the labels alongside the material, and screening the exhibition with the pop-up banners. I had the help of both of my supervisor's and the curator of the human remains at Bournemouth University. Luckily, the cabinets were easy to move, so it only took two people to manoeuvre them into place; there was a total of five cabinets, four small/ cube plinths and one big cabinet (please refer to Figure 12). Most of the panels were printed on high-quality gloss paper, though three of the main panels were printed on regular paper due to a shortage and later reprinted on gloss paper. The panels were backed to foam boards in advance by myself and one of my supervisors' a few days prior; therefore, they were ready to be installed onto the wall with the help of Velcro strips. The material and human remains were then placed into the cabinets – they were placed on black foam supports, which were cut to size and would help keep the bones stable and prevent them from rolling around. Once the remains were positioned and spaced out, the labels- which had been written prior were backed to foam and placed next to the remains. Finally, the feedback cards and posters were placed on the podium, which contained the feedback box. The pop-up banners were constructed and placed in the most convenient place, which acted as a shield for the sensitive material to the outside public. The construction started at 10 am and took until 6 pm to finish. To see photographs of the exhibition in full, please refer to Appendix III or view online here.

4.3 Feedback analysis

The feedback form was designed as A6 size, in a way where the statements could be answered by simply ticking a box – this has ensured much feedback from the public. In addition, an online version was created on Google Forms, which allows anybody who scans the QR code at the exhibition to fill in the same feedback form on their smartphone. Twenty-two feedback forms were collected and analysed from the physical feedback forms (18) and the online variant (4). A Likert-type (1931) scale was implemented in the feedback to make it easier for the participant to participate (Gliem 2003). The following statements were asked in the feedback:

1. You found the exhibition interesting
2. You learnt something today
3. You felt the human remains were treated respectfully
4. Human remains made the sailors/ the past more relatable
5. You would recommend to family and/ or friends

The participants then had a Likert-type five-point scale to tick in accordance with the statement ranging from 1 (Strongly Agree) to 5 (Strongly Disagree). Once the anonymous feedback was collected, it was converted into a dataset in excel to run statistics on the feedback in both excel and SPSS. Firstly, a reliability test was conducted to check the reliability of the data collected.

4.3.1 Reliability Statistics

Table 21 shows the results of the Cronbach's alpha reliability coefficient test. Due to the Cronbach's Alpha being .920, it shows the data is consistent throughout and therefore reliable enough to run statistics on. Anything below .7 is considered questionable and unreliable to trust (George and Mallery 2003; Gliem 2003).

Table 21: Cronbach's alpha reliability coefficient test (author's own 2021).

Reliability Statistics

Cronbach's Alpha	N of Items
.920	5

4.3.2 Responder experience

One of the most fundamental purposes of asking the public's feedback was to check how the public viewed the human remains on display and if they felt the human remains had been treated and displayed respectfully. The scores from the participants were split into three categories 1,2 = positive, 3 = unsure, 4,5 = negative.

The responder mean score was assessed by calculating the scores from each respondent from all the statements. Once the scores were calculated, a mean score for each individual was determined. Figure 15 shows the results from each score, and a similar approach to the human remains experience was adopted, whereas the mean score was split into three categories 1,2 = positive, 3 = unsure, 4,5 = negative. Overall, the graph shows that the respondents had a positive experience from the exhibition, with only one individual (A8) replying unsure.

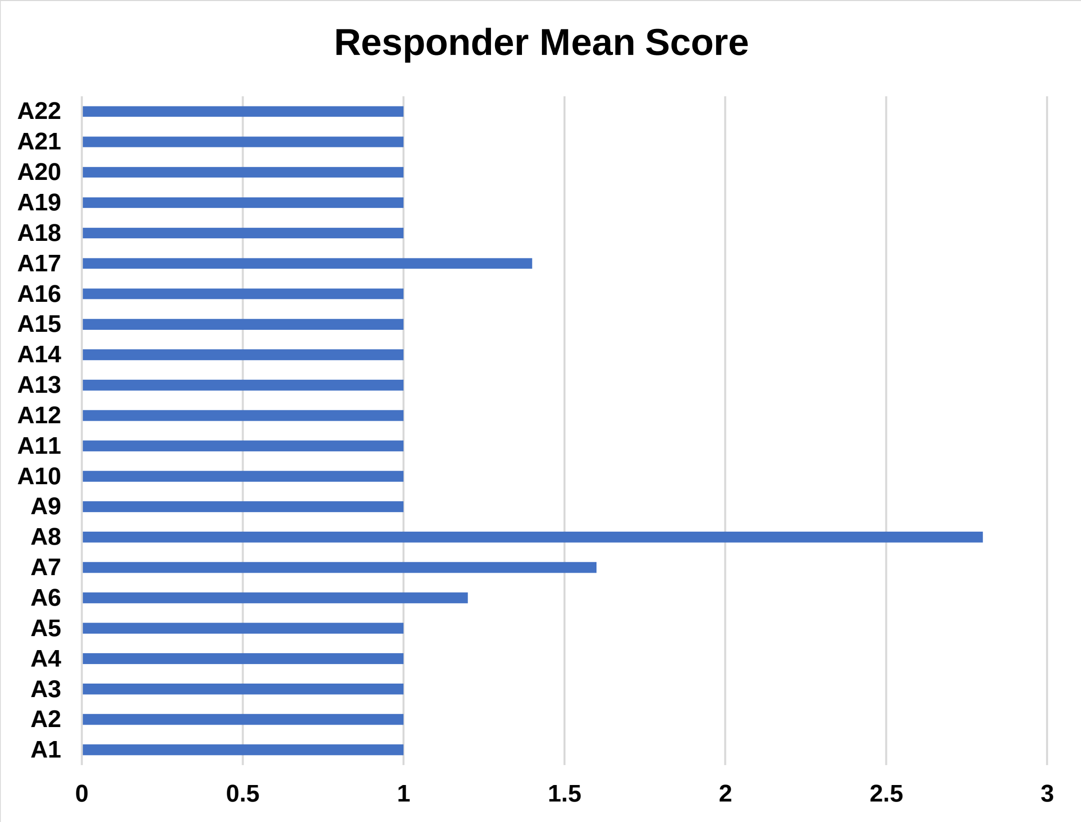

Figure 15: Graph depicting the overall mean score of each responder (author's own 2021).

4.3.3 Human Remains Experience

The scores for the following statement: 'You felt the human remains were treated respectfully' came back with 100% positive feedback, with all twenty-two respondents feeling the human remains were treated with respect, with 9% (2/22) responding "agree" and 91% (20/22) responding "strongly agree". This is crucial because, in all guidelines regarding the treatment of human remains, respect is a crucial principle (Vermillion Accord 1989; DCMS 2005; Museums Association 2015; BABAO 2019). 5% (1/22) was unsure whether the human remains made the past more relatable; however, an overwhelming 95% (21/22) believed they did. The respondent (A8) who replied "not sure" had a mean score of 2.8, meaning they were the "most negative respondent" of the cohort; they did leave feedback which suggests they would have liked to have seen more objects on display (Figure 16) – which demonstrates how well a more extensive exhibition would work.


Forgotten Heroes:
HUMAN TRACES OF
NELSON'S NAVY
UNCOVERED

A8.

Thank you for visiting -please could you spare a moment for feedback?

(Please tick the relevant boxes in relation to these statements)	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1. You found the exhibition interesting		✓			
2. You learnt something today				✓	
3. You felt the human remains were treated respectfully		✓			
4. Human remains made the sailors/ the past more relatable			✓		
5. You would recommend to family and/ or friends			✓		

Any further comments
Pls add more stuff
thx :)

Figure 16: Copy of A8's feedback form (author's own 2021).

5 Discussion

5.1 Revisiting the Objectives

The aim of this project was to bring forth new information about the eighteenth-century Royal Navy by approaching the topic through osteobiographies, highlighting the educational value of human remains and maritime archaeology. This was done by setting five objectives (Section 1.1).

5.1.1 Assess the wider sample of articulated individuals (n.=91) and choose fifteen to research in the lab. These individuals were selected for their age, sex, pathological, ancestral, or stature characteristics

Fifteen individuals were selected after recording and analysing ninety-one individuals from the EA6102 Plymouth sailor's assemblage (5.2.3). The individuals were selected according to interesting physical attributes that would interest museum visitors as well, pertaining information about factors such as age, amputations, stature, and pathological conditions (Table 20).

It was crucial that these individuals were selected because it shows variety among the British Navy in the eighteenth century. The remains of these individuals also revealed about a third of the ninety-one individuals had fractures, healed and unhealed where at least twenty-nine individuals had suffered from unhealed fractures, and six had healed fractures - this attests to the Royal Navy being an arduous place of work for the eighteenth-century man or boy, as this assemblage reveals. Certain developments of the eighteenth-century, including the use of Jean-Louis Petit's tourniquet and Pierre Dionis' adoption of the Paré's method (the use of vessel ligation over red-hot cautery), led to many more amputations performed in battle conditions during the eighteenth century (Kirkup 2007; Kinch and Clasper 2011). An eighteenth-century surgeon, Bell, claimed all techniques had improved so remarkably that nineteen of every twenty amputations healed (Kirkup 2007). Without accessing specific case records, it is difficult to assess this claim. However, the number of amputations showing either none or minimal remodelling amongst the Plymouth collection indicates that peri-operative death occurred repeatedly following such operations at the Stonehouse

Hospital at this time. Only one individual, Sk. 547 had new bone growth at the amputation site, which meant they survived the traumatic process.

The desk-based research proved to be essential in piecing together the story of these individuals. Historical documents were consulted, and Navy records and books regarding the eighteenth-century Navy and the Royal Naval Hospital of Stonehouse (Etherington and Royal Naval Hospital 1962; Pugh 1972; Historic England 1998; PastScape 2012). As well as learning the history of the hospital grounds and eyewitness accounts of how the men were treated at the hospital (Howard 1784), which is discussed in the background chapter, it was also possible to track down initial excavation reports (Hodgins and Salvatore 2009) and the original *in situ* site photographs of the burials taken at the time of their initial excavation in 2007 (courtesy of AC Archaeology). Unfortunately, whilst I have access to these images, I do not have the right to publish them in this thesis, as the rights belong to the Plymouth Archives (The Box). Regardless, it is still helpful to see how these individuals were initially buried, discussed in their osteobiographies in Appendix I.

5.1.2 Create osteobiographies which should include stature estimation, sexing, age estimation and any pathological abnormalities. Where feasible, the individual's ancestry will be examined

This next objective was achieved, and the osteobiographies have been discussed in the results section, and their full osteobiographies are in Appendix I. The way in which these osteobiographies were constructed was kept consistent. The reports included the following themes, which are then discussed in full in their osteobiographies:

- Background and material
- Age estimation
- Sex estimation
- Ancestry estimation
- Stature estimation
- Pathology

- Conclusion

The background and material section was crucial to understanding the individual in its original burial context, along with any accompanying material within the grave.

Estimating the age of the individuals proved challenging at times (Brooks and Suchey 1990; Buckberry and Chamberlain 2002). Due to some of the individuals being sub-adults, estimating their age using their pelvis was out of the question (4.1.1). This meant analysing the epiphyseal fusion of some of the bones, including the long bones was consulted for aging these individuals (Cunningham et al. 2016).

Sex estimation among these individuals was predominantly undertaken using the pelvis (Phenice 1969; Walker 1994). However, similar to the issues with estimating age, some individuals could not be estimated a sex due to the immaturity of their bones (Cunningham et al. 2016). However, the adult individuals predominantly had dominant male traits overall (4.1.2).

Ancestry analysis demonstrated to be fruitful for some individuals (Sk. 605 and 757), however for the other two (Sk. 100 and 617), it seemed to be hit and miss. The Fordisc3.1 and the craniomorphological results showed that it was doubtful that any of the four individuals that could be analysed were of European descent (4.1.3).

Stature estimation proved to be challenging and had to be reviewed for some individuals after the ancestry analysis was conducted. The main issue surrounding stature estimation was the assumption that these individuals were likely of European descent, as the majority of the individuals did not have intact skulls to analyse ancestry. Due to this assumption, a European stature equation was adopted for the entire assemblage. Though because four skulls (Sk. 100, 605, 617 and 757) were intact for ancestry analysis, the results suggested all four individuals were unlikely to be of European descent, therefore different stature equations had to be used for those individuals who, in some cases (Trotter 1970), showed a dramatic height difference (4.1.4). The sub-adults were also not applicable for stature estimation.

The pathology of the individuals proved to be consistent with what one would expect from an eighteenth-century Naval assemblage (Ortner 2003; Waldron 2009). Identifying the pathology was easier in some cases, for example, the appearance of fractures and infectious diseases such as tuberculosis. The appearance of periostitis and porotic hyperostosis together, along with the number of individuals with similar patterning, suggests a lot of the assemblage was suffering from the same issue, likely due to a diet lacking in vitamin C (Ortner 2003; Waldron 2009).

Finally, the conclusion section, which closes the osteobiographies, summarises the entire report of the individual in a form aimed at being understandable and appealing. It was beneficial to have the summary at the end of the report because it was easy to tweak and incorporate in the museum exhibition. However, due to the continuous research that coincided with the exhibition's creation, some of the osteobiographies have changed slightly due to stature and ancestry factors; this shows how changeable and continuous research in archaeology is.

5.1.3 Design a museum exhibition to present the human skeletal collection to the public while adhering to ethical and museology/heritage management requirements. This includes finding a venue, developing the panels and text for the exhibition, exhibiting the remains respectfully, and sourcing related artefacts.

The third objective proved possible to achieve, despite a third national UK lockdown due to the Covid-19 pandemic. At the start of this research, it was likely that this objective would only be attainable using a theoretical approach. Because the theoretical approach was written into the project's proposal, planning for the exhibition occurred before securing a venue. The creation of the small museum exhibition is summarised in the results chapter. Therefore, it is worth mentioning that the exhibition was a success among the public, who commented about the need for a more extensive exhibition. Therefore, the pilot of this small exhibition served well in its purpose to demonstrate that this exhibition worked, it was exciting, and it educated the public and brought attention to the 'forgotten heroes' themselves. Furthermore, designing this exhibition complied with current theories to museology/ heritage management and ethical standards.

5.1.3.1 Exhibition Design

The exhibition's ‘big idea’ (Table 19) was to introduce the public to the Plymouth assemblage and educate them on the British Navy during the eighteenth century while also implicitly showcasing osteoarchaeology's importance and the value of such studies.

Table 19: A revisit of the master interpretive plan first featured in the method's section (author's own 2021).

1. Big Idea	What do we know about eighteenth-century sailors? This exhibition aims to highlight what a vital and taxing role sailors in the past did and offer the public an insight into maritime archaeology from the remains of those who served in the British Navy. Without using these human remains on display and creating osteobiographies, the exhibition would not have been the same.
2. Key Messages	• The importance of osteobiographies to be included with historical accounts and documents; bones do not lie.
	• The use of human remains causes emotive responses; therefore, it is far more beneficial to create an exhibition with the skeletal remains on show than with written accounts about the Navy. In addition, it will grab the public's attention.
	• The remains of sailors who died in active service are rare; therefore, this exhibition is unique.
3. Critical Questions	1. Where were the sailors excavated, and why were they buried there?
	1. How do these sailors relate to Lord Admiral Nelson?
	2. Why were the individuals on display chosen?
	3. Who were the sailors?
	4. Does the analysis of their bodies support the historical accounts of the eighteenth-century Navy?

The key messages were embedded throughout the exhibition. First, the human remains were displayed to stress that the physical evidence can be equally if not more reliable than historical accounts and documents. Second, the following key message is that human remains cause emotive responses; this certainly proved to be an incentive for the public to visit the exhibition because viewing human remains proved popular. As a result, this engaged the public's attention and created a more meaningful interaction. Finally, it has been stressed that the human remains of sailors who died in active service are rare, which is why this key message was also embedded in the exhibition. Not only was it an honour to display these individuals in the exhibition, but it was also an honour to share this with the public and encourage them to remember the sailors with respect.

The critical questions (Table 19) had to be answered in the exhibition, and the aim was that the public would be able to answer these questions at the end of their visit. Therefore, it was important that this assemblage's provenance was known and included on the second panel of the exhibition to lay the groundwork for the rest of the exhibition – this answers the first critical question.

Question two was embedded throughout various exhibition panels where the dates of the assemblage were discussed, it was also linked into the title of the exhibition and also on the TV screen, which had rotating slides about the British empire at this time, and there was, in fact, a slide on Nelson himself. This is touched on again in one of the final panels with the Hardy monument. The monument, erected in 1844 in Portesham, Dorset, is in memory of Vice-Admiral Sir Thomas Masterman Hardy, Flag Captain of HMS Victory at the Battle of Trafalgar (Thompson et al. 1958). The monument is mentioned and encourages visitors to remember all those that lost their lives – it serves as a memorial panel and closes the exhibition.

Question three is answered throughout the exhibition, and there was a label for each bone to inform people what they were looking at and why. The individuals were selected to give a fair and variable impression of the Royal Navy in the eighteenth century. Question four regarding who the sailors were was answered using osteobiographies printed onto the exhibition panels. Due to the limited size of the exhibition, it was not possible to have all fifteen skeletons and their osteobiographies on display. The final question features whether the human remains support historical accounts of the eighteenth-century Navy and is again embedded throughout the exhibition. The four main panels consisted of the following chapters: (1) Becoming a sailor/ joining the crew, (2) Daily life in the fleet, (3) Physical injuries at sea and (4) Life and death at Stonehouse hospital. The information on these boards was taken from historical documents and the current, peer-reviewed literature about the Navy during this period. Therefore, the human remains are then used to illustrate and discuss the information on these boards, therefore supporting these accounts.

The physical objects on display alongside the bones, loaned by MAST, set the scene for the human remains. Having artefacts that people can relate to, such as the shoes, which were on display in the first cabinet, helps one realise that these belongings belonged to people once, which helps bring the human remains to life. Hodder and Hutson (2003) point out that one can relate to people through objects and material culture. These are the objects that humans use to survive, define social relationships, and represent facets of identity. Through these processes, other humans relate to each other through using such objects known as material culture.

Another way humans can relate to one another is through 'dwelling', simply by being present in the world and living, known as phenomenology (Brück 2005; Thomas 2008; Tilley 2008). Phenomenology shows that supporting material culture in a skeletal display is not essential for one to relate to the human remains; one can relate by being alive and present in the world. One recognises the human skeleton as they recognise their own; essentially, they are us (Sofaer 2006b). Therefore, in this context, the material culture is employed as a tool to help illustrate what the skeletons on display teach us.

5.1.3.2 Ethical Consideration

Ethical considerations are embedded throughout bioarchaeological research in general, but they are essential when dealing with the public. Therefore, BABAO's ethical guidelines (2019) and the Vermillion Accord (1989) was consulted extensively whilst assembling the exhibition and putting the human remains on display to the public. One of the most critical steps to provide ethical care was to make the public aware that the exhibition contained human remains before entering the exhibition. Special care was taken by designing an A3 size sign communicating the points shown in Figure 17. This was placed at the entrance to the display underneath the main title panel, where it was most visible.

Figure 17: Warning of Human Remains sign created for the 'Forgotten Heroes' exhibition (author's own 2021).

Another way to ensure ethical standards were upheld was to ensure the human remains were only visible when one would enter the exhibition (DCMS 2005); this was done by screening off the human remains using large banners positioned strategically to block the line of sight to the human remains from the outside. Finally, ensuring that the cabinets could be locked was another way to protect the human remains and respect the material.

Each principle was consulted when looking at BABAO's principles based on their code of ethics (2019) (Table 23). The very existence of this exhibition ensured that principle one was met, as the human remains allow knowledge about past human lifeways to be explored; this, in turn, was used to educate the general public by the continued conservation of these human remains by the

Archaeology and Anthropology department at BU. Principle two was adhered to by ensuring the human remains on display are respected and displayed respectfully; using material culture simultaneously reminds viewers of the exhibition that these remains are those of people who once lived and should be shown respect. Principle three has been met by selecting fifteen individuals for various reasons, including age, stature, ancestry and any pathological interests; therefore, there was no discrimination in the selection process, and all were photographed appropriately. Despite these human remains being more recent than other collections held at BU, they were stored respectfully in the same manner as other older collections are. Principle four is adhered to by ensuring the human remains are kept safe and monitored whilst on display at the exhibition; this is why the cases were locked. The exhibition was viewable by security. After the human remains are removed from display, they will return to BU's archaeology and anthropology department, where they are cared for and are part of the teaching collection. The 'Forgotten Heroes' exhibition advocates for principle five, and the exhibition was designed to promote the scientific study of ancient human remains to the public. The exhibition could not have been possible if the value of these human remains were not at the heart of this research.

Table 22: Summary of BABAO's principles based on their code of ethics (2018) (author's own 2021).

BABAO's principles based on their code of ethics (2019)
1. The generation of knowledge about past human lifeways using archaeological data is a worthy goal. Human remains are our most direct source of evidence in this respect. Their study is therefore central to our understanding of the human past
2. By virtue of their status as the remains of once living people, treatment of human remains requires ethical considerations over and above those that pertain to other classes of archaeological materials.
3. Human remains should always be treated with dignity and respect regardless of age or provenance.
4. Given the importance of human remains as a source of information about our past, osteoarchaeologists should work toward the long-term conservation of the osteoarchaeological record.

5. Osteoarchaeologists should be committed to public education and promote the value of the scientific study of ancient human remains.

Regarding the Vermillion accord (1989) (Table 24), it was vital that these principles were met when undertaking this research and designing the exhibition. Principle one is similar to that of BABAO's principle three. Therefore, this principle has been covered; to a large extent, these individuals' religion, ancestry and nationality are unknown. Concerning principle two, the wishes of these dead individuals are not known; however, as mentioned in the background chapter, these men did not wish to be buried where they were and tried to avoid it at all costs (Pugh 1972). – Further, by saving these remains from threats from redevelopment, they have ultimately been saved from destruction. Principle three involves the wishes of the local community and relatives of the dead; in this case, there is no way of tracing their relatives as these men's graves were unnamed and forgotten. The feedback forms at the exhibition also allowed the public and the local community to give their voice on whether they thought the remains had been displayed respectfully. Principle four is similar to BABAO's principle five, and therefore this principle has already been discussed and adhered to. Finally, regarding principle five, again, the relatives of these people are unknown and untraceable. Therefore, it is arguable that by putting these men’s remains on display to the public, the public can show their respect for these forgotten burials, which would not happen if they were reinterred for the sake of it, as the public would not know the story of these individuals. If various ethnic groups raised serious concerns regarding these individuals, principle six would be consulted; however, most individuals are of unknown ancestry and have no traceable relatives; therefore, the scientific value is fundamental regarding this assemblage.

Table 23: Summary of the Vermillion Accord (1989) (author's own 2021).

The Vermillion Accord on Human Remains (1989)
1. Respect for the mortal remains of the dead shall be accorded to all, irrespective of origin, race, religion, nationality, custom and tradition.
2. Respect for the wishes of the dead concerning disposition shall be accorded whenever possible, reasonable and lawful, when they are known or can be reasonably inferred.
3. Respect for the wishes of the local community and of relatives or guardians of the dead shall be accorded whenever possible, reasonable and lawful.
4. Respect for the scientific research value of skeletal, mummified and other human remains (including fossil hominids) shall be accorded when such value is demonstrated to exist.
5. Agreement on the disposition of fossil, skeletal, mummified and other remains shall be reached by negotiation on the basis of mutual respect for the legitimate concerns of communities for the proper disposition of their ancestors, as well as the legitimate concerns of science and education.
6. The express recognition that the concerns of various ethnic groups, as well as those of science are legitimate and to be respected, will permit acceptable agreements to be reached and honoured.

The Museums Association code of ethics (2015) was also consulted throughout the development of the exhibition. Table 25 summarises the Museums Association code of ethics (for museums). Each step of the code of ethics was consulted and upheld when creating the 'Forgotten Heroes' exhibition.

No.1, public engagement and the public benefit was predominantly achieved in creating the museum exhibition and in the end result. The exhibition was designed for those interested in archaeology; however, it was constructed so that anybody who visited did not need previous knowledge in the discipline; it reached out to a new and diverse audience. The exhibition was designed with colour blindness and dyslexia in mind and having enough room for any disability support to manoeuvre around the exhibition; this covers the equality and respectful side of things. All the information displayed on the panels is factual and was collected from various peer-reviewed literature; therefore, the information available to the public is accurate. Freedom of speech and debate is very much supported at the exhibition, which is why the feedback forms have been implanted. The human remains at the exhibition act as a tool to teach the public; therefore, the human remains on display, and the loaned artefacts are for the public benefit to learn, inspire and enjoy.

No. 2, the principles for the stewardship of collections have been consulted and met throughout the creation and display of the museum exhibition. The human remains which are on display in the exhibition have been managed and cared for by the department of archaeology and anthropology at Bournemouth university, this has allowed the Plymouth assemblage to be used to teach current and future generations, this has also covered the following principle regarding transparency and care of the collection. For the last principle in No.2, the exhibition was designed to remind viewers that the collection is a cultural, scientific and historic asset. There was never the possibility of an entrance fee at the exhibition; this exhibition was always free for the public to enjoy. Therefore, there was no financial gain involved.

No. 3, individual and institutional integrity, this principle was achieved and upheld throughout the creation and whilst the exhibition was open. Furthermore, integral relationships have been formed due to organising the exhibition with various individuals from different backgrounds.

Table 24: Summary of the Museums Association code of ethics (2015) (author's own 2021).

1. Public engagement & public benefit	• Actively engage and work in partnership with existing audiences and reach out to new and diverse audiences. • Treat everyone equally, with honesty and respect. • Provide and generate accurate information for and with the public. • Support freedom of speech and debate. • Use collections for public benefit – for learning, inspiration and enjoyment.
2. Stewardship of collections	• Maintain and develop collections for current and future generations. • Acquire, care for, exhibit and loan collections with transparency and competency in order to generate knowledge and engage the public with collections. • Treat museum collections as cultural, scientific or historic assets, not financial assets
3. Individual & institutional integrity	• Act in the public interest in all areas of work, uphold the highest level of institutional integrity and personal conduct at all times, build respectful and transparent relationships with partner organisations, governing bodies, staff and volunteers to ensure public trust in the museum's activities.

5.1.4 Create interesting versions of the fifteen osteobiographies for the museum display that the general audience can read and understand easily

The last objective was achieved during the exhibition process. The osteobiographies of the individuals were based upon the conclusion section from each individual's report. The conclusion chapter was then tweaked and worded in a simplifying yet informative and appealing way. The osteobiographies featured in the exhibition are summarised in Appendix II.IX. Table 25 is an example of one of the osteobiographies.

Table 25: Example of an osteobiography of Sk. 581, for the full osteobiographies, please refer to Appendix II.IX (author's own 2021).

Osteobiography
'*Sk. 581 was likely a young adult male in his 20s at the time of his death. Due to the absence of this individual's skull, there is no current way of knowing the ancestry of this individual. He was likely around 5ft 7inches (1.76m) tall. Saw marks to his neck (vertebrae) shows he was decapitated, likely by a surgeon at the hospital, after he had died.* *The decapitation raises various questions, such as why was the man decapitated? It is likely the individual's head was deemed interesting enough as a specimen for a surgeon's personal collection or larger establishment such as the Hunterian museum in London. Due to the missing skull, it is impossible to know why it was taken, however it could have been due to an unusual disease or physical condition, or even ancestral difference.* *The left arm and shoulder for this individual were also missing and the right arm and sternum show that he may have undergone a radical forequarter resection (a procedure that involves amputating the arm and shoulder). He had fractures to his right thumb (metacarpal 1, proximal), pelvis (acetabulum) on the left side and right foot (proximal phalange 1), which may have resulted from physical altercations, whether it be at battle or amongst his fellow sailors, or by accident. The fracture of the thumb, also known as a Bennett's fracture, can result from falls, but was also common from fist-fighting*.'

These osteobiographies were also accompanied by a photograph (Appendix II) of the skeleton rearticulated in the lab. The osteobiographies were essential in informing the public about an individual's life throughout the eighteenth century. Therefore, these osteobiographies helped put the assemblage into perspective and remind the public that these are the remains of people who once lived. The osteobiographies consisted of discussing who the individual was, which consisted of their age, sex, stature, and ancestry (in some cases). In contrast, their pathology was able to interpret the lives of these men. The osteobiographies were kept as concise as possible to ensure the public would read with ease and still be interested in reading the rest.

5.1.5 Collect feedback to evaluate the exhibition's success

The 'Forgotten Heroes' display at the Atrium Gallery at Bournemouth University seemed to captivate the public. Twenty-two feedback forms were collected from the public via the virtual QR feedback and the physical feedback cards held at the Atrium. An overwhelmingly positive experience of the exhibition can be determined from the scores/ comments (see Results 4.3). According to Perry (2019), an enchantment-led strategy is essential for developing a truly socially beneficial archaeological discipline. Thus, this exhibition can be seen as generating enchantment and appealing to the public by the presence of the human remains and the accompanying artefacts on display; this is evident in the feedback where most people strongly agreed or agreed with the statements (4.3). Thus, the feedback from the public proves that these osteobiographies were a success and that the majority of visitors learnt something and enjoyed the exhibition. However, one must be aware of a potential sampling bias due to the exhibition taking place on campus; therefore, it is likely the feedback collected are from staff and students who possibly already have an interest in the subject, though the exhibition was open to any member of the public.

5.2 Sailors in the Eighteenth Century: A New Outlook

The skeletons of the men that made up the Royal Navy in the eighteenth century show that the British Navy was made up of men from various backgrounds and stages in life. This assemblage is made up of likely males; despite the burial ground being designated to the Royal Naval Hospital of Stonehouse, it appears that most individuals who could be sexed are male. Therefore, this burial ground may have been reserved for deceased seamen. Whilst it has been recorded that women were sometimes onboard ships; only two possible females could be identified among the assemblage. It is a maritime superstition that women on board a ship are bad luck (Hickox 2005; Compton 2013). Despite the superstition, women onboard ships were sometimes hidden and ignored. There were three types of women on ships: prostitutes who shared the crew's quarters (lower deck) whenever a ship was in port (Hubbard 2016; Stark 2017). The second were the wives of warrant officers, many of whom spent years at sea. These women were helpful in battle, nursing the wounded and carrying powder to the guns (Stark 2017). The last category was composed of women in male disguise, such as the famous case of Hannah Snell, who in 1745 swore an oath under the guise of James Gray and went to sea on the *HMS Swallow* (Snell 2021). The results from this research show that it is likely that most of the skeletons sampled were male, with the exception of two possible females. Therefore, it poses two interesting theories: either women onboard eighteenth-century ships is an uncommon occurrence, or they were treated differently to men after they died– at least at Stonehouse, which may play a part in keeping the taboo at bay.

The results show that the majority of this assemblage was made up of young adults and sub-adults. As discussed in the background chapter, many boys were ‘pressed’ into service, so the immaturity of these skeletons is not surprising (Rodger 1986; Adkins 2008). In addition, there are many accounts of boys being onboard, living alongside the older men to learn how to work the ships from a young age (Rodger 1986; Fremont-Barnes 2005; Adkins 2008). However, the shock of this assemblage is the high percentage of young adults and sub-adults compared to the middle adults and older adults. The reasons why sub and young adults dominate the assemblage may be due to a higher mortality rate among the young, which is reflected in the hospital deaths or, simply that there were many more young recruits in the Navy than one initially thought.

The ancestry analysis of the four individuals (Sk. 100, 605, 617 and 757) who could be analysed are interesting. Figures 18, 19 and 20 show that the craniometric analysis revealed that it is unlikely that any four of those individuals are of European descent, which is interesting considering the remains are from a British eighteenth-century Naval graveyard.

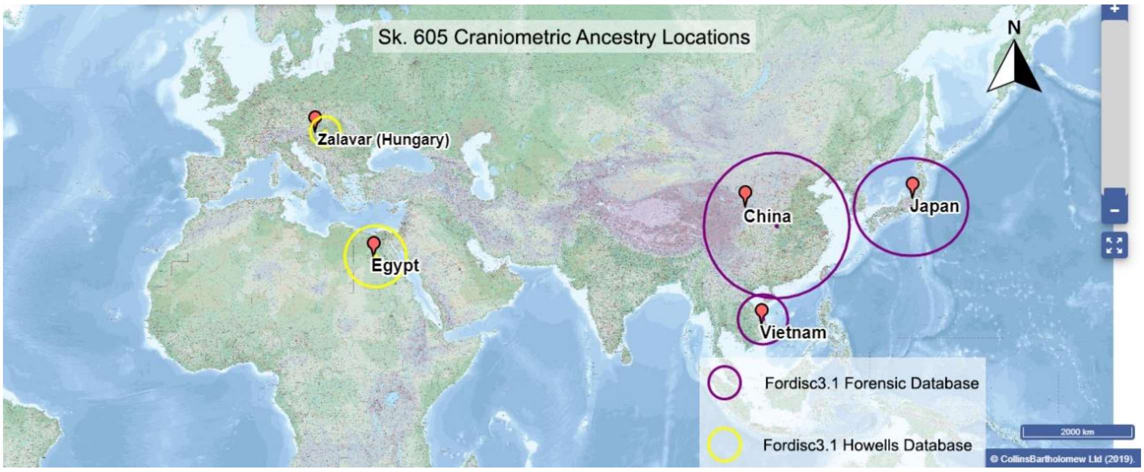

Figure 20: Craniometric ancestry locations for Sk. 605 based on Fordisc3.1 results (author's own 2021).

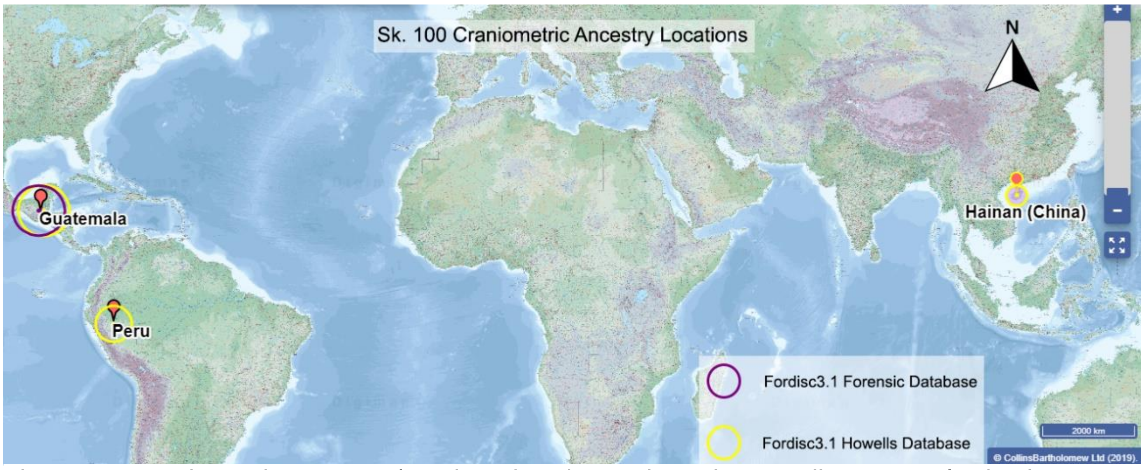

Figure 19: Craniometric ancestry locations for Sk. 100 based on Fordisc3.1 results (author's own 2021).

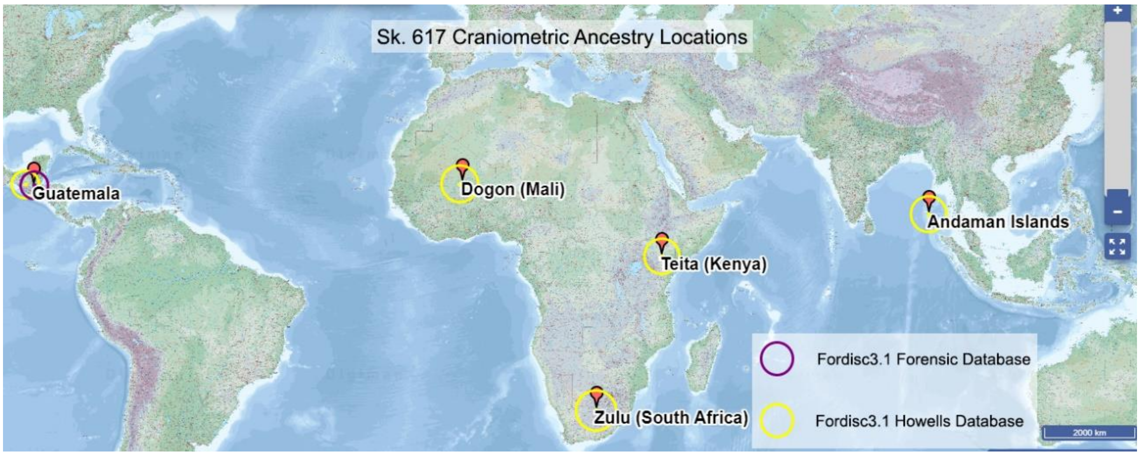

Figure 18: Craniometric ancestry locations for Sk. 617 based on Fordisc3.1 results (author's own 2021).

The craniometric results for individual Sk. 757 have not been mapped because the samples matched with nineteenth and twentieth-century black males, Hispanic males and white males rather than a specific population that can be mapped. These individuals appear to be of African, South American or Asian descent, rather than European. The fact that these individuals are unlikely to be European does not mean the entire assemblage reflects this. Instead, their skulls were more robust and prone to survival than the others. The analysis suggests that the British Navy in the eighteenth century was made up of more of a multi-cultural population than previously thought. However, the results do classify samples differently depending on the database. There appear to be no discrimination factors in the way these men were buried.

The stature of these individuals shed light on the stature of eighteenth-century sailors. It is generally assumed that men of the eighteenth century were shorter than today due to the height of doorways and the height of the decks constructed on British ships (Steegmann 1985). However, the results section reveals that the assemblage comprises individuals with a shorter and taller stature, their heights varied, which does not seem to impede their initial recruitment. Instead, it is much more likely that doorways and the ship's decks were low due to the high demand for timber for shipbuilding and the cost; therefore, it was cheaper and resourceful to build the decks and doorways shorter using less timber (Dunkley 2016).

The pathological results show that periostitis, and the probable cause, scurvy, was rampant in this assemblage, in the old and young individuals, which likely suggests these men died before the Admiralty commissioned lemon juice in 1795 in a bid to avoid vitamin-C deficiency (Lloyd 1965). The lack of infectious diseases was surprising among this assemblage; there were very few tuberculosis cases. Only chronic cases of infectious diseases are likely to leave a trace in the skeleton; therefore, the men were likely exposed to various acute infections that do not leave a trace in the skeleton (Ortner 2003; Smith 2017). Although it is reported prostitutes would be sought out frequently whilst at port, very few cases of syphilis could be diagnosed from the overall assemblage (none in the selected fifteen). The cases examined in this assemblage are congenital and therefore passed to the individual in the womb as a foetus from their mother, rather than the result of sexual contact (Barnett 2014). However, the low cases of syphilis may not mean it was not common in the assemblage, primarily since most of the assemblage comprises young adults. Venereal syphilis only shows up in the skeleton if the condition is chronic; therefore, the individual would have suffered from it for years. With high mortality rates among the young, the disease may not have impacted their skeleton yet (Smith 2017).

The sheer amount of healed and unhealed fractures among these men attest to their arduous time onboard the ships of the Royal Navy, and even though the mortality rate of the Royal Navy was impacted the least by battle, the wounds on individuals Sk. 633 and Sk. 581 show that it is likely that at least some of these men engaged in battle. The amputations among this assemblage show a very high mortality rate, with only one amputation that shows signs of healing out of the four examined for this research. Therefore, if you required amputation during the eighteenth century, it was likely to be fatal. The possible decapitation of individual Sk. 581 post-mortem may point to the immoral continuation of seventeenth-century practises where physicians also acted as collectors (Walker 2008; Jenkins 2014).

5.3 Summary

To summarise, the current study generated a varied dataset that was then used to inform a planned exhibition as envisaged, illustrating the potential of human remains to inform and engage the public in a manner that would be difficult to achieve using other forms of evidence. The assemblage consists of primarily young adults and sub-adults; these individuals are likely to be male. The older individuals showed more male dominant traits when assessing sex estimation. The ancestry for the individuals was first assumed to be an assemblage made up of European’s due to the nature of the assemblage. However, since ancestry analysis was conducted on four individuals, though these results do not provide conclusive ancestral origins for these individuals, it does suggest that it is doubtful none of the four are of European descent. The variation in stature discredits the myth that sailors were always short; however, because many men were recruited at such a young age, that individual's height would be unknown to the employer because many died young, a complete picture of stature estimation is unknown. The pathology shows that fractures among this assemblage were common, and they likely sustained them due to their arduous duties onboard. Many men also appear to share similar pathological conditions such as periostitis and porotic hyperostosis; it is clear a common factor was causing these changes to the skeleton, such as a diet deficiency.

The feedback obtained from the exhibition shows that it was a success among most visitors; everyone who attended and left feedback had an overall positive experience. The exhibition proved to be challenging and time-consuming in organising at times. Ethical considerations were embedded throughout the building of the exhibition, and this was upheld by reviewing numerous published guidelines and principles from the Vermillion Accord (1989), DCMS (2005), Museums Association (2015) and BABAO (2019). Researching up-to-date museological literature and theories were fundamental in creating such an appealing yet respectful and informative exhibition. Due to the exhibition's success, it served its purpose in bringing public attention to the assemblage and educating the public regarding the wider value of osteoarchaeological studies.

6 Conclusion

Forgotten heroes: Design and production of a public engagement and display strategy for a historic skeletal collection.

The purpose of this research has been to analyse and create osteobiographies from a skeletal collection and design a museum exhibition to present the research and historic assemblage to the public.

6.1 The Process – a Reflection

A variety of things have been learned by going through this research process; this involves three main topics: osteology, maritime archaeology, and heritage management. These have been the three themes embedded throughout this research, each equally important.

6.1.1 Osteology

It would not have been possible to put on an educational museum exhibition without the essential osteological analytical skills learnt throughout this process. As with most life skills, practice is vital, and due to the extensive assemblage, osteological methods became very familiar throughout conducting this research. However, an important realization was that each method has its limitations. Validation studies played a fundamental part in the methods section and understanding the results obtained; these areas must be explored.

6.1.2 Maritime Archaeology

The project is heavily researched, with a powerful Naval theme running throughout this project. This would not be possible without all the historical sources and literature already established upon the eighteenth-century Royal Navy. Good knowledge of this topic has ensured a clear understanding of these individuals' lives and in portraying their stories to the public. The maritime element was embedded throughout this thesis, but it was mainly explored in depth in the background chapter. Due to the heavy consultation of Naval sources, solid knowledge has been formed around this topic. With the help of maritime archaeology, it has helped portray the stories of these individuals and has given us a snapshot into their lives.

6.1.3 Heritage Management

The heritage side of this project was critical; it was ingrained in all aspects of the research and the aim and objectives. One of the objectives was to be able to display this historical skeletal collection to the public. However, the creation of the museum exhibition was a fundamental learning outcome. Without consulting relevant guides (DCMS 2003; Brooks and Rumsey 2008; Smithsonian Exhibits 2018), liaising with individuals from various backgrounds, and visiting other institutions, creating the 'Forgotten Heroes' exhibition would not have been possible.

6.2 Key messages

The undertaking of this research has reached the following conclusions, which are supported and demonstrated within all aspects of this thesis: -

a) The public enjoys seeing human remains on display. Furthermore, they engage in learning from this way; this was evident from the overwhelmingly positive response to visiting the exhibition, though one must be aware of the potential bias of a university audience and the small sample size. Therefore, a more extensive exhibition based on this research will further explore this theme and benefit maritime archaeology.

b) The eighteenth-century Navy was made up of more sub-adults and young adults than older individuals and were likely male; however, the skeletal analysis shows an incredible amount of variation among these individuals regarding their ancestry, stature, trauma and pathological conditions, as well as the general size shape and robustness of their bones.

c) The ancestry analysis for the four skulls examined from this assemblage reveals that just because this assemblage was derived from a British Naval hospital, the individuals themselves may not have been British; Ancestry results show that none of the four individuals were likely of European descent. This sheds light on the diversity of the Royal Navy in the eighteenth century and should be explored further.

d) A balance between osteobiographies and historical accounts is crucial; these two factors work better together. While historical accounts risk having been written under false or biased intentions, they teach us about the idealisms of the people at the time, whilst the physical remains show us that it may not have happened that way in practice. In this research, the skeletal analysis provided evidence supporting historical sources, such as the sailor's having an arduous life on-board due to their daily tasks, and against historical sources; for example, there was a variety in stature instead of all the individuals being considered ‘short’.

Therefore, this research has achieved its aim and objectives set out in Section 1.1 and, by doing so, has presented a rare and valuable skeletal collection to the public and allowing them to meet the people who once governed the seas at a time when England pioneered in naval history.

6.3 Future developments

While ancestry and craniometrics were touched upon in this research, future developments lie in tracing the entire assemblage's ancestry, perhaps using biochemical (aDNA) techniques. This would be key in understanding and revealing the true picture of the diversity of the Royal Navy in the eighteenth century. In addition, a more extensive exhibition of this collection should be explored further, in a place fitting for these individuals, such as in the heart of the Navy herself: Portsmouth Dockyard. This would tremendously benefit the public and tourism sector and generate greater interest in maritime archaeology. Finally, the 3D recreation of the assemblage would also be a great way to further enhance the understanding of this assemblage, in a similar way the crew of the Mary Rose were recreated (The Mary Rose Trust 2020).

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7.1 Legislation

Vermillion Accord 1989

Appendix I – Archaeological Reports/ Osteobiographies

I.I Sk. 100

I.I.I Background and Material

Individual SK. 100 was recovered from unstratified soil; due to this, only the skull and cervical vertebrae 1 & 2 are present (C Boston 2021, personal communication, 21 January). This skull is very well articulated and preserved and likely to be from a disturbed articulated burial.

I.I.II Age Estimation

Due to the absence of the post-cranial skeleton, no age estimation could be obtained for this individual by scoring the pubis symphysis (Brooks and Suchey 1990) or the auricular surface (Buckberry and Chamberlain 2002). Although the obliteration of some of the cranial sutures, such as the midcoronal and bregma (Figure 21), may suggest an older individual (Meindl and Lovejoy 1985), without further examination, this cannot be confirmed. However, it is undoubtedly an adult skeleton.

Figure 21: Right side of the cranium of individual SK. 100 showing the midcoronal and the bregma sutures (author's own 2021).

I.I.III Sex Estimation

Table 26 shows the numerous sex indicators from the skull analysed and scored to determine the sex of individual SK. 100. Table 26 shows that the indicators scored primarily scored 5 and 4 and therefore SK. 100 was likely a male due to the features' masculinity (Walker 1994; Mays 1998; White and Folkens 2005).

Table 26: The scoring of the sex estimation analysed for individual SK. 100 (author's own 2021).

Region	Indicator	Score
Cranial	Nuchal Crest	4
	Mastoid Process	5
	Supraorbital Margin	4
	Supraorbital Ridge/ Glabella	5
	Mental Eminence	3

I.I.IV Ancestry Estimation

The skull of SK. 100 showed excellent preservation (grade 1). Therefore, a Fordisc3.1 assessment was available to explore.

I.I.IV.I Results from Fordisc3.1 (Forensic Databank sample – 20th Century sample)

Due to the possible facial deformity of Sk. 100 the results produced from the forensic database sample have a low accuracy due to the distance from the mean. Of the 16 measurements that were inputted (refer to Methods *), three measurements were chosen to analyse the cranium due to their statistical power: basion-bregma height, nasal breadth, and orbital breadth. The final model was generated using the samples Guatemalan Males (53/79) and Hispanic Males (171/233) after removing samples that did not fit with the cranium. The final model produced a LOOCV accuracy of 66.7% for Guatemalan male and a 66.8% accuracy for Hispanic Male. Figure 22 shows a very close accuracy between Guatemalan male and Hispanic male. However, the Guatemalan male had a closer distance to the mean with 3.7, whereas the Hispanic male had 5.4 distance to the mean.

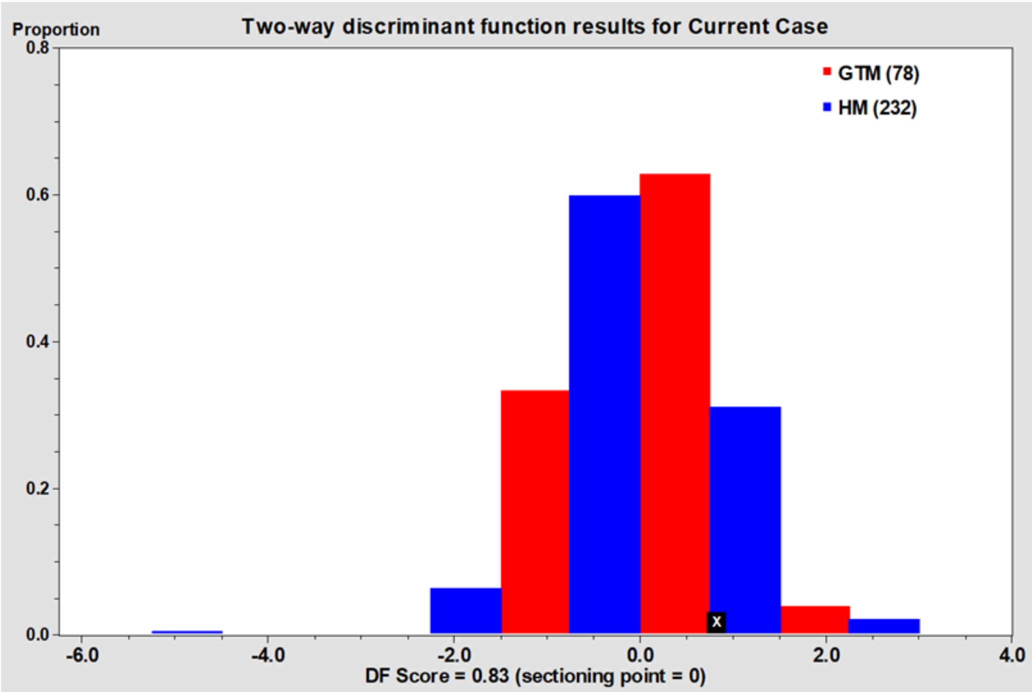


Figure 22: Two-way discriminant function results for Sk. 100 (author's own 2021).

I.I.IV.II Results from Fordisc3.1 (Howells Dataset – Historical & Archaeological sample)

Table 27 shows the relationship of the current sample to reference groups. The distance from the mean for all three groups is further away than the results from the forensic database. Figure 23 shows that this individual is just as likely to be Hainan or Peruvian than he is to be Guatemalan.

Table 27: Distance from the mean and posterior probability including Typ F, Chi and R variations of Sk. 100's Fordisc3.1 results (author's own 2021).

Group	Distance	PProb	Typ_F	Typ_Chi	Typ_R
Guatemalan Male	14.46	0.325	0.019	0.013	0.024
Hainan (Chinese) Male	15.15	0.230	0.015	0.010	0.022
Peru Male	13.83	0.445	0.024	0.017	0.036

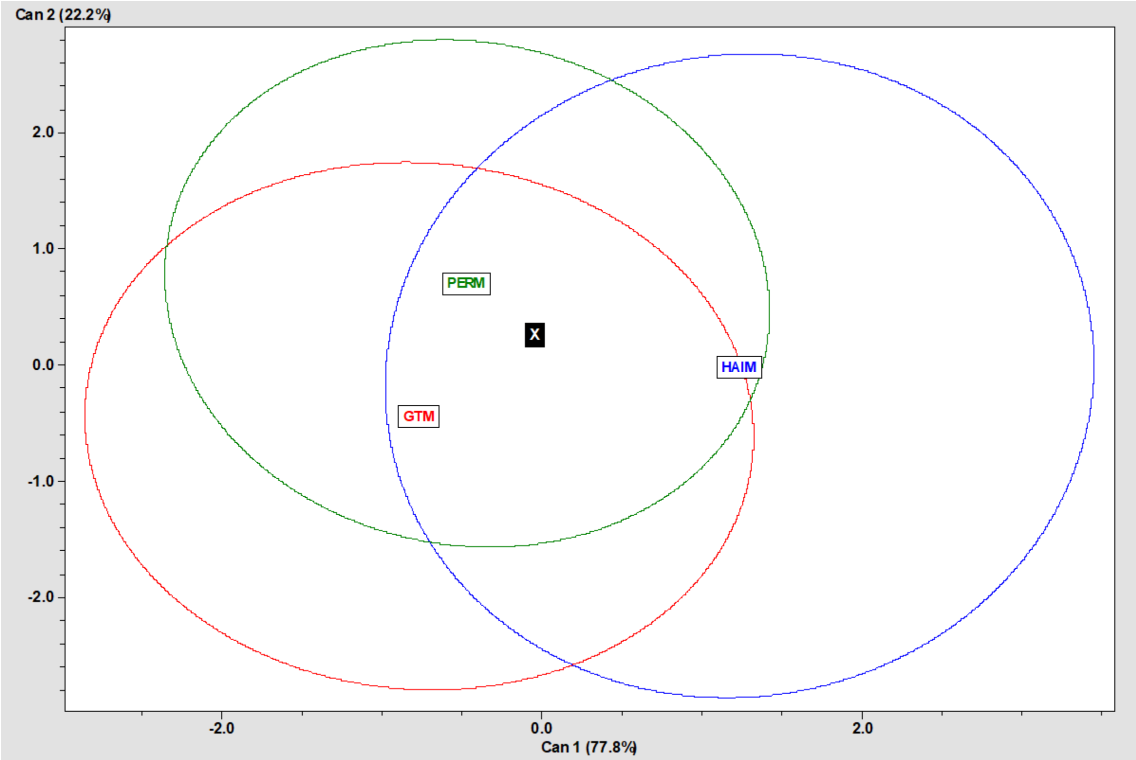


Figure 23: Graph showing the distance of the reference groups in relation to the test sample: Sk. 100 (author's own 2021).

I.I.IV.III Results from craniomorphological analysis using HefneR

This model states that Sk. 100 has a 48.32% chance of being of African descent, 38.56% of being of Asian descent, 12.67% of being of American Indian descent and 00.44% of being of European descent (Figure 24).

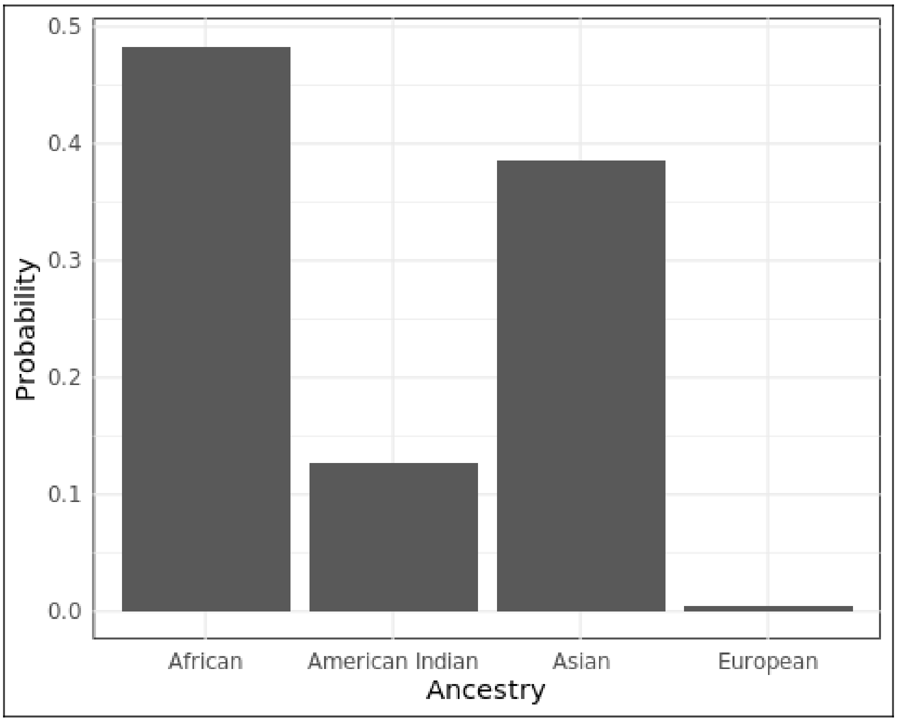


Figure 24: The probability of Sk. 100 craniomorphology matching those of different ancestral groups, via HefneR (author's own 2021).

I.I.V 6.1.5 Stature Estimation

Due to the absence of the post-cranial skeleton of individual SK. 100, it was impossible to conduct a stature estimation using Trotter and Gleser’s (1958) or Trotter’s (1970) methods.

I.I.VI Pathology

Figure 25 shows a depressed cranial fracture to the frontal bone. The fracture is located to the right side of the frontal bone, very close to the midcoronal suture. The fracture is roughly 1cm in diameter.

Figure 25: Healed depressed fracture to the right side of the frontal bone of the cranium (author's own 2021).

I.I.VII Conclusion

The burial of SK. 100 could not be examined since the skull was found in unstratified soil, which is also likely why this individual's body is missing; the original burial itself was likely disturbed.

Due to the absence of the post-cranial skeleton, the individual's age and stature could not be estimated. However, the robust bone structure and the apparent obliteration of most cranial sutures may suggest an older individual (30+ years). The ancestry analysis suggests this individual is very likely not of European descent, with a strong probability of African descent; however, the cranial morphology suggests this individual could also be of Asian descent. The pathology shows this individual sustained a depressed fracture to his frontal bone by a circular object, roughly 1cm in diameter – this could have been a musket ball. However, there is no further evidence to prove this. It is also possible that this individual suffered from muscular torticollis due to prominent asymmetrical features of the cranium, such as the mastoid process and the distortion of the atlas bone (C1). Figures 26, 27 and 28 show the skull of SK. 100 in various other angles.

Figure 26: The cranium of individual Sk. 100 (author's own 2021).

Figure 27: The cranium of individual Sk. 100 from the right side (author's own 2021).

Figure 28: The cranium of Individual Sk. 100 from the left side (author's own 2021).

I.II Sk. 523

I.II.I Background and Material

Individual Sk. 523 was excavated from grave [522] and was the only individual exhumed from this burial (C Boston 2021, personal communication, 21 January). Figure 29 shows the preservation and fragmentation condition of the skeletal fragments recovered from individual Sk. 523.

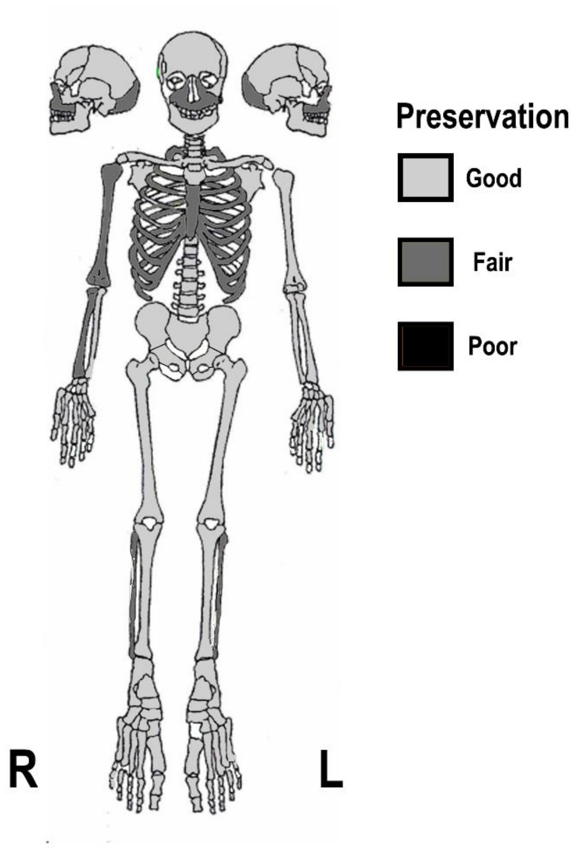


Figure 29: Available skeletal fragments of Sk. 523 and the overall preservation and fragmentation of the human remains (author's own 2021).

I.II.II Age Estimation

The age assessment for Sk. 523 was conducted by first recognising the unfused long bones, which immediately indicated this individual was not biologically mature and, therefore, a sub-adult. Table 28 shows the age ranges for the specific bones which showed signs of incomplete fusion. Due to the fusion analysis, the individual is very likely to be no younger than 16 years old (Schaefer et al. 2009; Cunningham et al. 2016).

Table 28: Epiphyseal fusion present on individual Sk. 523 and the likely age (author's own 2021).

Bone	*Proximal (yrs)*	*Medial (yrs)*	*Distal (yrs)*	*Age (yrs)*
Humerus	16-21	16-18	15-18	< 16
Fused	No	Yes	Yes	-
Ulna	14-18	N/A	16-21	< 16
Fused	Yes	N/A	No	-
Radius	-	N/A	16-20	< 16
Fused	-	N/A	No	-
Femur	14-19	N/A	16-20	< 16
Fused	Yes	N/A	No	-
Tibia	15-19	N/A	16-18	< 15
Fused	No	N/A	No	-
Mean				15.8

The auricular surface was then analysed (Buckberry and Chamberlain 2002). Table 29 shows the results of scoring the auricular surface. Scoring the pelvis suggests this individual is around 16-19 years old, which corresponds well with the long bones' epiphyseal fusion (Schaefer et al. 2009; Cunningham et al. 2016).

Table 29: Scoring of the auricular surface for individual Sk. 523 (Author's own 2021).

Method	*Characteristic*	*Score*	*Age Range*
Auricular Surface	Transverse Organisation	1	-
	Surface Texture	1	-
	Microporosity	2	-
	Macroporosity	1	-
	Apical Changes	1	-
			-
Total		6	16-19 yrs

Boston aged individual Sk. 523 to 15-17 years, which corresponds to the results obtained by analysing the long bones' epiphyseal union and the auricular surface ageing. Therefore, this individual likely was *c.* 16-19 years old at their time of death (C Boston 2021, personal communication, 21 January).

I.II.III Sex Estimation

Table 30 shows the numerous sex indicators from the skull, and the pelvis analysed and scored to determine the sex of individual Sk. 523. Table 30 shows that the indicators scored primarily scored 3 and 4 and therefore Sk. 523 was likely a male due to the features' masculinity (Phenice 1969; Walker 1994; Mays 1998; White and Folkens 2005).

Table 30: The scoring of the sex estimation analysed for individual Sk. 523 (Author's own 2021).

Region	*Indicator*	*Score*
Cranial	Nuchal Crest	3
	Mastoid Process	3
	Supraorbital Margin	4
	Supraorbital Ridge/ Glabella	3
	Mental Eminence	3
Pelvic	Ventral Arc	2
	Subpubic Concavity	3
	Medial Aspect of the Ischiopubic Ramus	-
	Greater Sciatic Notch	4

I.II.IV Ancestry Estimation

The skull of Sk. 523 showed excellent preservation (grade 1), but the facial region was highly fragmented. Therefore, CRANID and Fordisc3.1 assessments are currently not available to explore for future work. However, a craniomorphological assessment was available.

I.II.IV.I Results from craniomorphological analysis using HefneR

This model states that Sk. 523 has a 44.62 % chance of being of African descent, 31.86% of Asian descent, 22.58% of being of Native American descent and 0.93% of being of European descent (Figure 30).

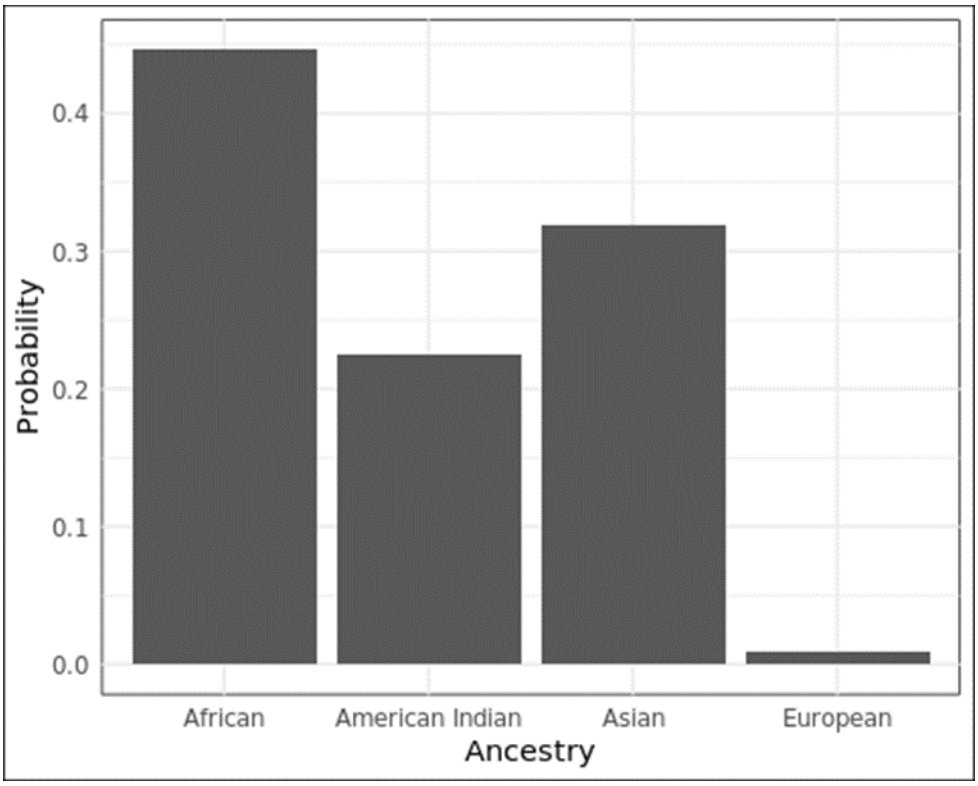


Figure 30: Morphological analysis results for Sk. 523 using HefneR (author's own 2021).

I.II.V Stature Estimation

Due to the age of individual Sk. 523, it was not possible or advisable to conduct stature estimation using Trotter's (1970) method.

I.II.VI Pathology

Figure 31 shows a healed depressed fracture to the right parietal bone, roughly 2cm in size and circular.

Figure 31: Depressed healed fracture to the right parietal bone, just above where the right temporal articulates (author’s own 2021).

Figure 32 shows healed, remodelled bone growth is present on the maxillary sinuses. Therefore, this individual likely suffered from maxillary sinusitis for a long time, probably due to exposure to poor air quality on board a Navy vessel (Lewis et al. 1995; Roberts 2007; Valme 2019).

Figure 32: Remodelled healed bone on the maxillary sinuses (author's own 2021).

Figure 33 shows the skull has an 'orange-peel’ like porosity on the parietal bones and the occipital. The affected area covers both parietals and the occipital, which may result from scurvy (Ortner 2003; Waldron 2009).

Figure 33: 'Orange-peel' like porosity on the cranium back (author's own 2021).

The postcranial skeleton shows active periostitis to the right rib (Figure 34). Periostitis to the rib is consistent with a scurvy diagnosis (Ortner 2003; Waldron 2009; Melikian and Waldron 2003).

Figure 34: Periostitis to the right rib (author's own 2021).

Figure 35 shows the patterning of pathology and trauma on individual Sk. 523.

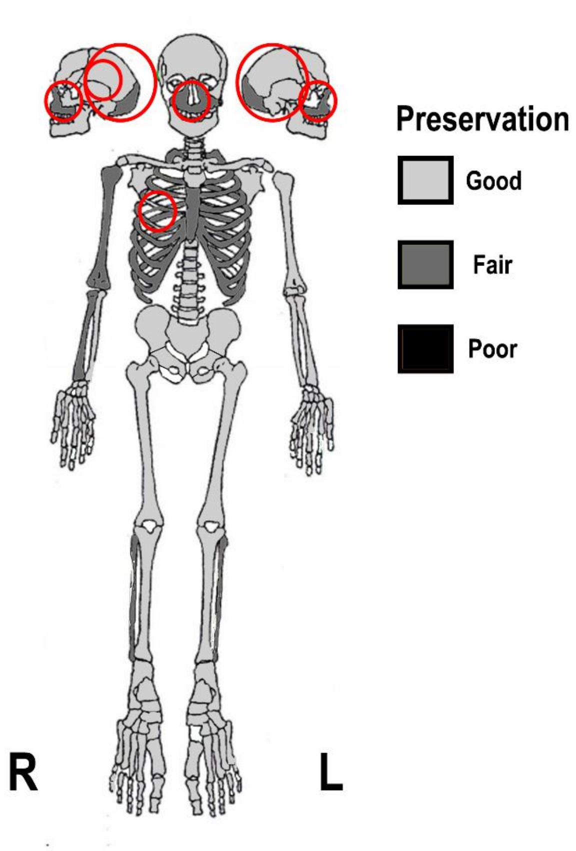


Figure 35: Pathology and trauma patterning on individual
SK. 523 (Author’s own 2021).

I.II.VII Conclusion

Individual Sk. 523's burial was not associated with any supporting artefacts, consistent with most of the assemblage (Hodgins and Salvatore 2009). The burial itself was exhumed in a single grave, and the overall preservation of this individual was excellent.

This individual was an older adolescent, around 16-19 years old, at his death. The skull's morphology suggests this individual was likely not of European descent; however, there is no further data to support this. It is unclear how long this individual had served in the Royal Navy. However, due to the presence of chronic maxillary sinusitis, he had likely been exposed to poor air quality for quite some time, whether that be within the Royal Navy or growing up in polluted areas.

This individual's bones show a vitamin-C deficiency is also likely, resulting in scurvy – similar to other individuals in this assemblage and indeed throughout the 18th century Royal Navy (Lind 1753; Lloyd 1965; Adkins 2008). Figure 36 shows the individual articulated.

Figure 36: Full articulation of SK. 523 (author's own 2021).

I.III Sk. 547

I.III.I Background and Material

Burial Sk. 547 was excavated within a single burial (C Boston 2021, personal communication, 21 January). The burial was discovered in grave [556]. Figure 37 shows the skeletal fragments which were recovered from burial Sk. 547 and the overall preservation of the fragments.

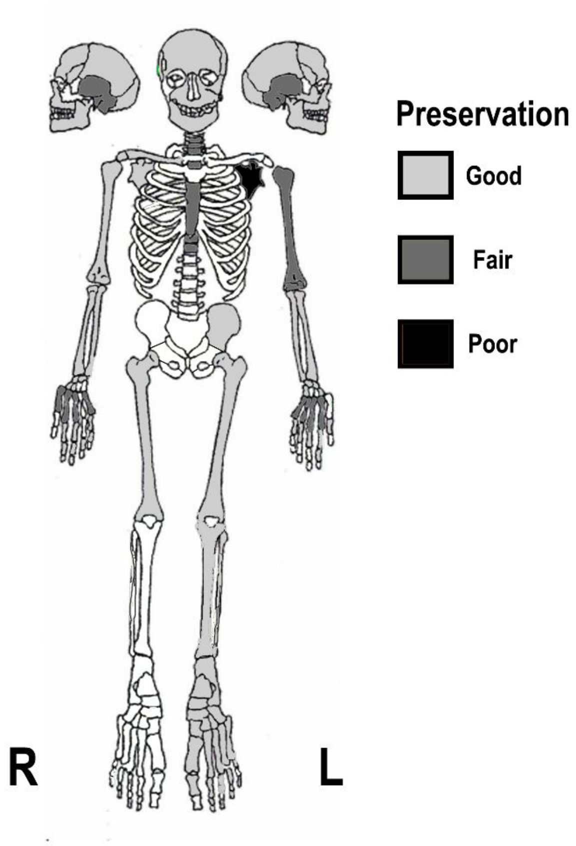


Figure 37: Available skeletal fragments of Sk. 547 and the overall preservation of the human remains (author's own 2021).

I.III.II Age Estimation

Unfortunately, due to the lack of the pelvic girdle, the auricular surface and pubic symphysis were not present, and therefore the age of this individual could not be estimated. However, the long bones show that the epiphyseal fusion had been completed in this individual, and therefore they were considered an adult.

I.III.III Sex Estimation

Table 31 shows the numerous sex indicators from the skull analysed and scored to determine the sex of individual Sk. 547. Table 31 shows that the indicators scored primarily scored 5 and 3 and therefore Sk. 547 was probably a male due to the features' masculinity. However, there were no intact pelvis traits that could be observed. Therefore, it is unreliable to obtain a sex estimation from the skull alone (Section 4.1.4) (Phenice 1969; Walker 1994; Mays 1998; White and Folkens 2005).

Table 31: The scoring of the sex estimation analysed for individual Sk. 547 (author's own 2021).

Region	*Indicator*	*Score*
Cranial	Nuchal Crest	5
	Mastoid Process	5
	Supraorbital Margin	-
	Supraorbital Ridge/ Glabella	-
	Mental Eminence	3

I.III.VI Ancestry Estimation

The skull of Sk. 547 showed good preservation (grade 2). The cranium's facial region was highly fragmented, and as a result, CRANID and Fordisc3.1 assessments are currently not available to explore for future work. Boston (2021, personal communication, 21 January) conducted a morphological assessment, which suggested that the skull could be Caucasian morphologically.

I.III.V Stature Estimation

Due to the excellent preservation (grade 1) of the right humerus and left tibia (measurement did not include the malleolus), a stature estimation was obtained (Trotter and Gleser 1958; Trotter 1970). Table 32 shows that both stature estimations broadly correspond with one another. However, since the tibia directly impacts stature, the humerus result was not considered for stature estimation in this individual. Furthermore, since, morphologically, this individual could be Caucasian, it is plausible that Sk. 547 was around 5ft 5inches tall at the time of his death.

Table 32: Measurements of Sk. 547's long bones, which were intact, with the stature estimation for each one, following Trotter and Gleser's (1958) equation and Trotter's (1970) equation (author's own 2021).

Burial Sk. 547	*Length (mm)*	*Stature Estimation (cm)*
Right Humerus	311	166.24 ± 4.43
Left Tibia	356	167.49 ± 4.04

I.III.VI Pathology

Figure 38 shows that the cranium of individual Sk. 547 has an orange-peel porosity on the ectocranial surface. Figure 39 shows that the right maxilla has a porous texture to the frontal sinus, likely chronic sinusitis (Lewis et al. 1995).

Figure 38: 'Orange-peel' like porosity on the parietals (author's own 2021).


Figure 39: Porous texture on the maxillary sinuses (author's own 2021).

The post-cranial skeleton shows a healed amputation to the right femur. Figures 40 and 41 show the amputation, which has bony outgrowths, because of its healing. Figure 41 also shows long-standing periostitis on the right femur, close to the amputation. The amputation itself was conducted midshaft on the femur.

Figure 40: Healed amputation of the right femur of individual Sk. 547 (author's own 2021).

Figure 41: Healed amputation of the right femur of individual Sk. 547 and evidence of long-standing periostitis on the femur (author's own 2021).

Figure 42 shows healed periostitis to the left tibia. The periostitis is located proximally on the left tibia. Periostitis can result from scurvy; however, it is most commonly associated with excessive physical activity (Cosca and Navazio 2007). The 'orange-peel' porosity on the ectocranial surface, together with the left tibia's healed periostitis, can support a possible scurvy diagnosis.


Figure 42: Healed periostitis located proximally on the left tibia (author's own 2021).

The pathology of individual Sk. 547 reveals a crush fracture to the first metatarsal on the left side of the body. Figure 43 shows the fracture, which is located distally on the metatarsal. The force of the fracture has caused the distal end of the metatarsal to have a crushing distortion.

Figure 43: Left side first metatarsal with a crush fracture distally (author's own 2021).

Figure 44 shows the patterning of pathology and trauma on individual Sk. 547.

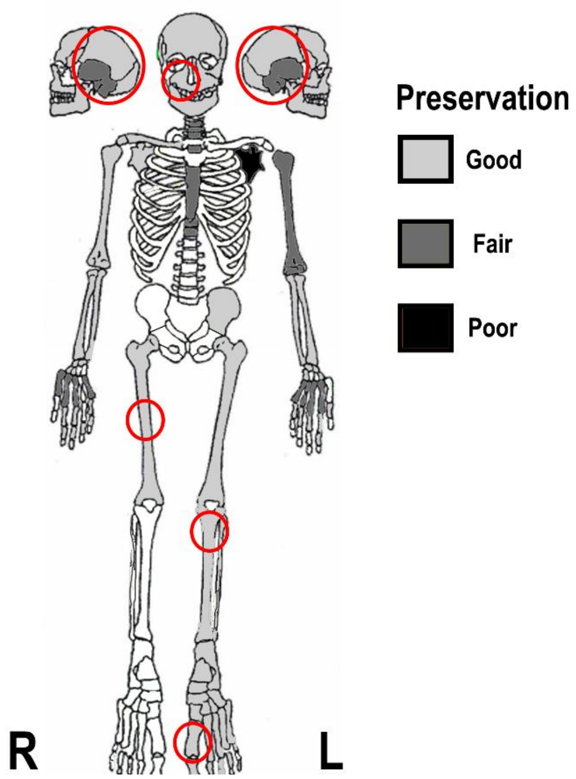


Figure 44: Pathology and trauma patterning on individual Sk. 547 (author's own 2021).

I.III.VII Conclusion

Individual Sk. 547's burial was not associated with any grave goods, consistent with most of the assemblage (Hodgins and Salvatore 2009). The burial itself was inhumed in a single grave. The overall preservation of this individual was good (grade 2).

The age of this individual at the time of their death was not able to be estimated; however, the individual was an adult and likely a male. The individual was possibly Caucasian due to the morphology of the skull. SK. 547 was roughly 5 ft 5". The pathology shows that SK. 547 had undergone an amputation to the right femur. Due to the excessive bone growth on the femur, it is clear this individual had survived the procedure long enough for the amputation to heal. Various indicators such as the skull and the tibia suggest this individual may have suffered from scurvy due to a vitamin-c deficiency. A fracture to the left big toe suggests this individual sustained a crushing injury to that region.

I.IV Sk. 551

I.IV.I Background and Material

Individual Sk. 551 was excavated within coffin 552 [550]; unlike most of the assemblage, this burial was not truncated (C Boston 2021, personal communication, 21 January). Figure 45 shows the preservation and fragmentation condition of the skeletal fragments recovered from individual Sk. 551.

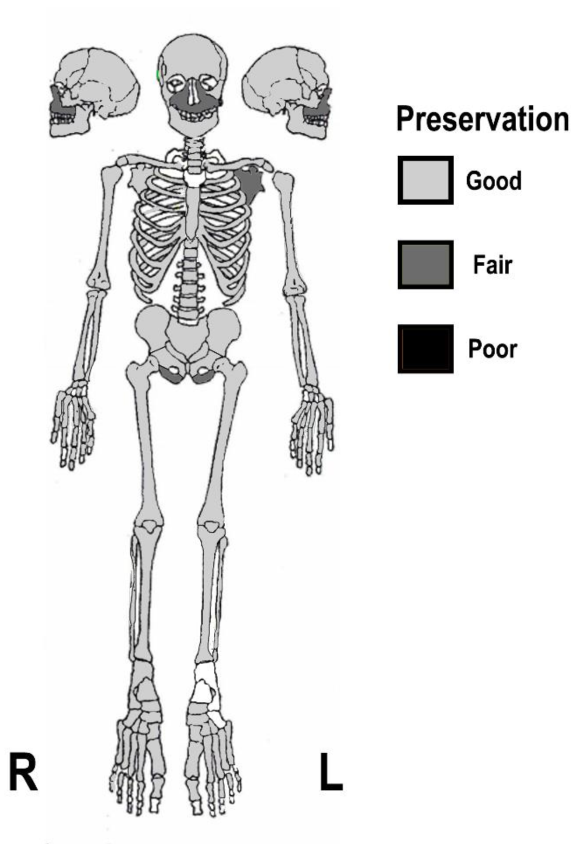


Figure 45: Available skeletal fragments of Sk. 551 and the overall preservation and fragmentation of the human remains (author's own 2021).

I.IV.II Age Estimation

The age assessment for Sk. 551 was conducted by analysing the pubis symphysis and auricular surface (Brooks and Suchey 1990; Buckberry and Chamberlain 2002). Table 33 shows the scoring for the pubic symphysis, and

Table 34 shows the scoring of the auricular surface and the corresponding age range.

Table 33: Scoring of the pubis symphysis for individual Sk. 551 (author's own 2021).

Method	*Score*	*Age Range*
Pubis Symphysis	4	23-57 years

Table 34: Scoring of the auricular surface for individual Sk. 551 (author's own 2021).

Method	*Characteristic*	*Score*	*Age Range*
Auricular Surface	Transverse Organisation	2	-
	Surface Texture	2	-
	Microporosity	2	-
	Macroporosity	2	-
	Apical Changes	2	-
			-
Total		10	16-65 yrs

An average was conducted using the age ranges, with a mean of 40 years for the pubis symphysis and 40.5 years for the auricular surface; a mean of 40.25 years was then calculated from both results. Scoring the pelvis suggests this individual is around 40 years old. Boston aged individual Sk. 551 to 40-50 years (C Boston 2021, personal communication, 21 January) which corresponds with the auricular surface and pubis symphysis results. Instead of pinpointing an exact age, age categories are more reliable and appropriate among this assemblage (except for the sub-adults). Therefore Sk. 551 falls among the 'Old Adults' category; please refer to Table 35.

Table 35: The three age categories to which the adult individual's from EA6102 have been assigned. The categories are based upon Stirland's (2005) age ranges due to the similarity and nature of both assemblages (author's own 2021).

Category	*Age*
Young Adults	18-30 years
Middle Adults	30-40 years
Old Adults	>40 years

I.IV.III Sex Estimation

Table 36 shows the numerous sex indicators from the skull, and the pelvis analysed and scored to determine the sex of individual Sk. 551. Table 36 shows that the indicators scored primarily 5 with an equal mix of 2,3 and 4 and therefore Sk. 551 was likely a male due to the features' masculinity (Phenice 1969; Walker 1994; Mays 1998; White and Folkens 2005).

Table 36: The scoring of the sex estimation analysed for individual Sk. 551 (author's own 2021).

Region	*Indicator*	*Score*
Cranial	Nuchal Crest	5
	Mastoid Process	5
	Supraorbital Margin	3
	Supraorbital Ridge/ Glabella	4
	Mental Eminence	2
Pelvic	Ventral Arc	3
	Subpubic Concavity	5
	Medial Aspect of the Ischiopubic Ramus	2
	Greater Sciatic Notch	4

I.IV.IV Ancestry Estimation

The skull of Sk. 551 showed good preservation (grade 2). The cranium's facial region was highly fragmented, and as a result, CRANID and Fordisc3.1 assessments are currently not available to explore for future work. Boston (2021, personal communication, 21 January) conducted a morphological assessment, which suggested that the skull could be Caucasian morphologically.

I.IV.V Stature Estimation

Due to the excellent preservation of both humeri, both radii, both ulnae, both femora, both tibiae (measurement did not include the malleolus) and both fibulae, a stature estimation was obtained (Trotter and Gleser 1958; Trotter 1970). Table 37 shows that all the stature estimations broadly correspond with one another. However, since the femora, tibiae, and fibulae directly impact stature, a mean of 176.61cm was calculated from all six measurements. Furthermore, since this individual is possibly Caucasian, it is likely Sk. 551 was around 5ft 8inches tall at the time of his death.

Table 37: Measurements of Sk. 551's long bones, which were intact, with the stature estimation for each one, following Trotter and Gleser's (1958) equation and Trotter's (1970) equation (author's own 2021).

Burial SK. 551	*Length (mm)*	*Stature Estimation (cm)*
Right Humerus	346	176.42 $\pm$ 4.05
Left Humerus	344	175.80 $\pm$ 4.05
Right Ulna	273	174.46 $\pm$ 4.32
Left Ulna	273	174.46 $\pm$ 4.32
Right Radius	253	174.04 $\pm$ 4.32
Left Radius	256	175.18 $\pm$ 4.32
Right Femur	485	176.24 $\pm$ 3.27
Left Femur	485	176.24 $\pm$ 3.27
Right Tibia	400	177.64 $\pm$ 3.97
Left Tibia	400	177.58 $\pm$ 3.95
Right Fibula	390	175.70 $\pm$ 3.29
Left Fibula	392	176.24 $\pm$ 3.29

I.IV.VI Pathology

Figure 46 shows that the cranium of individual Sk. 551 has an ‘orange-peel’ porosity on the ectocranial surface. The ‘orange-peel’ porosity spanned the occipital, parietals, and temporal bones.

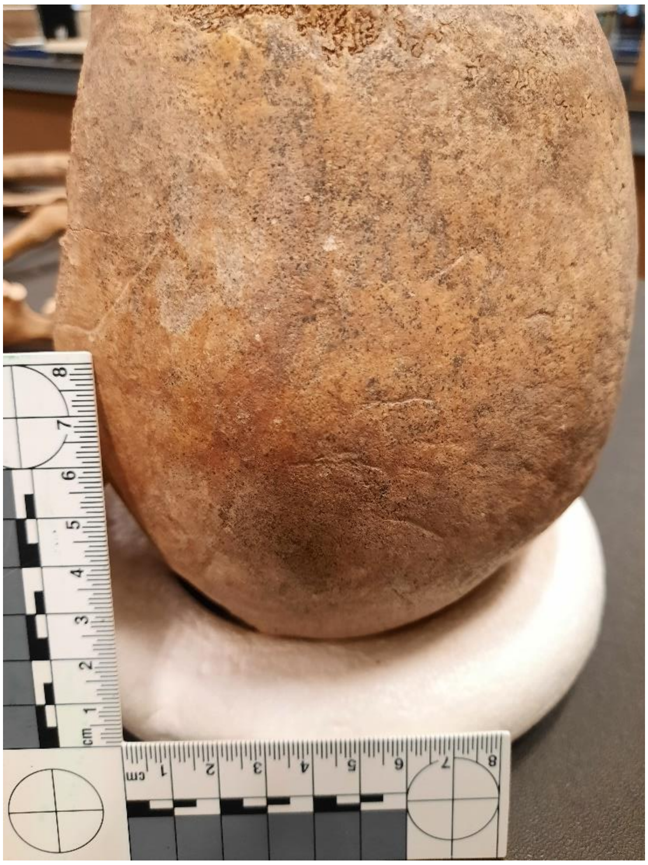


Figure 46: 'Orange-peel' like porosity on the parietals (author's own 2021).

The post-cranial skeleton shows various pathological markers. For example, Figure 47 shows small holes in the sacrum and the vertebrae spanning Thoracic 10-Lumbar 3 (Figure 48 and 49). This ‘hole-like’ appearance is consistent with a tuberculosis diagnosis (Ortner 2003; Waldron 2009). The holes vary between 0.5-1cm in diameter.

Figure 47: Sacrum of individual Sk. 551 (author's own 2021).

Figure 48: Thoracic 10- Lumbar 3 of individual Sk. 551 (author's own 2021).

Figure 49: Holes on thoracic vertebrae of Sk. 551, consistent with tuberculosis (author's own 2021).

According to Ortner (2003), lesions which are caused by tuberculosis are most prevalent in the spine. Figure 50 shows a possible soft tissue lesion to the right first metacarpal. The lesion is located distally.

Figure 50: Right first metacarpal of Individual Sk. 551 showing a possible soft tissue lesion (author's own 2021).

A fracture to the right patella has distorted the patella slightly distally. The apex of the patella also appears elongated due to the fracture (Figure 51).

Figure 51: Fracture to the right patella of individual Sk. 551 (author's own 2021).

Figures 52 and 53 show that the right tibia and fibula have healed periostitis. The periostitis is located in patches distally, mid-shaft and proximally on the right tibia and located midshaft on the right fibula.

Figure 52: Healed periostitis located on the right tibia on individual Sk. 551 (author's own 2021).

Figure 53: Periostitis located on the right fibula of individual Sk. 551 (author's own 2021).

Periostitis can result from scurvy; however, it is most commonly associated with excessive physical activity (Cosca and Navazio 2007). The 'orange-peel' porosity on the ectocranial surface, together with the right tibiae and fibula, is healed periostitis, may support a possible scurvy diagnosis. Figure 54 shows the patterning of pathology and trauma on individual Sk. 551.

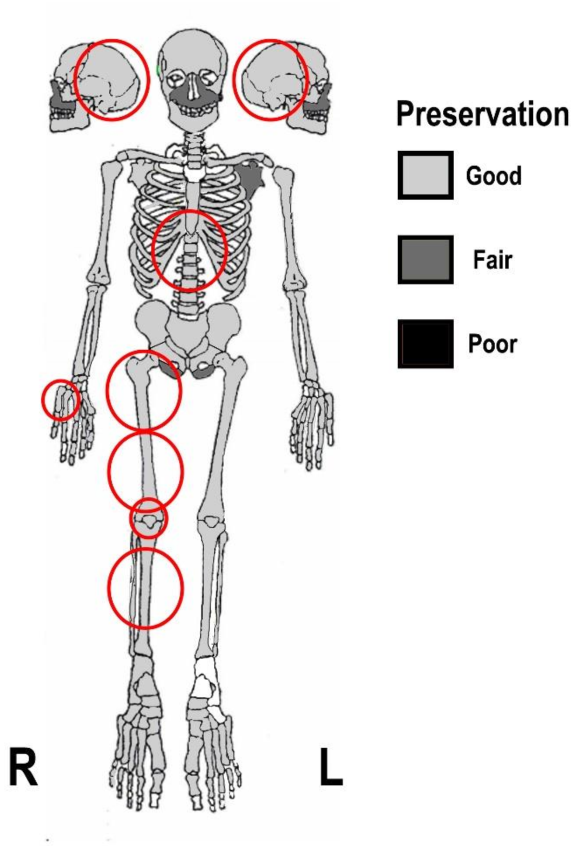


Figure 54: Pathology and trauma patterning on individual
Sk. 551 (author's own 2021).

I.IV.VII Conclusion

Individual Sk. 551's burial was not associated with any grave goods, consistent with most of the assemblage (Hodgins and Salvatore 2009). The burial itself was exhumed in a single grave. The overall preservation of this individual was excellent (grade 1).

This individual was older, likely around the age of 40, at the time of his death. The individual was possibly Caucasian due to the morphology of the skull. Sk. 551 was roughly 5 ft 8". The pathology in the spine shows Sk. 551 likely suffered from tuberculosis. Additionally, various indicators such as the skull and tibia, and fibula suggest this individual may have suffered from scurvy due to a vitamin-C deficiency. Figure 55 shows the individual articulated.


Figure 55: Photograph of Sk. 551 rearticulated (author's own 2021).

I.V Sk. 581

I.V.I Background and Material

Individual Sk. 581 was recovered from grave [583]. This individual was recovered from a single burial within a single break wooden coffin. The burial truncated the burial of individual Sk. 608. An iron nail fragment was found in the grave and some charnel (C Boston 2021, personal communication, 21 January). Figure 56 shows the preservation and fragmentation condition of the skeletal fragments recovered from individual Sk. 581.

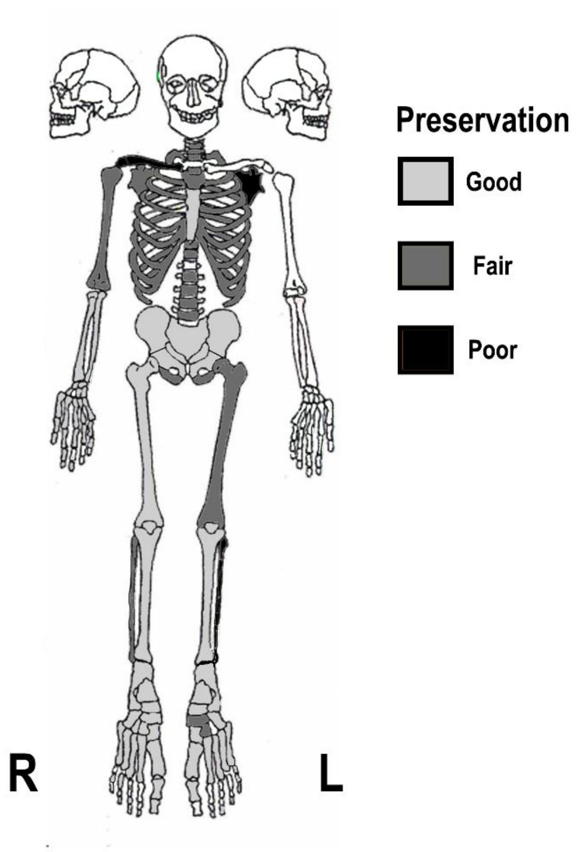


Figure 56: Available skeletal fragments of Sk. 581 and the overall preservation and fragmentation of the human remains (author's own 2021).

I.V.II Age Estimation

The age assessment for Sk. 581 was conducted by analysing the auricular surface (Buckberry and Chamberlain 2002). Unfortunately, the pubis symphysis was too poor to analyse. Table 38 shows the scoring for the auricular surface and the corresponding age range.

Table 38: Scoring of the auricular surface for individual Sk. 581 (author's own 2021).

Method	*Characteristic*	*Score*	*Age Range*
Auricular Surface	Transverse Organisation	1	-
	Surface Texture	2	-
	Microporosity	2	-
	Macroporosity	1	-
	Apical Changes	1	-
			-
Total		7	21-38 yrs

An average of the auricular surface shows a mean of 29.5 years. Using Boston's age as a comparison, she aged Sk. 681 to 20-25 years of age (C Boston 2021, personal communication, 21 January). Since the medial epiphysis of the right clavicle has not fused for this individual, it is likely the individual is between 20-30 years (Cunningham et al. 2016), therefore estimating this individual as a young adult at the time of their death, please refer back to Table 35.

I.V.III Sex Estimation

Table 40 shows the numerous sex indicators from the pelvis analysed and scored to determine the sex of individual Sk. 581. Table 40 shows that the indicators scored 3, 4 and 5, therefore Sk. 581 was likely a male due to the features' masculinity (Phenice 1969; Walker 1994; Mays 1998; White and Folkens 2005).

Table 39: The scoring of the sex estimation analysed for individual Sk. 581 (author's own 2021).

Region	*Indicator*	*Score*
Cranial	Nuchal Crest	-
	Mastoid Process	-
	Supraorbital Margin	-
	Supraorbital Ridge/ Glabella	-
	Mental Eminence	-
Pelvic	Ventral Arc	4
	Subpubic Concavity	5
	Medial Aspect of the Ischiopubic Ramus	3
	Greater Sciatic Notch	4

I.V.IV Ancestry Estimation

Unfortunately, there was no skull for individual Sk. 581 recovered at the time of the excavation (C Boston 2021, personal communication, 21 January). Due to the absence of the skull, no ancestry estimation could be determined for this individual.

I.V.V Stature Estimation

Due to the excellent preservation of the right radius, right ulna, right femur, and tibiae (measurement did not include the malleolus), a stature estimation was obtained (Trotter and Gleser 1958; Trotter 1970). Table 41 shows that all the stature estimations broadly correspond with one another. However, since the femur and tibiae directly impact stature, a mean of 175.98cm was calculated from all three measurements. Furthermore, whilst this individual's ancestry cannot be estimated, most of the assemblage appears Caucasian; therefore, if this individual is presumed Caucasian, it is likely Sk. 581 was around 5ft 7inches tall at the time of his death.

Table 40: Measurements of Sk. 581's long bones, which were intact, with the stature estimation for each one, following Trotter and Gleser's (1958) equation and Trotter's (1970) equation (author's own 2021).

Burial SK. 581	*Length (mm)*	*Stature Estimation (cm)*
Right Radius	258	176.53 $\pm$ 4.32
Right Ulna	277	176.54 $\pm$ 4.32
Right Femur	479	175.41 $\pm$ 3.27
Right Tibia	394	176.80 $\pm$ 3.97
Left Tibia	390	175.75 $\pm$ 3.95

I.V.VI Pathology

The post-cranial body of individual Sk. 581 raises interesting questions. Vertebrae cervical #5 shows fine cutmarks on the bone, consistent with decapitation (Pitts et al. 2002; Armitt et al. 2011; Smith 2017). Figure 57 shows the location of the cutmarks on the body, pedicle, and transverse process. Figure 58 shows the cutmarks on the side of the body. Due to the appearance of the cutmarks, the decapitation was likely done with a surgical saw during post-mortem.

Figure 57: Cut marks on the fifth cervical vertebrae of Individual Sk. 581 (author's own 2021).

Figure 58: Cut marks on the side of the fifth cervical vertebrae of Individual Sk. 581 (author's own 2021).

The manubrium, three rib shafts, and the right scapula display fine cutmarks, due to the marks in this region of the body, this may be the result of a possible radical forequarter resection (Dimas et al. 2007; Nierlich et al. 2011; Parsons et al. 2011) or removed post-mortem. Figure 59 shows the location of the cutmarks on the manubrium are near the left clavicular notch. Figures 60, 61 and 62 show the cutmarks on three separate rib shafts. Figure 63 shows the cutmarks located on the infraspinous fossa (near the bottom) of the right scapula. Surgeon Ralph Cuming conducted the first recorded case of a radical forequarter resection at a Royal Naval hospital in Antigua in 1808 (Keevil 1949).

Figure 59: Cutmarks located near the left clavicular notch on the manubrium of Individual SK. 581 (author's own 2021).

Figure 60: Cutmarks on the first unidentified rib shaft (author's own 2021).

Figure 61: Cutmarks on the second unidentified rib shaft (author's own 2021).

Figure 62: Cutmarks on the third unidentified rib shaft (author's own 2021).

Figure 63: Cutmarks on the right scapula, on the posterior surface (author's own 2021).

Figure 64 shows a healing Bennett fracture to the first metacarpal on the right hand, an injury which is commonly caused either through punching or in contact sports (Smith 2017).

Figure 64: Bennett fracture to the first metacarpal of the right hand (author's own 2021).

Both femora show porous lesions on the anterior aspect of the femoral neck, which may be attributed to *Cribra femoris* (Radi et al. 2013). Figures 65 and 66 show the porotic lesions located on both femora.

Figure 65: Porotic lesions located on the anterior aspect of the femoral neck of the right femur (author's own 2021).

Figure 66: Porotic lesions located on the anterior aspect of the femoral neck of the left femur (author's own 2021).

The right acetabulum of the pelvis displays an impaction fracture (Figure 67), most likely due to the age of this individual; it was sustained as a result of high-energy trauma (Fagerson et al. 2016).

Figure 67: Fracture to the acetabulum of the right ilium (pelvis) (author's own 2021).

There is also a fracture in the right foot to the proximal first phalanx (Figure 68).

Figure 68: Fracture to the proximal first phalanx of the right foot (author's own 2021).

Figure 69 shows the patterning of pathology and trauma on individual Sk. 581.

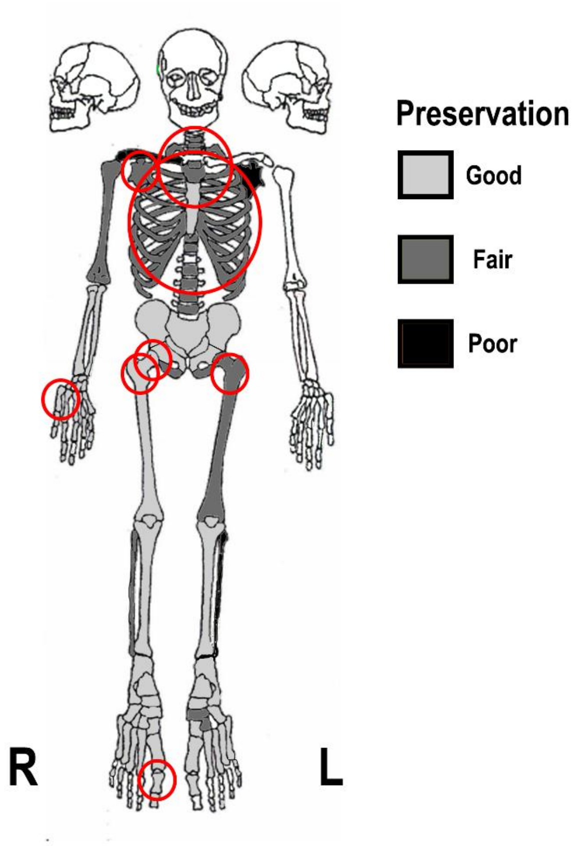


Figure 69: Pathology and trauma patterning on individual
Sk. 581 (author’s own 2021).

I.V.VII Conclusion

Individual Sk. 581’s burial was not associated with any other objects, consistent with most of the assemblage (Hodgins and Salvatore 2009). The burial itself was consistent with most of the assemblage, coffined and truncated. The recovered charnel supports the likelihood of cremation burials amongst the assemblage.

Due to the absence of this individual’s skull, there is no current way of knowing this individual's ancestry. However, if one assumes he is Caucasian because most of the assemblage is, he was likely around 5ft 7inches tall. He was likely a young adult, a man in his 20s at the time of his death. The pathology for this individual shows he was decapitated, likely by a surgeon at the hospital during post-mortem. The decapitation raises various questions, such as why was the man decapitated? The individual’s head was likely deemed interesting enough as a specimen for a surgeon’s personal collection or larger establishment such as the Hunterian Museum in London (Alberti 2011; Mitchell et al. 2011). Due to the missing skull, it is impossible to know why it was taken; however, it could have been due to an unusual pathological condition or ethnic diversity. The left arm and shoulder for this individual were also missing. The right arm and manubrium show that he may have undergone a radical forequarter resection; the presence of the right arm indicates he may have died as a result of this surgery. A fracture to his right thumb indicates he may have been involved in a brawl or engaged in boxing, perhaps as a leisure activity. Sk. 581 suffered a traumatic fracture to his pelvis, which could have been sustained during battle, a brawl onboard or the result of an accident. Fractures to his foot also suggest that this individual was likely involved in a physical altercation, whether at battle or amongst his fellow sailors. Figure 70 shows the individual articulated.

Figure 70: Full articulation of Sk. 581 (author's own 2021).

I.VI Sk. 605

I.VI.I Background and Material

Individual Sk. 605 was recovered from grave [607], the upper of two skeletons within this grave. A large amount of charnel was found within the grave fill (605) and is likely to be the remains of at least two individuals (C Boston 2021, personal communication, 21 January). An additional femur and mandible were found in the same fill (605), thus showing how commingled the burial is. An iron nail was found in grave [607] and supported the likelihood that this individual was initially buried within a coffin. Figure 71 shows the preservation and fragmentation condition of the skeletal fragments recovered from individual Sk. 605.

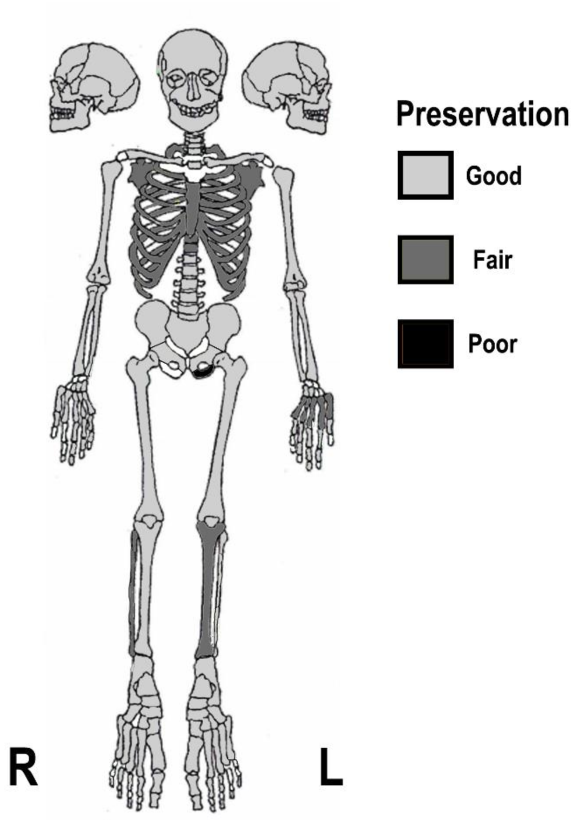


Figure 71: Available skeletal fragments of Sk. 605 and the overall preservation and fragmentation of the human remains (author's own 2021).

I.VI.II Age Estimation

The age assessment for Sk. 605 was conducted by analysing the auricular surface (Buckberry and Chamberlain 2002). Unfortunately, the pubis symphysis was too poor to analyse. Cranial suture closure dating was also conducted due to the complete skull being available to analyse and see if it corresponds with the auricular surface dating (Meindl and Lovejoy 1985). Table 42 shows the scoring for the auricular surface and the corresponding age range. Table 43 shows the results from the cranial suture closure dating and mean.

Table 41: Scoring of the auricular surface for individual Sk. 605 (author's own 2021).

Method	***Characteristic***	***Score***	***Age Range***
Auricular Surface	Transverse Organisation	1	-
	Surface Texture	1	-
	Microporosity	2	-
	Macroporosity	1	-
	Apical Changes	1	-
			-
Total		**6**	**16-19 yrs**

Table 42: Scoring of the cranial suture closure for individual Sk. 605 and the mean (author's own 2021).

Cranial suture closure	**Age Range (yrs)**	**Mean**
Interdecile range (vault)	23-45	34
Interdecile range (lateral-anterior)	28-52	40
Mean	**-**	**37**

An average of both the auricular surface and cranial suture closure was then calculated, with a mean of 27.5 years. Using Boston's age as a comparison, she aged Sk. 605 to 22-30 years of age (C Boston 2021, personal communication, 21 January). Both results correspond with each other, and therefore it is likely individual Sk. 605 was a young adult aged between 20-30 years. The third mandibular molar on the right side of the mandible shows that it was erupting at the time of the death for this individual, which broadly supports the age range of 20-30 years (Nelson and Ash 2010).

I.VI.III Sex Estimation

Table 44 shows the numerous sex indicators from the skull, and the pelvis analysed and scored to determine the sex of individual Sk. 605. Table 44 shows that the indicators scored, scored 3, 4 and 5, therefore Sk. 605 was likely a male due to the features' masculinity (Phenice 1969; Walker 1994; Mays 1998; White and Folkens 2005).

Table 43: The scoring of the sex estimation analysed for individual Sk. 605 (author's own 2021).

Region	Indicator	Score
Cranial	Nuchal Crest	4
	Mastoid Process	4
	Supraorbital Margin	4
	Supraorbital Ridge/ Glabella	3
	Mental Eminence	4
Pelvic	Ventral Arc	5
	Subpubic Concavity	3
	Medial Aspect of the Ischiopubic Ramus	4
	Greater Sciatic Notch	4

I.VI.IV Ancestry Estimation

The skull of Sk. 605 showed excellent preservation (grade 1) and minimal fragmentation. Due to the remarkable skull preservation, a Fordisc3.1 assessment was available to explore.

I.VI.IV.I Results from Fordisc3.1 (Forensic Databank sample – 20th Century sample)

Table 44 shows that Sk. 605 has a similar cranial structure to that of an Eastern Asian male, with a 53.7% probability of the individual being a Chinese male, 24.3% probability of the individual being a Japanese male and a 22% probability of the individual being a Vietnamese male. The distance from the mean for these results are closer to the mean than that of the previous individual (Sk. 100). Figure 72 shows that Sk. 605 is closer to the Chinese male samples than Japanese or Vietnamese male.

Table 44: Distance from the mean and posterior probability including Typ F, Chi and R variations of Sk. 605's Fordisc3.1 results (author's own 2021).

Group	Distance	PProb	Typ_F	Typ_Chi	Typ_R
Chinese Male	7.77	0.537	0.286	0.256	0.214
Japanese Male	9.36	0.243	0.180	0.155	0.153
Vietnamese Male	9.55	0.220	0.174	0.145	0.286

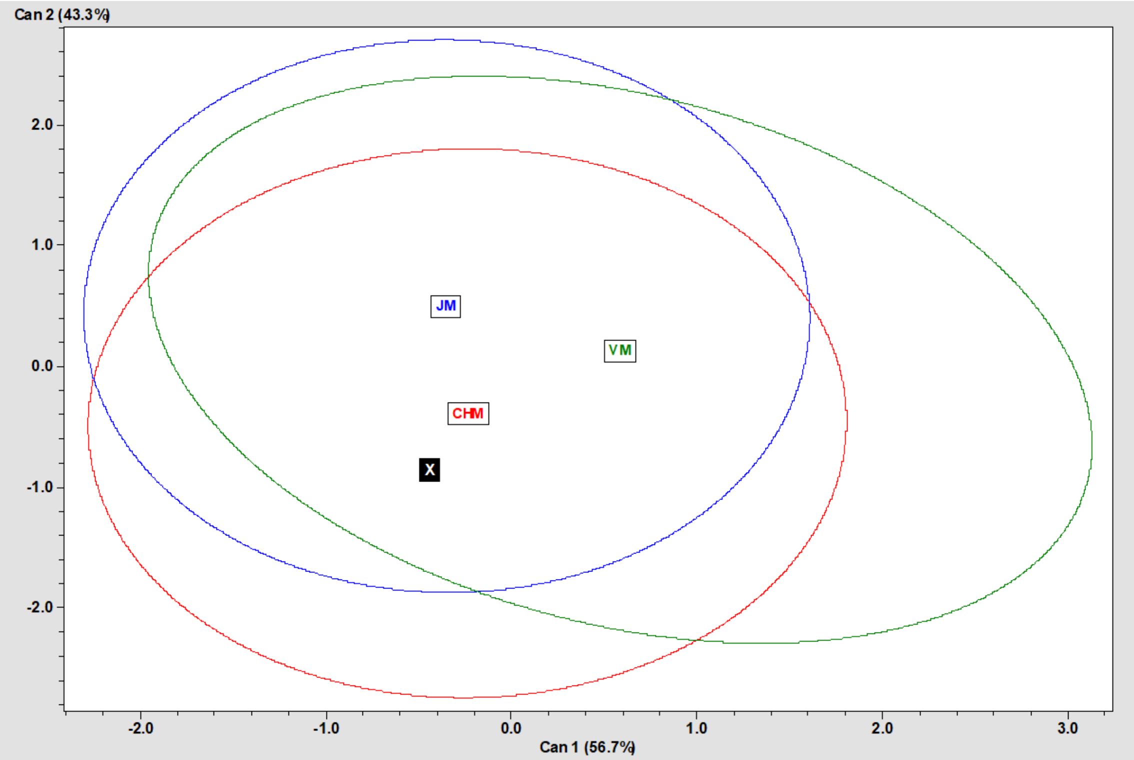


Figure 72: Graph showing the distance of the reference groups in relation to the test sample: Sk. 605 (author's own 2021).

I.VI.IV.II Results from Fordisc3.1 (Howells Dataset – Historical & Archaeological sample)

Table 45 shows the relationship of the current sample to reference groups. The distance from the mean for both groups is closer than the results from the forensic database. Figure 73 shows that this individual has a closer match with the Egyptian male samples than the Zalavar sample.

Table 45: Distance from the mean and posterior probability including Typ F, Chi and R variations of Sk. 605's Fordisc3.1 results (author's own 2021).

Group	Distance	PProb	Typ_F	Typ_Chi	Typ_R
Egyptian Male	1.33	0.622	0.524	0.513	0.542
Zalavar (Hungary) Male	2.3	0.378	0.326	0.312	0.352

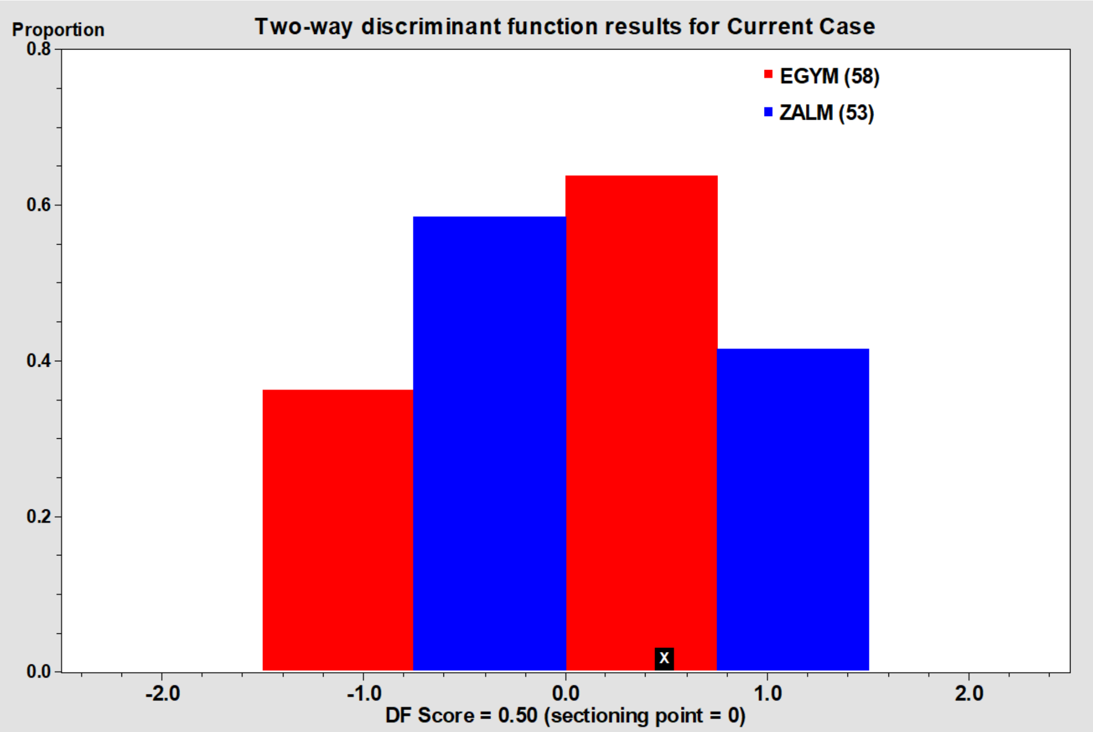


Figure 73: Two-way discriminant function results for Sk. 605 (author's own 2021).

I.VI.IV.III Results from craniomorphological analysis using HefneR

This model states that Sk. 605 has a 69.15% chance of being of Asian descent, 21.37% of being of American Indian descent, 9% of being of African descent and 0.46% of being of European descent (Figure 74).

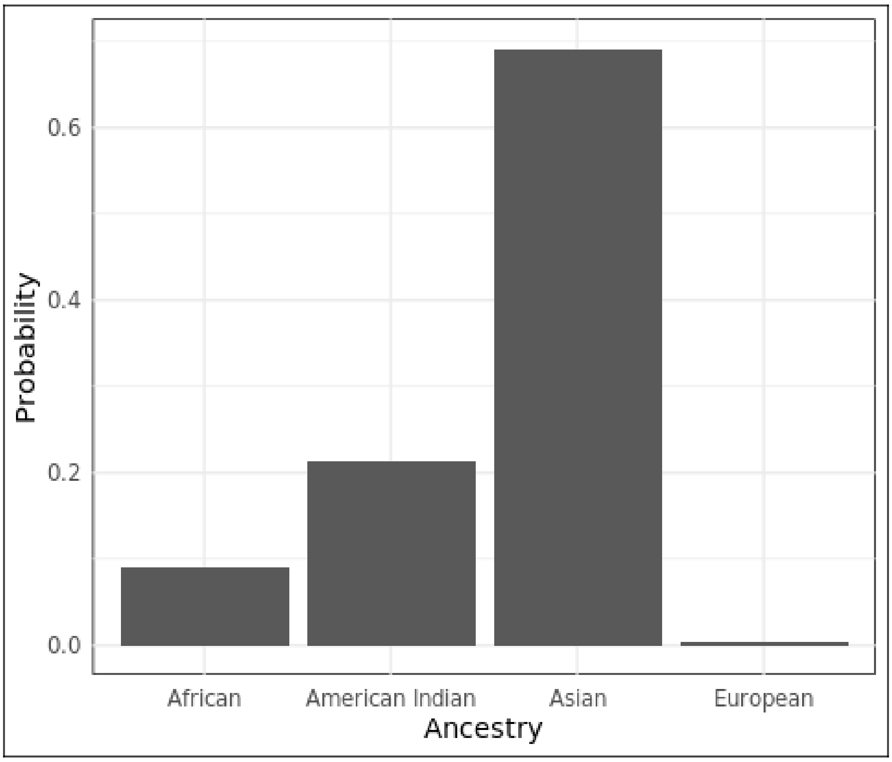


Figure 74: Morphological analysis results for Sk. 605 using HefneR (author's own 2021).

I.VI.V Stature Estimation

Due to the excellent preservation of all the long bones (excluding the tibiae), a stature estimation was obtained (Trotter 1970). Table 46 shows that all the stature estimations broadly correspond with one another. However, since the lower long bones directly impact stature, a mean of 164.44cm was calculated from both femurs and fibulas. Furthermore, since this individual is likely of Asian descent, it is likely Sk. 605 was around 5ft 4inches tall at the time of his death.

Table 46: Measurements of Sk. 605's long bones, which were intact with the stature estimation for each one, following Trotter's (1970) equation (author's own 2021).

Burial SK. 605	Length (mm)	Stature Estimation (cm)
Right Humerus	304	**164.66 + 4.25**
Left Humerus	301	**163.86 + 4.25**
Right Radius	240	**166.96 + 4.60**
Left Radius	237	**165.90 + 4.60**
Right Ulna	260	**167.93 + 4.66**
Left Ulna	261	**168.28 + 4.66**
Right Femur	426	**164.16 + 3.80**

Left Femur	424	**163.73 + 3.80**
Right Fibula	352	**165.04 + 3.24**
Left Fibula	351	**164.80 + 3.24**

I.VI.VI Pathology

When examining the skull of individual Sk. 605 an 'orange peel' like porosity is evident on the ectocranial surface and may be related to scurvy (Figure 75) (Ortner 2003; Waldron 2009).

Figure 75: 'Orange peel' porosity present on the cranium of Individual Sk. 605 (author's own 2021).

There were evident orbital lesions on both of the orbits of the cranium (Figure 76), known as *Cribra orbitalia* (Waldron 2009); whilst *Cribra orbitalia* is not characteristic of a specific disease, it is a symptom of several diseases, including scurvy (Ortner 2003; Stirland 2005).

Figure 76: Cribra orbitalia present on the orbits of Sk. 605 (author's own 2021).

New bone growth is evident on the maxilla's posterior (Figure 77), another indicator of chronic scurvy (Ortner et al. 1999 and 2001; Klaus 2017).

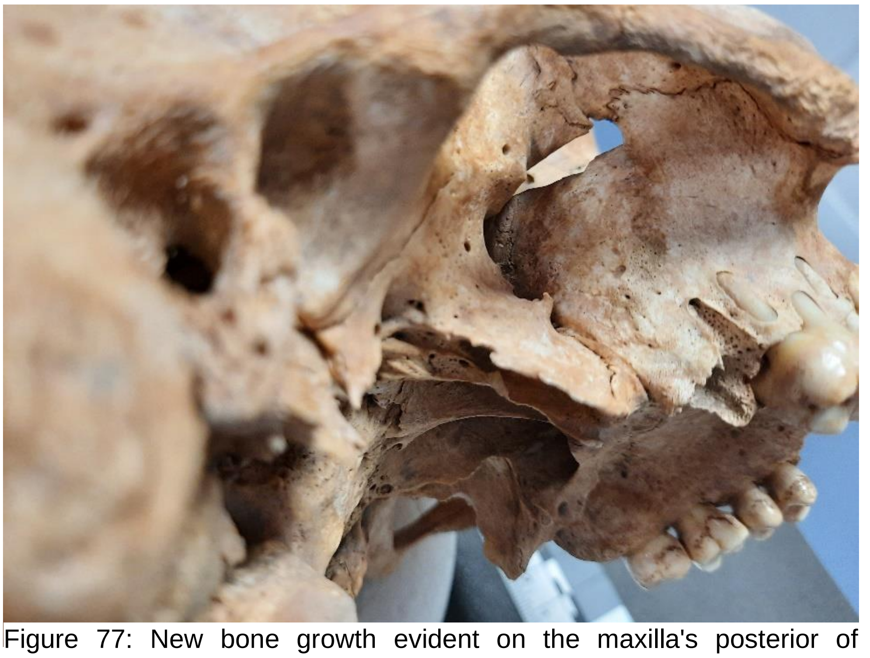


Figure 77: New bone growth evident on the maxilla's posterior of individual Sk. 605 (author’s own 2021).

The postcranial skeleton shows healed periostitis on the left and right tibia distally (Figure 78) and the right fibula distally (Figure 79). Due to the skull's indicators, the periostitis is likely a result of healed scurvy in this individual (Ortner 2003, Waldron 2009; (C Boston 2021, personal communication, 21 January). Periostitis is a condition that many modern-day athletes suffer from due to repetitive stress to the lower limb bones. Therefore, the presence of periostitis in this individual may reflect his body's physical stress daily (Cosca and Navazio 2007).

Figure 78: Right tibia with the presence of periostitis (author's own 2021).

Figure 79: Right fibula with the presence of periostitis (author's own 2021).

Figure 80 shows the patterning of pathology on individual Sk. 605.

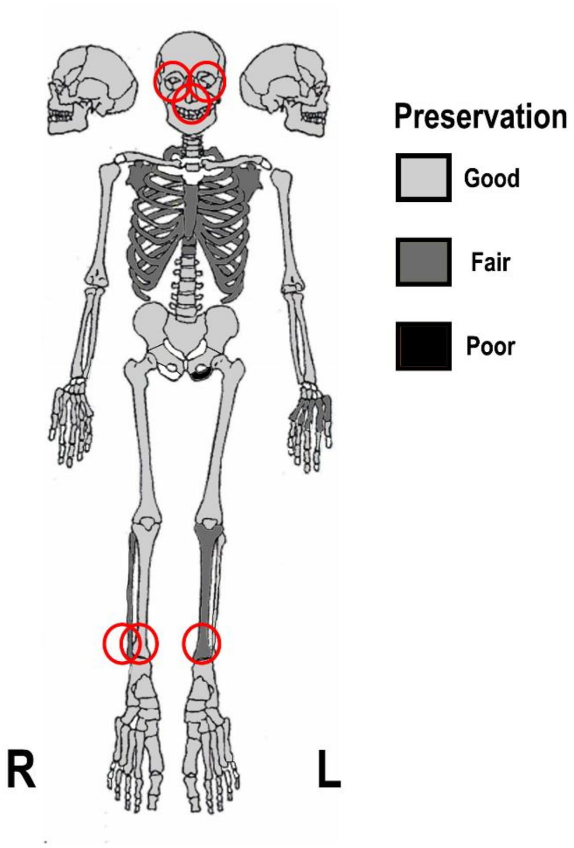


Figure 80: Pathology and trauma patterning on individual Sk. 605 (Author's own 2021).

I.VI.VII Conclusion

Individual Sk. 605's burial was not associated with any accompanying artefacts, consistent with most of the assemblage (Hodgins and Salvatore 2009). The presence of an iron nail recovered suggests that this individual was likely original buried within a coffin. The charnel of at least two individuals shows that cremations were also present within the burial ground (C Boston 2021, personal communication, 21 January).

Sk. 605 was a young adult at the time of his death, likely around 20-30 years. The ancestry analysis shows that this individual is very likely not of European descent; however, it is plausible that this individual is of Asian descent. Sk. 606 is likely to have been around 5ft 4inches tall – the shorter end of the height spectrum amongst this assemblage. The individual's bones show it was likely he suffered from a vitamin-C deficiency and thus resulting in chronic scurvy. In addition, trauma to the lower limbs may have resulted from intense, repetitive physical activity, likely due to daily life on board a ship. Figure 81 shows the individual articulated.

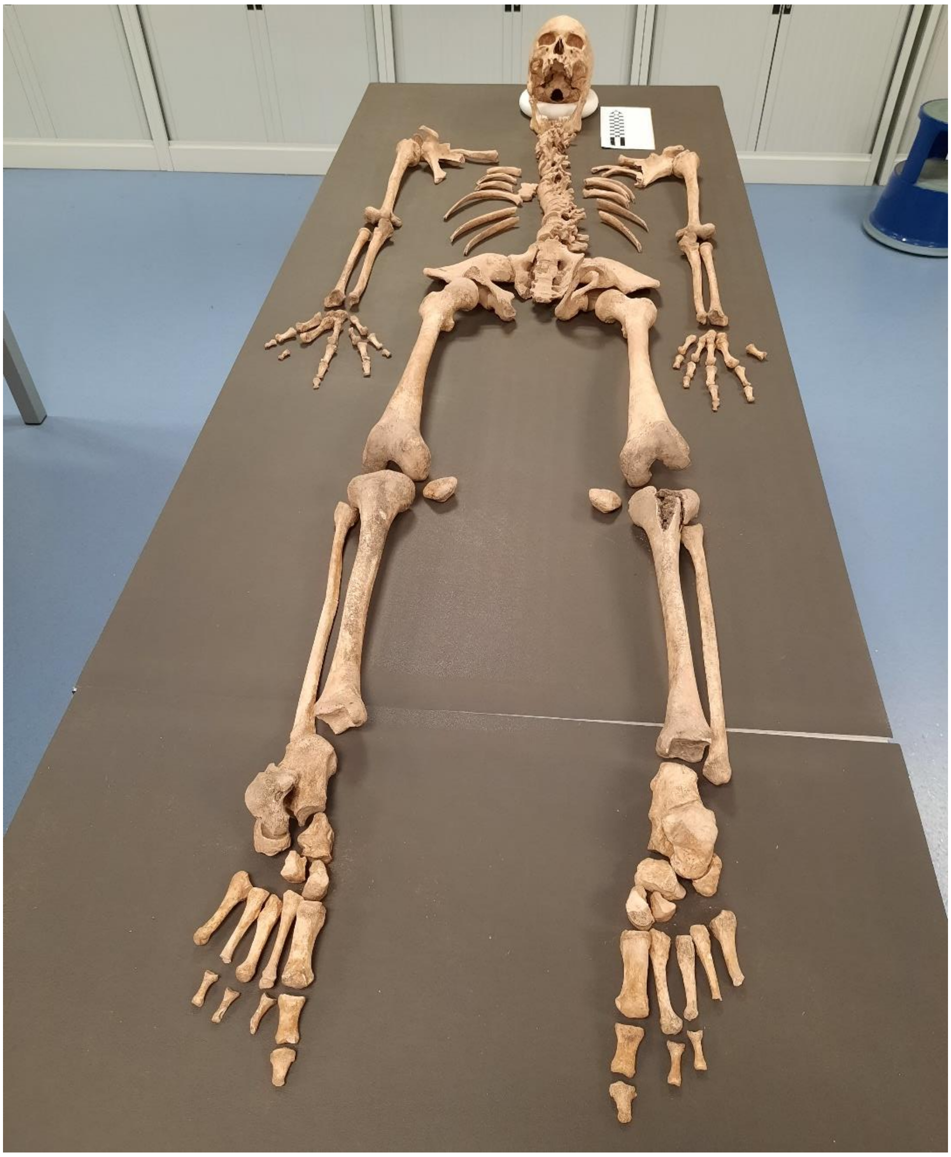


Figure 81: Individual Sk. 605 articulated (author's own 2021).

I.VII Sk. 617

I.VII.I Background and Material

Individual Sk. 617 was recovered from grave [619] and overlaid another skeleton (number not given). This individual was buried within a clear single break coffin (C Boston 2021, personal communication, 21 January). Figure 82 shows the preservation and fragmentation condition of the skeletal fragments recovered from individual Sk. 617.

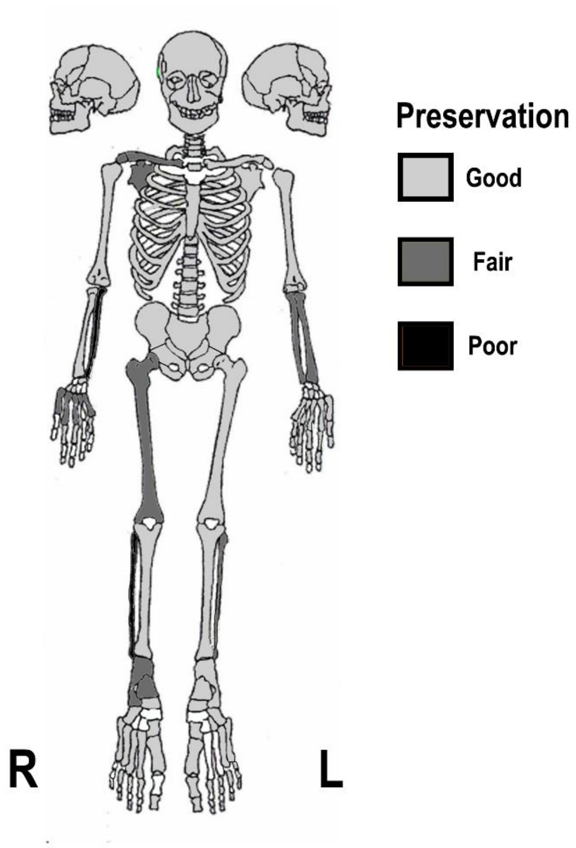


Figure 82: Available skeletal fragments of Sk. 617 and the overall preservation and fragmentation of the human

I.VII.II Age Estimation

Upon initial observation, due to some of the cranial suture closures' obliteration, this individual was likely an older adult compared to the rest of the assemblage (Meindl and Lovejoy 1985). The age assessment for Sk. 617 was conducted by analysing the pubis symphysis and auricular surface (Brooks and Suchey 1990;

Buckberry and Chamberlain 2002). Table 47 shows the scoring for the pubic symphysis and the auricular surface and the corresponding age range.

Table 47: Scoring of the auricular surface and pubic symphysis for individual Sk. 617 (Author's own 2021).

Method	Score	Age Range
Auricular Surface	8	29-67 yrs
Pubis Symphysis	2	19-34 yrs

Due to the wide-range age brackets from Table 47, the results do not appear to correlate with the first instinct that the individual's bones physically appeared older than those techniques suggested. Since both techniques are known to overage or underage an individual, some discrepancies regarding age among the assemblage are inevitable (Hoppa 2000; Falys et al. 2006). Boston's (2021, personal communication, 21 January) data showed that she had aged this individual to around 45- 50 years, which seems more likely due to the skeleton's appearance and the sutures. It is necessary to suggest that this individual's appropriate age range is likely around 40-50 years.

I.VII.III Sex Estimation

Table 49 shows the numerous sex indicators from the skull, and the pelvis analysed and scored to determine the sex of individual Sk. 617. Table 49 shows that the indicators scored 3, 4 and 5, therefore Sk. 617 was likely a male due to the features' masculinity (Phenice 1969; Walker 1994; Mays 1998; White and Folkens 2005).

Table 48: The scoring of the sex estimation analysed for individual Sk. 617 (Author's own 2021).

Indicator	Score
Nuchal Crest	-
Mastoid Process	-
Supraorbital Margin	-
Supraorbital Ridge/ Glabella	3
Mental Eminence	3
Ventral Arc	4

Subpubic Concavity	5
Medial Aspect of the Ischiopubic Ramus	5
Greater Sciatic Notch	4

I.VII.IV Ancestry Estimation

The skull of Sk. 617 showed excellent preservation (grade 1) and minimal fragmentation. Due to the excellent skull preservation, a Fordisc3.1 assessment was available to explore.

I.VII.IV.I Results from Fordisc3.1 (Forensic Databank sample – 20th Century sample)

Table 49 shows that Sk. 617 has a 61.2% probability of being a Guatemalan male and a 38.8% probability of the individual being a Black male. The distance from the mean for these results are too far away from the sample to be considered accurate. Figure 83 shows that Sk. 617 is a closer match with the Guatemalan sample than the Black male sample.

Table 49: Distance from the mean and posterior probability including Typ F, Chi and R variations of Sk. 617's Fordisc3.1 results (author's own 2021).

Group	Distance	PProb	Typ_F	Typ_Chi	Typ_R
Guatemalan Male	14.9	0.612	0.029	0.021	0.012
Black Male	15.8	0.388	0.021	0.015	0.035

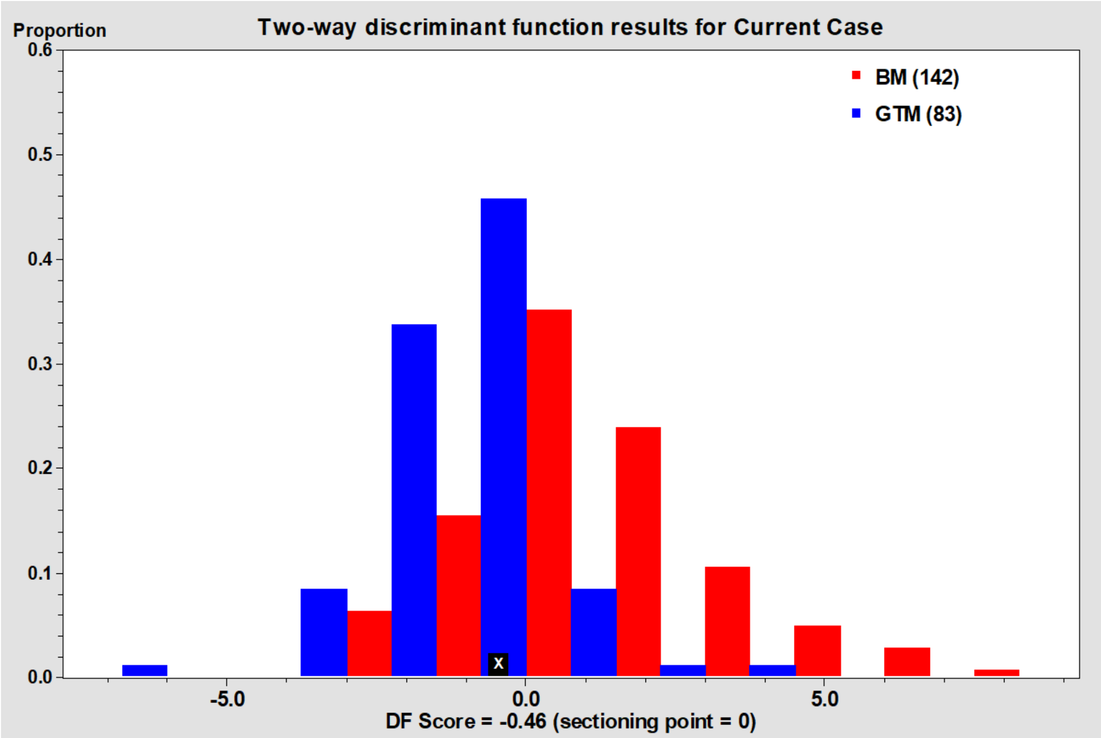


Figure 83: Two-way discriminant function results for Sk. 617 (author's own 2021).

I.VII.IV.II Results from Fordisc3.1 (Howells Dataset – Historical & Archaeological sample)

Table 50 shows the relationship of the current sample to reference groups. The distance from all the groups is too far from the sample; this shows that there are no immediate matches for this individual's ancestry, and therefore, the further away, the more unlikely the result. Figure 84 shows that this individual does not match any of the samples. The closest match is with a black male (19th century) sample.

Table 50: Distance from the mean and posterior probability including Typ F, Chi and R variations of Sk. 617's Fordisc3.1 results (author's own 2021).

Group	Distance	PProb	Typ_F	Typ_Chi	Typ_R
Black Male (19th century)	48.9	0.863	0.000	0.000	0.013
Andaman Island Male	53.7	0.080	0.000	0.000	0.028
Dogon (Mali) Male	55.5	0.033	0.000	0.000	0.021
Guatemalan Male	57.7	0.011	0.000	0.000	0.013
Teita (Kenya) Male	58.5	0.007	0.000	0.000	0.029
Zulu Male	59.2	0.005	0.000	0.000	0.018
White Male (19th century)	62.6	0.001	0.000	0.000	0.010
Egyptian Male	65.7	0.000	0.000	0.000	0.017
Bushman (South Africa) Male	67.5	0.000	0.000	0.000	0.024
South Japan Male	68.2	0.000	0.000	0.000	0.020
Atayal (Taiwan) Male	68.4	0.000	0.000	0.000	0.033
Peruvian Male	72.7	0.000	0.000	0.000	0.018
Santa Cruz (USA) Male	73.6	0.000	0.000	0.000	0.019
North Japan Male	73.6	0.000	0.000	0.000	0.018
Tolai (New Britain) Male	74.9	0.000	0.000	0.000	0.018
Phillipines Male	76.3	0.000	0.000	0.000	0.020
Easter Island Male	77.4	0.000	0.000	0.000	0.020
Hainan (China) Male	78.7	0.000	0.000	0.000	0.022
Ainu (Japan) Male	79.8	0.000	0.000	0.000	0.020
Australian Male	81.4	0.000	0.000	0.000	0.019
Anyang (China) Male	86.2	0.000	0.000	0.000	0.023
Mokapu (Hawaii) Male	87.1	0.000	0.000	0.000	0.019
Tasmania Male	88.1	0.000	0.000	0.000	0.022
Guam Male	94.7	0.000	0.000	0.000	0.032
Moriori (Chatham Islands) Male	96.5	0.000	0.000	0.000	0.017
Eskimo (Greenland) Male	96.6	0.000	0.000	0.000	0.019
Arikara (USA) Male	102.6	0.000	0.000	0.000	0.023
Buriat (Siberia, Russia) Male	120.3	0.000	0.000	0.000	0.018

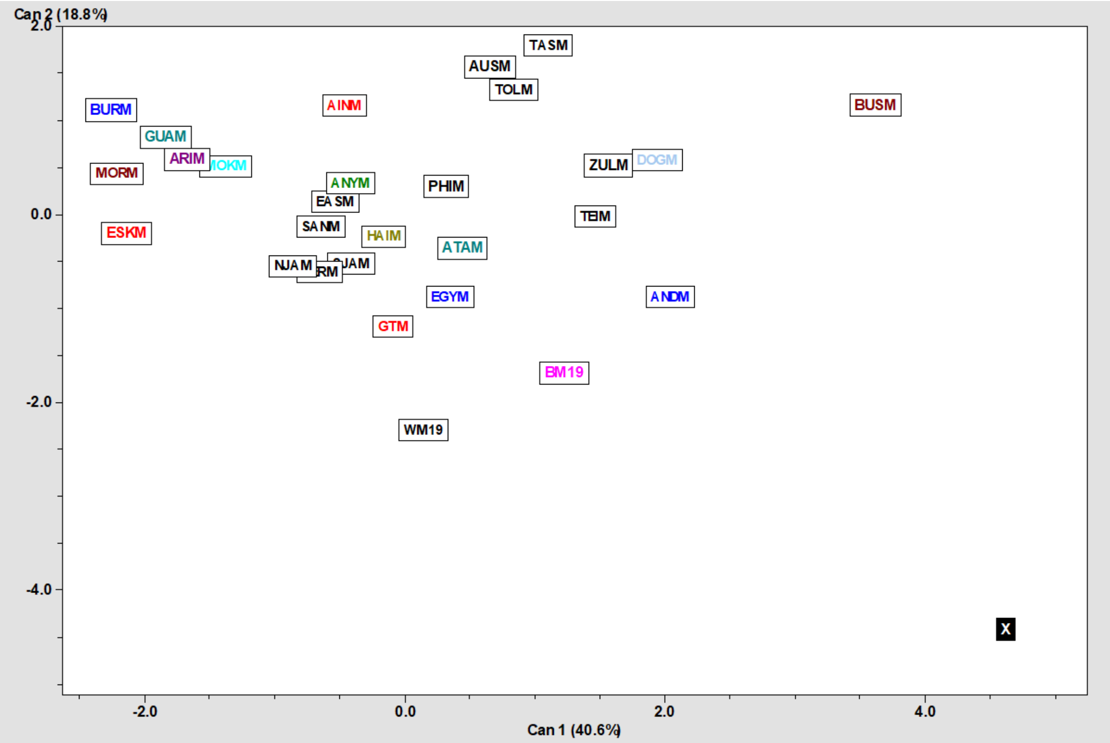


Figure 84: Graph showing the distance of the reference groups in relation to the test sample: Sk. 617 (author's own 2021).

I.VII.IV.III Results from craniomorphological analysis using HefneR

This model states that Sk. 617 has a 52.6% chance of being of African descent, 34.71% of being of Asian descent, 10.76% of being of American Indian descent and 1.92% of being of European descent (Figure 85).

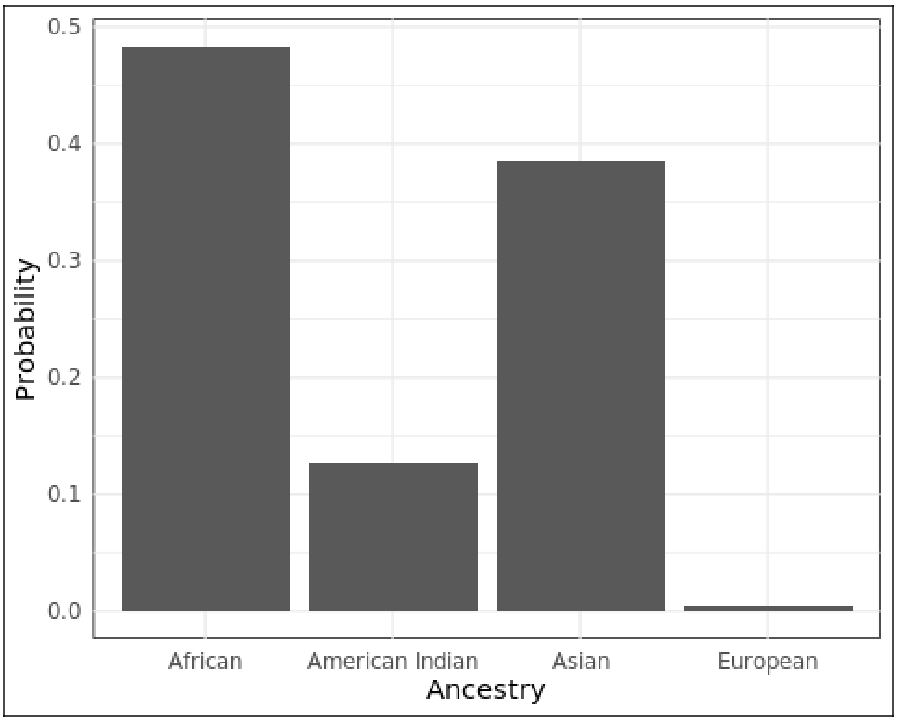


Figure 85: Morphological analysis results for Sk. 617 using HefneR (author's own 2021).

I.VII.V Stature Estimation

Due to the excellent preservation of both humeri, right radius and both femurs, a stature estimation was obtained (Trotter 1970). Table 51 shows that all the stature estimations broadly correspond with one another. However, since the femurs directly impact stature, a mean of 163.41cm was calculated from them both. Furthermore, since this individual is likely of African descent, it is likely Sk. 617 was around 5ft 4inches tall at the time of his death.

Table 51: Measurements of Sk. 617's long bones were intact, with the stature estimation for each one, following Trotter's (1970) equation (Author's own 2021).

Burial SK. 617	**Length (mm)**	**Stature Estimation (cm)**
Right Humerus	324	**167.72 ± 4.43**
Left Humerus	321	**166.75 ± 4.43**
Right Radius	234	**161.59 ± 4.30**
Right Femur	446	**164.46 ± 3.94**
Left Femur	436	**162.35 ± 3.94**

I.VII.VI Pathology

When examining the skull of individual Sk. 617 an 'orange peel' like porosity is evident on the ectocranial surface and may be related to scurvy (Ortner 2003; Waldron 2009).

Figure 86: 'Orange peel' porosity on the cranium of Sk. 617 (author's own 2021).

The postcranial skeleton shows a fracture in an un-sided rib (C Boston 2021, personal communication, 21 January). In addition, the tibiae show healed periostitis and may be an indicator of scurvy, especially when scurvy indicators are also present on the skull (Ortner 2003, Waldron 2009).

When investigating the axial skeleton further, it was clear that lumbar #1 had a wedge fracture (Figure 87); this may result from the weakened trabecular bone due to primary osteoporosis and general ageing of the skeleton (Waldron 2009; Giambini et al. 2013). A wedge fracture in the vertebral column secondary to vertebral collapse is often caused by infection or malignant disease (Waldron 2009). Schmorl's nodes were also evident in some of the thoracic vertebrae. Schmorl's nodes are common, and the cause is often due to significant stresses to the lower spine, such as hard, manual labour (Ortner 2003; Waldron 2009).

Figure 87: Wedge fracture in lumbar #1 (author's own 2021).

Schmorl's nodes and stress of the spine were evident amongst the Mary Rose sailors and attributed to activities undertaken on board the ship (Stirland and Waldron 1997). This individual also appears to have lumbarisation, the abnormal appearance of six lumbar vertebrae rather than five (Figure 88) (Wade et al. 2019).

Figure 88: Lumbarisation of Sk. 617 (author's own 2021).

The individual's right scapula reveals os acromiale (Figure 89), a developmental aberration in which the distal acromion fails to fuse (Youm et al. 2005); this again indicates a certain level of physical activity (Rogers et al. 2006).

Figure 89: os acromiale of the right scapula (right in photo) (author's own 2021).

Figure 90 shows the patterning of pathology on individual Sk. 617.

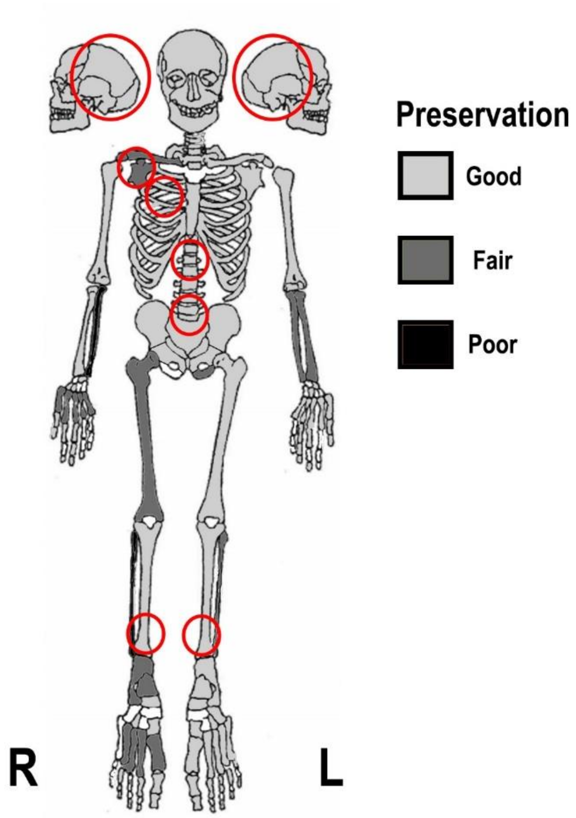


Figure 90: Pathology and trauma patterning on individual SK. 617 (Author's own 2021).

I.VII.VII Conclusion

Individual Sk. 617's burial was not associated with any burial artefacts, consistent with most of the assemblage (Hodgins and Salvatore 2009). The individual was buried with a single break coffin, which is not unusual among this assemblage (C Boston 2021, personal communication, 21 January).

Sk. 617 was an older adult at the time of his death, likely around 40-50 years, one of the eldest among this assemblage. This individual's skeleton has a morphology like that of the Greenwich pensioners (C Boston 2021, personal communication, 21 January). The ancestry analysis for this individual, although somewhat conflicting, suggests he is not of European descent; this individual is more likely to be of African descent. Sk. 617 is likely to have been around 5ft 5inches tall – an average height for a man of this time (Stirland 2005). The individual's pathology shows it was likely he suffered from a vitamin-C deficiency and thus resulted in scurvy - much like the rest of the men of this assemblage. In addition, there were notable injuries to the spine, probably due to a lifetime of manual labour on a ship, similar to that of the *Mary Rose* sailors (Stirland and Waldron 1997). As a result of these spine injuries, he likely suffered back problems and pain. It is pretty remarkable that at the age of 40-50 years old, this man was able to continue his occupation as a sailor, especially when the average life expectancy of a man of this period is 49.5 years (Johansson 2010), unlike the majority of the assemblage he lived an entire life. Figure 91 shows the individual articulated.

Figure 91: Sk. 617 rearticulated not including the lower limbs and feet) (author's own 2021).

I.VIII Sk. 624

I.VIII.I Background and Material

Burial Sk. 624 was found underlying burial Sk. 623 (C Boston 2021, personal communication, 21 January). The burial was situated in grave [626]. Figure 92 shows the preservation condition of the skeletal fragments recovered from individual Sk. 624. No evidence such as wood or iron nails were found to indicate this individual was buried in a coffin.

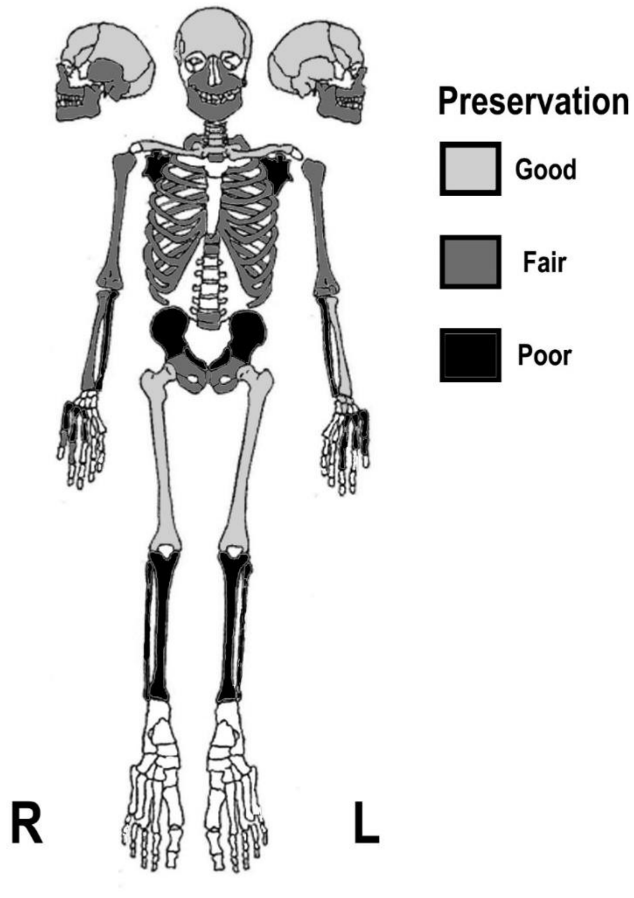


Figure 92: Available skeletal fragments of Sk. 624 and the overall preservation of the human remains (author's own 2021).

I.VIII.II Age Estimation

The age assessment for Sk. 624 was conducted by first recognising the unfused long bones, which immediately indicated this individual was not biologically mature and, therefore, a sub-adult. Table 52 shows the age ranges for the specific bones which showed signs of incomplete fusion. Due to the fusion analysis, the individual is very likely to be younger than 14 years of age (Schaefer et al. 2009; Cunningham et al. 2016). However, due to the development of the long bones and morphological appearance (such as the appearance of the metaphyseal surface on the distal radius and the fovea on the proximal radius), this individual is likely no younger than 10-11 years old (Schaefer et al. 2009; Cunningham et al. 2016). There is also no sign of the third, permanent molars, which correlates with the suggested age range (Nelson and Ash 2010).

Table 52: Epiphyseal fusion present on individual Sk. 624 and the likely age (author's own 2021).

Bone	*Proximal (yrs)*	*Medial (yrs)*	*Distal (yrs)*	*Age (yrs)*
Humerus	16-21	16-18	15-18	< 15
Fused	No	No	No	-
Ulna	14-18	N/A	-	< 14
Fused	No	N/A	-	-
Radius	-	N/A	16-20	< 16
Fused	-	N/A	No	-
Femur	14-19	N/A	16-20	< 14
Fused	No	N/A	No	-
Tibia	15-19	N/A	-	< 15
Fused	No	N/A	-	-
Fibular	-	N/A	-	-
Fused	-	N/A	-	-
Clavicle	N/A	16-30	-	< 16
Fused	N/A	No	-	-
Acetabulum	14-18	N/A	N/A	< 14
Mean				14.86

The pubic symphysis and auricular surface were then analysed (Brooks and Suchey 1990; Buckberry and Chamberlain 2002). Table 53 shows the results of scoring both the auricular surface and the pubic symphysis. While scoring the pelvis suggests this individual is a little older than the epiphyseal fusion shows, it further supports that this individual is very young and likely a sub-adult.

Table 53: Scoring of the auricular surface and pubic symphysis for individual Sk. 624 (author's own 2021).

Method	*Score*	*Age Range*
Auricular Surface	6	16-19 yrs
Pubis Symphysis	1	15-21 yrs

Boston ages individual Sk. 624 to *c*. 11-13 years, which corresponds to the results obtained by analysing the long bones' epiphyseal union. Therefore, this individual likely was *c.* 11-13 years old at their time of death (C Boston 2021, personal communication, 21 January).

I.VIII.III Sex Estimation

Table 54 shows that numerous sex indicators from the skull and the pelvis were analysed and scored to determine the sex of individual Sk. 624. Table 54 shows that the indicators were very mixed; the skull showed signs of femininity, whereas the pelvis showed masculinity scores. Due to the pelvis's reliability, the individual is likely male rather than female (Phenice 1969; Walker 1994; Mays 1998; White and Folkens 2005). Due to the young age of this individual, estimating the sex for Sk. 624 is unreliable. It produces less accuracy than in an older individual. However, it is plausible that this individual is a male due to the nature of this assemblage.

Table 54: The scoring of the sex determination analysed for individual Sk. 624 (author's own 2021).

Indicator	*Score*
Nuchal Crest	1
Mastoid Process	3
Supraorbital Margin	-
Supraorbital Ridge/ Glabella	-
Mental Eminence	4
Ventral Arc	5
Subpubic Concavity	3
Medial Aspect of the Ischiopubic Ramus	4
Greater Sciatic Notch	4

I.VIII.IV Ancestry Estimation

The skull of Sk. 624 shows mixed preservation; the upper crania show good (grade 1) preservation, whereas the lower crania show fair (grade 3) preservation. Unfortunately, the skull was too fragmented for any morphological assessment.

I.VIII.V Stature Estimation

Due to the age of individual Sk. 624, it was not possible or advisable to conduct stature estimation using Trotter's (1970) method.

I.VIII.VI Pathology

Evidence of remodelled bone on the maxillary sinuses (Figure 93) suggests this individual may have been suffering from active sinusitis (Waldron 2009; Brothwell 2012). Whilst sinusitis is considered a reasonably modern infection; studies have linked the infection with poor air quality (Lewis et al. 1995; Roberts 2007; Valme 2019). Due to the cramped conditions on board an 18th-century ship and the toxic vapours of the hold, this individual was likely exposed to poor air quality and thus not surprising that this individual suffered from chronic sinusitis (Rodger 1986).

Figure 93: Remodelled bone growth to the maxillary sinuses, possible sinusitis (author's own 2021).

The postcranial skeleton shows active periostitis on the right tibia (Figure 94) and fibula, consistent with active healing scurvy; however, no other scurvy indicators could be observed on this individual (Ortner 2003; Waldron 2009).

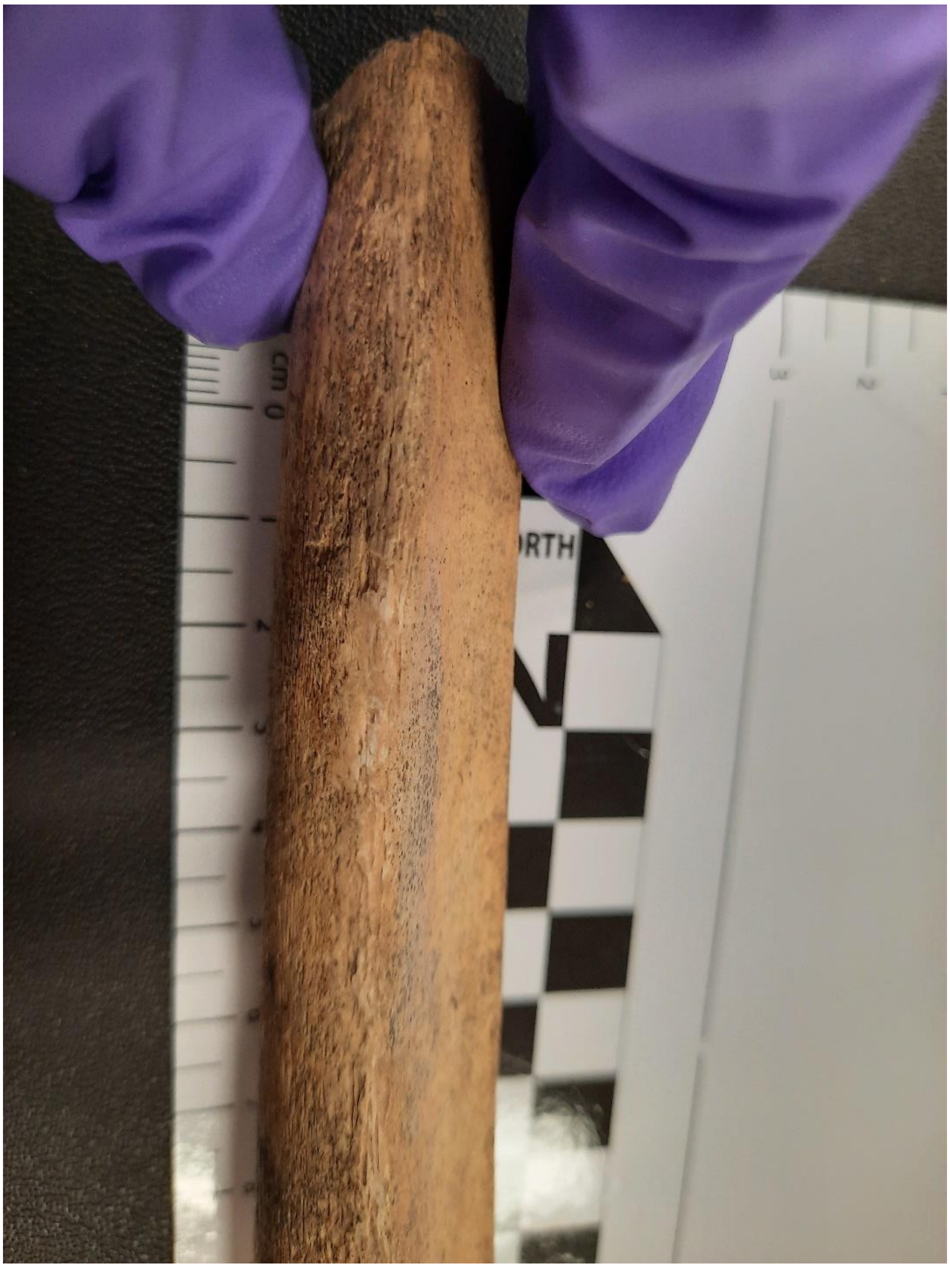


Figure 94: Active periostitis on the right tibia (author's own 2021).

Due to the size and length of this individual's long bones (Table 55), it appears that Sk. 624 suffered from stunted growth. The long bones of this individual measure the length of a nine-year-old/ ten-year-old, whereas the bones' morphology is a little too mature for this age (Anderson et al. 1964; Maresh 1970; Gindhart 1973; C Boston 2021, personal communication, 21 January). Stunted growth may be associated with continuous malnutrition, which correlates with a scurvy diagnosis and starvation (Follis 1948; Ortner 2003; Ragsdale and Lehmer 2012).

The individual suffered an amputation on the proximal left tibia (Figure 95); this is evident due to the straight, precise cut just below where the patella sits. Cut/ seriation marks are also present on the bone, which was likely caused by a surgical saw. Unfortunately, there is no sign of healing on the bone, and therefore it is likely that the individual died shortly after or during the amputation process (Kirkup 2007; Skaar 2014). The individual's feet were not recovered – however it is entirely possible that due to the size of some of the tarsals, metatarsals and phalanges, they were missed at the excavation, or they did not preserve well due to acidic soil conditions.

Figure 95: Amputation to the left tibia (author's own 2021).

Table 55: Diaphyseal length of long bones from Sk. 624 with age correlation studies (author's own 2021).

Bone	*Diaphyseal Length (mm)*	*Anderson et al. (1964) Age (yrs)*	*Maresh (1970) Age (yrs)*	*Gindhart (1973) Age (yrs)*	*Mean (yrs)*
Humerus (L)	262	-	12	-	12
Humerus (R)	258	-	11.5	-	11.5
Radius (L)	175	-	9.5	8.5	9
Radius (R)	175	-	9.5	8.5	9
Femur (L)	349	10	10	-	10
Femur (R)	346	9	10	-	9.5
Total					10.16

Figure 96 shows the patterning of pathology and trauma on individual Sk. 624.

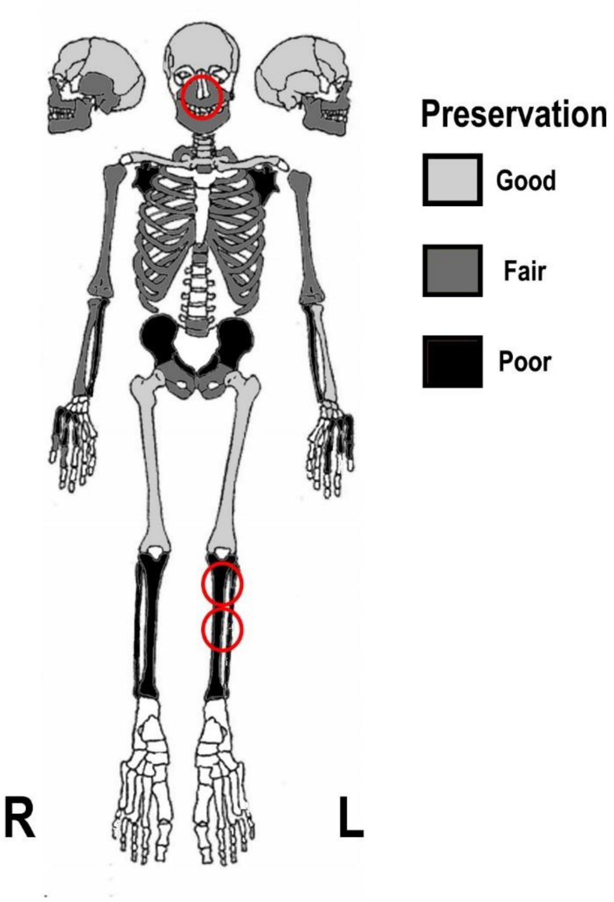


Figure 96: Pathology and trauma patterning on individual SK. 624 (author's own 2021).

I.VIII.VII Conclusion

The burial of Sk. 624 was not associated with any accompanying objects, typical of the 18th century Royal Navy (Rodger 1986; Adkins 2008; Hodgins and Salvatore 2009). The burial is somewhat consistent with the rest of the EA6102 assemblage; however, there is no physical evidence to suggest this individual was buried within a coffin, which may support the theory that this child came from a poorer/ less privileged background. The placement of this individual was found directly underneath burial Sk. 623 and highlights the mass of burials that were taking place at this time relating to the high mortality rate of the Royal Navy.

Sk. 624 was likely a young boy aged between 11-13 years old. It is plausible that this individual had already served a fair number of years in the Royal Navy, despite his tender age. His bones indicate ongoing malnutrition, possible scurvy and exposure to poor air quality, fitting for life on board an 18th-century ship (Adkins 2008). Perhaps this individual was recruited at six years of age (Rodger 1986). Sk. 624 was small for his age which may attest further to his laborious upbringing onboard a ship. He likely suffered from scurvy, but his bones show the condition was healing; this could mean that he sustained a richer vitamin-C diet whilst a patient in the hospital (Lind 1753; Lloyd 1965). After his amputation, the lack of healing attests that either he succumbed to death during or quickly after the amputation process (Adkins 2008). Figure 97 shows the individual articulated.


Figure 97: Individual Sk. 624 rearticulated (author's own 2021).

I.IX Sk. 633

I.IX.I Background and Material

Individual Sk. 633 was found buried in a truncated grave [635]. There was no mention of this individual being buried in a coffin, nor were any accompanying objects recovered from this burial (C Boston 2021, personal communication, 21 January). A later burial truncated this individual's legs; Figure 98 shows the preservation and fragmentation condition of the skeletal fragments recovered from individual Sk. 633.

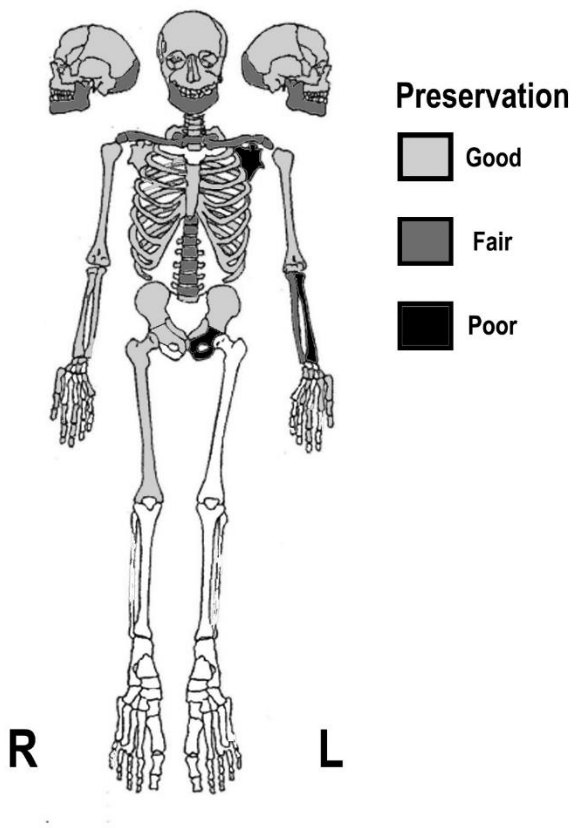


Figure 98: Available skeletal fragments of Sk. 633 and the overall preservation and fragmentation of the human remains (author's own 2021).

I.IX.II Age Estimation

The age assessment for Sk. 633 was conducted by analysing the pubic symphysis and the auricular surface (Brooks and Suchey 1990; Buckberry and

Chamberlain 2002). Table 56 shows the scoring for the pubic symphysis and the auricular surface and the corresponding age range.

Table 56: Scoring of the auricular surface and pubic symphysis for individual Sk. 633 (author's own 2021).

Method	*Score*	*Age Range*
Auricular Surface	8	21-38 yrs
Pubis Symphysis	1	15-23 yrs

An average was then conducted using the age ranges, with a mean of 29.5 years for the auricular surface and 19 years for the pubic symphysis; therefore, the means produced an age range spanning 19-29.5 years. When comparing Boston's unpublished, raw data for the individuals at the time of their initial excavation, she aged Sk. 633 to 20-30 years of age (C Boston 2021, personal communication, 21 January). The combined mean's age of the auricular surface and pubis symphysis corresponds with Boston's age range, and therefore it is likely this individual was between 20-30 years of age at the time of his death. Instead of pinpointing an exact age, age categories are more reliable and appropriate among this assemblage (except for the sub-adults). Therefore Sk. 633 falls among the 'Young Adults' category; please refer to Table 35.

I.IX.III Sex Estimation

Table 58 shows the numerous sex indicators from the skull, and the pelvis analysed and scored to determine the sex of individual Sk. 633. Table 58 shows that the indicators that could be scored ranged between 3-5, therefore Sk. 633 was likely a male due to the features' masculinity, emphasising the very masculine greater sciatic notch (Phenice 1969; Walker 1994; Mays 1998; White and Folkens 2005).

Table 57: The scoring of the sex estimation analysed for individual Sk. 633 (author's own 2021).

Indicator	*Score*
Nuchal Crest	3
Mastoid Process	5
Supraorbital Margin	4
Supraorbital Ridge/ Glabella	3
Mental Eminence	4
Ventral Arc	-
Subpubic Concavity	-
Medial Aspect of the Ischiopubic Ramus	-
Greater Sciatic Notch	5

I.IX.IV Ancestry Estimation

The skull of Sk. 633 shows significant preservation and minimal fragmentation compared to the rest of the assemblage: EA6102. A craniomorphological assessment of the cranium was carried out.

I.IX.IV.I Results from craniomorphological analysis using HefneR

This model states that Sk. 633 has a 72.67% chance of being of African descent, 12.66% of being of Asian descent, 11.79% of being of Native American descent and 2.86% of being of European descent (Figure 100).

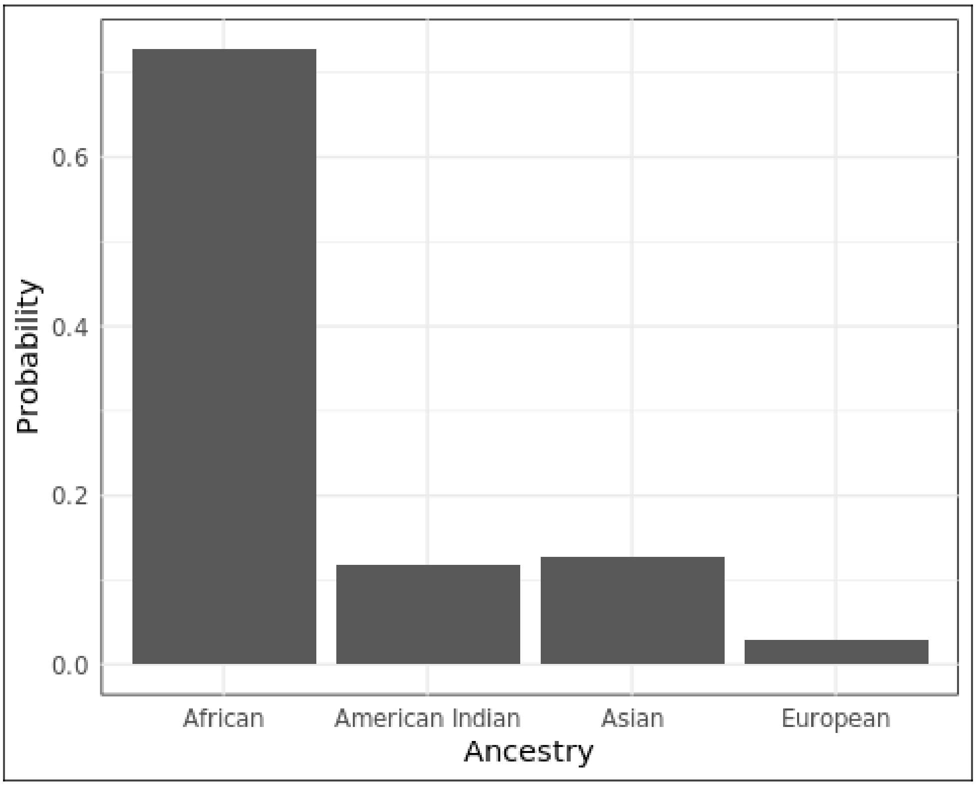


Figure 100: Morphological analysis results for Sk. 633 using HefneR (author's own 2021).

I.IX.V Stature Estimation

Due to the excellent preservation of both humeri and the right ulna and radius of Sk. 633, a stature estimation was obtained (Trotter 1970). Unfortunately, due to the fragmentation of the other long bones, they could not be measured correctly or included in the equation for stature estimation. Table 59 shows that the humerus, radius and ulna give similar stature estimations; therefore, due to the absence of the lower, long bones, a mean was calculated from these results. The mean calculated from the humerus, radius and ulna is 158.09cm. This individual is likely of African descent; therefore, it is credible Sk. 633 was around 5ft 2inches tall at the time of his death.

Table 58: Measurements of Sk. 633's long bones, which were intact with the stature estimation for each one, following Trotter's (1970) equation (author's own 2021).

Burial	*Right Humerus*	*Left Humerus*	*Right Radius*	*Right Ulna*
Sk. 633	283mm	296mm	230mm	245mm
Stature Estimation (cm)	154.36 $\pm$ 4.43	158.60 $\pm$ 4.43	160.22 $\pm$ 4.30	159.16 $\pm$ 4.42

I.IX.VI Pathology

The skull of individual Sk. 633 showed likely *osteomyelitis* on the right side of the mandible due to slight swelling and inflammatory destruction of bone; interestingly, *osteomyelitis* became an amputation indicator in the 18th century (Waldron 2009). Though *osteomyelitis* is rare in adults and the skull, it may represent continued or recurrent juvenile *osteomyelitis*; this is much more likely to occur within mandibular infections (Adelstein and Courville 1933; Ortner 2003). There were also fractures to the left parietal bone and the right side of the mandible (Figure 101). *Osteomyelitis* in the skull may occur from ear or sinonasal infections (Ridder et al. 2015).

Figure 101: Swollen right side of the mandible, likely the result of osteomyelitis (author's own 2021).

A large, likely, abscess is evident on the left side of the hard palate (Figure 102). Abscesses on the hard palate are most commonly to maxillary lateral incisors or palatal roots of the posterior teeth; they are usually very painful (Jauch and Valdez 2021). In addition, an 'orange-peel' like porosity is evident on the ectocranial surface and may be related to scurvy (Ortner 2003; Waldron 2009; C Boston 2021, personal communication, 21 January).

Figure 102: Abscess to the left side of hard palate (author's own 2021).

The postcranial skeleton shows a healed fracture to the right humerus (Figure 103), which has caused the bone to bend inwards slightly.

Figure 103: Healed fracture to the right humerus (author's own 2021).

There are also fractures to the third metacarpal on the right hand and a distal phalange on the right side. In addition, the acetabula's of both ilia have fractures, and there are fine cutmarks to the left ilium (Figure 104).

Figure 104: Cut marks to the right illium (author's own 2021).

The right ilium shows potential projectile trauma (Figure 105) (C Boston 2021, personal communication, 21 January).


Figure 105: Possible projectile trauma to the right ilium (author's own 2021).

The individual suffered an amputation on the right femur; this is evident due to the straight, precise cut through the bone's midshaft (Figure 106). Cut/ seriation marks are also present on the bone, which was likely caused by a surgical saw. There is no sign of healing on the bone, and therefore it is likely that the individual died shortly after or during the amputation process (Kirkup 2007; Skaar 2014).

Figure 106: Amputation to the midshaft of the right femur (author's own 2021).

Figure 107 shows the patterning of pathology and trauma on the bones.

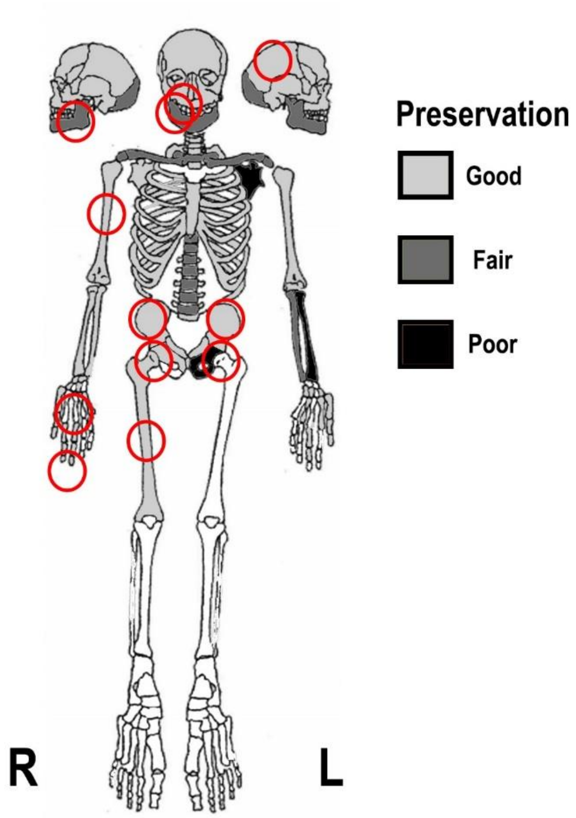


Figure 107: Pathology and trauma patterning on individual Sk. 633 (author's own 2021).

I.IX.VII Conclusion

Individual Sk. 633's burial was not associated with any accompanying objects, consistent with most of the assemblage (Hodgins and Salvatore 2009). There were also no findings suggesting the individual was initially placed in a coffin (C Boston 2021, personal communication, 21 January).

This individual was aged between 20-30 years old, a young adult, at the time of his death. Cranial morphology indicates that Sk. 633 was likely not of European descent; however, there is no further data to support this. Sk. 633 is likely to have been around 5ft 2inches tall – shorter than most of the other men in this assemblage. The individual's bones show he suffered multiple fractures to his body, likely due to his daily duties. Sk. 633's injuries also show he suffered trauma to his pelvis, likely from a projectile shot and therefore, it is credible to suggest he suffered this in battle. Cut marks to his pelvis raise interesting questions about the treatment of his body post-mortem. It is entirely possible he suffered from numerous infections such as *osteomyelitis* as well as an abscess, which would have left this individual in severe pain (Jauch and Valdez 2021). Sk. 633 underwent an amputation to his right femur, though with no sign of healing; it is very likely he died during or quickly after this procedure, likely due to infection of the wound. Finally, it is also possible this individual suffered from a vitamin-C deficiency, much like the majority of this assemblage and thus resulting in scurvy (Lind 1753; Ortner 2003; Waldron 2009). Figure 108 shows the individual articulated.

Figure 108: Sk. 633 rearticulated (author's own 2021).

I.X Sk. 648

I.X.I Background and Material

Individual Sk. 648 was found overlying and older adolescent, individual Sk. 645. Like the other graves, there were no accompanying objects recovered; however, the recovery of a single iron nail indicates this individual was likely initially buried in a coffin. Situated in grave [647], Figure 109 shows the preservation and fragmentation condition of the skeletal fragments recovered from individual Sk. 648.

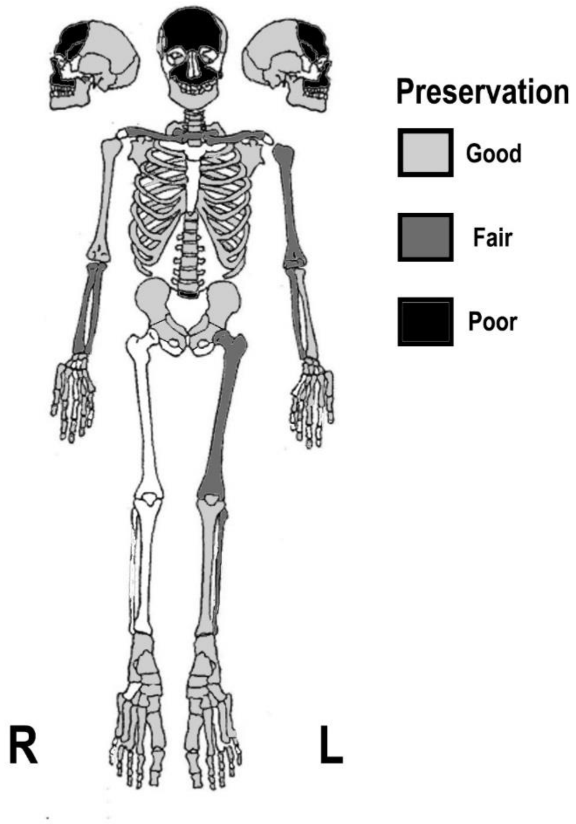


Figure 109: Available skeletal fragments of Sk. 648 and the overall preservation and fragmentation of the human remains (author's own 2021).

I.X.II Age Estimation

The age assessment for Sk. 648 was conducted by first recognising the unfused long bones, which immediately indicated this individual was not biologically mature and, therefore, a sub-adult. Table 60 shows the age ranges for the specific bones which showed signs of incomplete fusion. Due to the fusion analysis, the individual is very likely *c.* 16-18 years of age (Schaefer et al. 2009; Cunningham et al. 2016). The third, permanent molars have also not erupted yet, which correlates with the suggested age range (Nelson and Ash 2010).

Table 59: Epiphyseal fusion present on individual Sk. 648 and the likely age (author's own 2021).

Bone	*Proximal (yrs)*	*Medial (yrs)*	*Distal (yrs)*	*Age (yrs)*
Humerus	16-21	16-18	15-18	< 21
Fused	No	Yes	Yes	-
Radius	-	N/A	16-20	< 20
Fused	-	N/A	No	-
Femur	14-19	N/A	16-20	< 20
Fused	Yes	N/A	No	-
Tibia	15-19	N/A	-	< 19
Fused	No	N/A	-	-
Metacarpals	15-16	N/A	14-16	<16
Fused	No	No	Yes	-

The auricular surface was then analysed (Buckberry and Chamberlain 2002). Table 61 shows the results of scoring the auricular surface. Scoring the pelvis suggests this individual is a little older than the epiphyseal fusion shows; however, epiphyseal fusion is more accurate ageing sub-adults than scoring the auricular surface (Schaefer et al. 2009; Cunningham et al. 2016).

Table 60: Scoring of the auricular surface for individual Sk. 648 (author's own 2021).

Method	*Score*	*Age Range*
Auricular Surface	8	21-38 yrs

Boston aged individual Sk. 648 to *c*. 16-18 years, which corresponds to the results obtained by analysing the various epiphyseal union markers. Therefore, this individual likely was *c.* 16-18 years old at their time of death (C Boston 2021, personal communication, 21 January).

I.X.III Sex Estimation

Table 62 shows the numerous sex indicators from the skull, and the pelvis analysed and scored to determine the sex of individual Sk. 648. Table 62 shows that the indicators that could be scored did score 4, therefore Sk. 648 was likely a male due to the features' masculinity (Phenice 1969; Walker 1994; Mays 1998; White and Folkens 2005). Due to the young age of this individual, estimating the sex for Sk. 648 is unreliable. It produces less accuracy than in an older individual. However, it is plausible that this individual is a male due to the nature of this assemblage.

Table 61: The scoring of the sex determination analysed for individual Sk. 648 (author's own 2021).

Indicator	*Score*
Nuchal Crest	4
Mastoid Process	4
Supraorbital Margin	-
Supraorbital Ridge/ Glabella	-
Mental Eminence	4
Ventral Arc	-
Subpubic Concavity	-
Medial Aspect of the Ischiopubic Ramus	-
Greater Sciatic Notch	4

I.X.IV Ancestry Estimation

The skull of Sk. 648 shows mixed preservation; the upper crania show poor fragmentation and preservation (grade 4), whereas the lower crania show good preservation and fragmentation (grade 1). The skull was very fragmented and incomplete; however, the morphological assessment conducted by Boston (2021, personal communication, 21 January) did suggest Caucasian features.

I.X.V Stature Estimation

Due to the age of individual Sk. 648, it was not possible or advisable to conduct stature estimation using Trotter's (1970) method. Interestingly, however, the left femur measured 495mm, which indicates this individual was very tall for his age.

In addition, this individual's femur length was longer than most of the other assemblages femurs' in comparison.

I.X.VI Pathology

The cranium of individual Sk. 648 shows new bone growth on the orbits known as *Cribra orbitalia* (Figure 110) (Waldron 2009).

Figure 110: Cribra orbitalia on the orbits on the frontal bone (author's own 2021).

The postcranial skeleton shows significant trauma. The left humerus shows *osteochondritis dissecans* to the capitulum (elbow), which is likely due to repetitive trauma to the capitulum. The trauma is prevalent in sports and young adults and more common in males than females (Stougaard 1964; Ortner 2003; Waldron 2009). The glenoid cavities on both scapulae show signs of trauma which may also relate to *osteochondritis dissecans* (Figure 111) (Debeer and Brys 2005).

Figure 111: The glenoid cavity of the left scapula (author's own 2021).

The left tibia showed slight bowing in the bone's mid-shaft (Figure 112), similar to that of individual Sk. 844. The most common reason for bowing in the lower long bones is often attributed to a vitamin-D deficiency, resulting in rickets (Ortner 2003; Waldron 2009).

Figure 112: Bowing of the left tibia and fibula (author's own 2021).

The left and right talus of individual Sk. 648 have incomplete shepherd's (stieda process) fractures (Figure 113) (Moore and Harger 2018; C Boston 2021, personal communication, 21 January).

Figure 113: Shepherd fractures to both talus' of Sk. 648 (author's own 2021).

Figure 114 shows the patterning of pathology and trauma on individual Sk. 648.

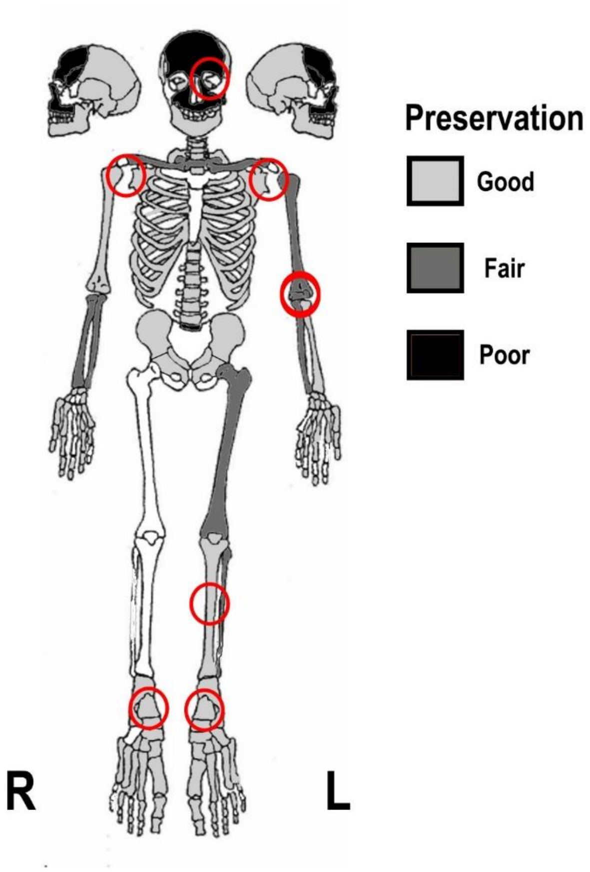


Figure 114: Pathology and trauma patterning on individual
Sk. 648 (author's own 2021).

I.X.VII Conclusion

The burial of Sk. 648 was not associated with any accompanying objects besides a nail, which is consistent with most of the assemblage. The burial itself is similar to the rest of the assemblage, buried within a coffin and near other burials to conserve space.

Sk. 648 was likely Caucasian, in his mid-late teenager years at the time of his death, probably around 16-18 years. This age may seem young, but he likely already served many years in the Royal Navy due to the numerous fractures evident on his body. Due to his femur's long length, he was likely a rather tall individual for his age, and his height may have played a part in what made him more susceptible to the multiple fractures he had. Fractures on his collarbone and elbow highlight that they were likely caused by a repetitive movement on board an 18th-century ship that may have involved loading cannons, climbing up and down the rigging, hoisting the sails or shovelling coal (Rodger 1986; Adkins 2008). It is likely Sk. 648 was in much pain when he walked due to the shepherd fractures in his feet (Moore and Harger 2018). The symmetry of these fractures is also unusual and, therefore, likely the result of a single cause of trauma, such as falling from a height with impact and landing on his feet. Due to the fractures, it is clear that this young boy worked hard on the ship. It is entirely possible Sk. 648 also suffered from a vitamin-D deficiency due to the bowing in his left tibia (unfortunately, the right leg was not present to examine), which may have resulted in very mild rickets (Ortner 2003; Waldron 2009). The new bone growth on his left orbit may be an indicator of scurvy, which would be consistent with the rest of the assemblage; however, it is an isolated patch of new bone growth and could result from many metabolic diseases (Ortner 2003; Waldron 2009). Figure 115 shows the individual articulated.

Figure 115: Rearticulation of Sk. 648, not including the lower limbs and the feet (author's own 2021).

I.XI Sk. 651

I.XI.I Background and Material

Individual Sk. 651 was excavated from a single burial in grave [650]; however, another unnumbered skeleton was buried directly beneath individual Sk. 651. Sk. 651 was buried in a single break wooden coffin (C Boston 2021, personal communication, 21 January). Figure 116 shows the preservation and fragmentation condition of the skeletal fragments recovered from individual Sk. 651.

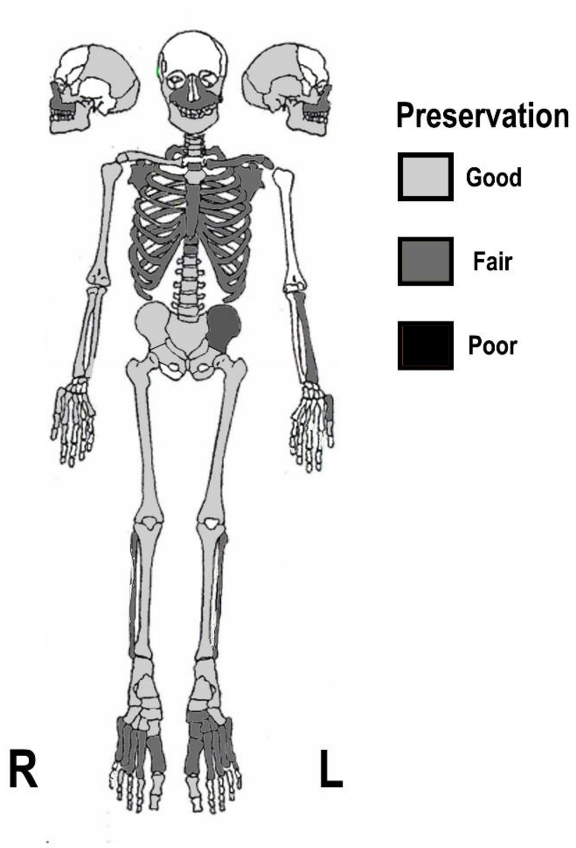


Figure 116: Available skeletal fragments of Sk. 651 and the overall preservation and fragmentation of the human remains (author's own 2021).

I.XI.II Age Estimation

The age assessment for Sk. 651 was conducted by first recognising both radii's unfused distal end, which immediately indicated this individual was either a young adult or older adolescent. Table 63 shows the age ranges for the radius, which shows signs of incomplete fusion. Due to the fusion analysis, the individual is very likely to be no younger than 18 years old but no older than 20 (Schaefer et al. 2009; Cunningham et al. 2016).

Table 62: Epiphyseal fusion present on individual Sk. 651 and the likely age (author's own 2021).

Bone	*Proximal (yrs)*	*Medial (yrs)*	*Distal (yrs)*	*Age (yrs)*
Radius	15-18	N/A	16-20	< 18
Fused	Yes	N/A	No	-
Mean				18

The pubis symphysis and auricular surface were then analysed (Brooks and Suchey 1990; Buckberry and Chamberlain 2002). Table 64 shows the pubis symphysis scoring, whilst Table 65 shows the scoring for the auricular surface.

Table 63: Scoring of the pubis symphysis for individual Sk. 651 (author's own 2021).

Method	*Score*	*Age Range*
Pubis Symphysis	1	15-23 yrs

Table 64: Scoring of the auricular surface for individual Sk. 651 (author's own 2021).

Method	*Characteristic*	*Score*	*Age Range*
Auricular Surface	Transverse Organisation	1	-
	Surface Texture	1	-
	Microporosity	2	-
	Macroporosity	1	-
	Apical Changes	1	-
			-
Total		6	16-19 yrs

An average was conducted using the age ranges, with a mean of 19 years for the pubis symphysis and 17.5 years for the auricular surface; therefore, the means produced an age range spanning 17.5-19 years. Scoring the pelvis suggests this individual is around 17.5-19 years old, which corresponds well with the radius's epiphyseal fusion (Schaefer et al. 2009; Cunningham et al. 2016). Boston aged individual Sk. 651 to *c*. 18-20 years (C Boston 2021, personal communication, 21 January), which corresponds with the results obtained by analysing the epiphyseal union of the radius and the scoring of both the pubis symphysis and auricular surface. Therefore, this individual likely was *c.* 18-20 years old at their time of death, a young adult.

I.XI.III Sex Estimation

Table 66 shows the numerous sex indicators from the skull, and the pelvis analysed and scored to determine the sex of individual Sk. 651. Table 66 shows that the indicators scored primarily scored 4 and 5 and therefore Sk. 651 was likely a male due to the features' masculinity (Phenice 1969; Walker 1994; Mays 1998; White and Folkens 2005).

Table 65: The scoring of the sex estimation analysed for individual Sk. 651 (author's own 2021).

Region	*Indicator*	*Score*
Cranial	Nuchal Crest	5
	Mastoid Process	4
	Supraorbital Margin	5
	Supraorbital Ridge/ Glabella	-
	Mental Eminence	4
Pelvic	Ventral Arc	-
	Subpubic Concavity	-
	Medial Aspect of the Ischiopubic Ramus	4
	Greater Sciatic Notch	3

I.XI.IV Ancestry Estimation

The skull of Sk. 651 showed excellent preservation (grade 1), but the facial region was highly fragmented. Therefore, CRANID and Fordisc3.1 assessments are currently not available to explore for future work. However, Boston (2021, personal communication, 21 January) conducted a morphological assessment, which concluded the individual was likely Caucasian.

I.XI.V Stature Estimation

Due to the excellent preservation (grade 1) of the right humerus, right ulna, right femur and both tibiae (measurement did not include the malleolus), a stature estimation was obtained (Trotter and Gleser 1958; Trotter 1970). Table 67 shows that all the stature estimations broadly correspond with one another. However, since the femur and tibiae directly impact stature, a mean of 176.07cm was calculated from all three measurements. Furthermore, since morphologically, this individual appears Caucasian, it is likely Sk. 651 was around 5ft 8inches tall at the time of his death.

Table 66: Measurements of Sk. 651's long bones, which were intact, with the stature estimation for each one, following Trotter and Gleser's (1958) equation and Trotter's (1970) equation (author's own 2021).

Burial Sk. 651	*Length (mm)*	*Stature Estimation (cm)*
Right Humerus	351	178.56 $\pm$ 4.05
Right Ulna	283	178.76 $\pm$ 4.32
Right Femur	477	174.94 $\pm$ 3.27
Right Tibia	393	176.56 $\pm$ 3.97
Left Tibia	394	176.72 $\pm$ 3.95

I.XI.VI Pathology

Figure 117 shows a perimortem projectile trauma to the occipital bone. There are some signs of healing, but, likely, this individual died soon after the event. The projectile trauma is roughly 1cm in size and circular and is similar in size to that of an 18th-century lead ball used in guns such as a flintlock pistol (Harding 1999; Mandzy 2015).

Figure 117: Projectile trauma to the occipital bone (author's own 2021).

Figure 118 shows that the projectile trauma on the occipital bone is located roughly 2cm to the left of the foramen magnum.

Figure 118: Projectile trauma 2cm away from the foramen magnum on the occipital (author's own 2021).

The post-cranial skeleton of Individual Sk. 651 shows well-healed periostitis on the right (Figure 119) and left femur, and the right tibia (Figures 120 and 121), which could be the result of scurvy. The affected area of periostitis on both femora is located proximal bilaterally. The affected area on the right tibia spans the proximal end to the midshaft of the bone.

Figure 119: Healed periostitis on the right femur of individual SK. 651 (author's own 2021).

Figure 120: Healed periostitis on the proximal end of the right tibia (author's own 2021).


Figure 121: Healed periostitis on the mid-shaft of the right tibia (author's own 2021).

Whilst periostitis can result from scurvy, it is most commonly associated with excessive physical activity (Cosca and Navazio 2007). Since there appear to be no other scurvy indicators on this individual, it is much more likely that the healed periostitis is due to the excessive physical stress this individual's body was put under daily. Figure 122 shows the patterning of pathology and trauma on individual Sk. 651.

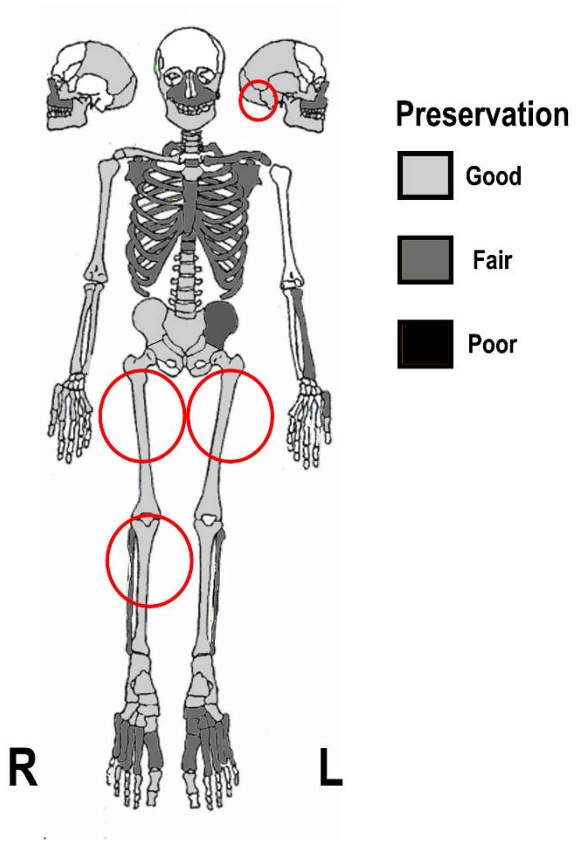


Figure 122: Pathology and trauma patterning on individual
Sk. 651 (author's own 2021).

I.XI.VII Conclusion

Individual Sk. 651's burial was not associated with any grave goods, consistent with most of the assemblage (Hodgins and Salvatore 2009). The burial itself was exhumed in a single grave, buried over an unknown burial in a single break wooden coffin. The overall preservation of this individual was good (grade 2).

This individual was a young adult, around 18-20 years old, at his death. The individual was likely Caucasian due to the morphology of the skull. Sk. 651 was roughly 5 ft 8" tall for this individual's age and certainly on the assemblage's taller end. The pathology shows Sk. 651 has a projectile trauma to the occipital bone, which may be interpreted as a gunshot (pistol) wound to the back of the head. Suppose it is the result of a gunshot wound. In that case, it is evident that the individual was shot from behind due to the projectile's location. Due to the lack of healing on the occipital wound, this individual died soon after the wound was inflicted. The presence of healed periostitis to the lower limbs highlights the excessive stress this individual's body was under. However, the healing suggests that his body was under less stress towards the end of this individual's life. Figure 123 shows the individual articulated.

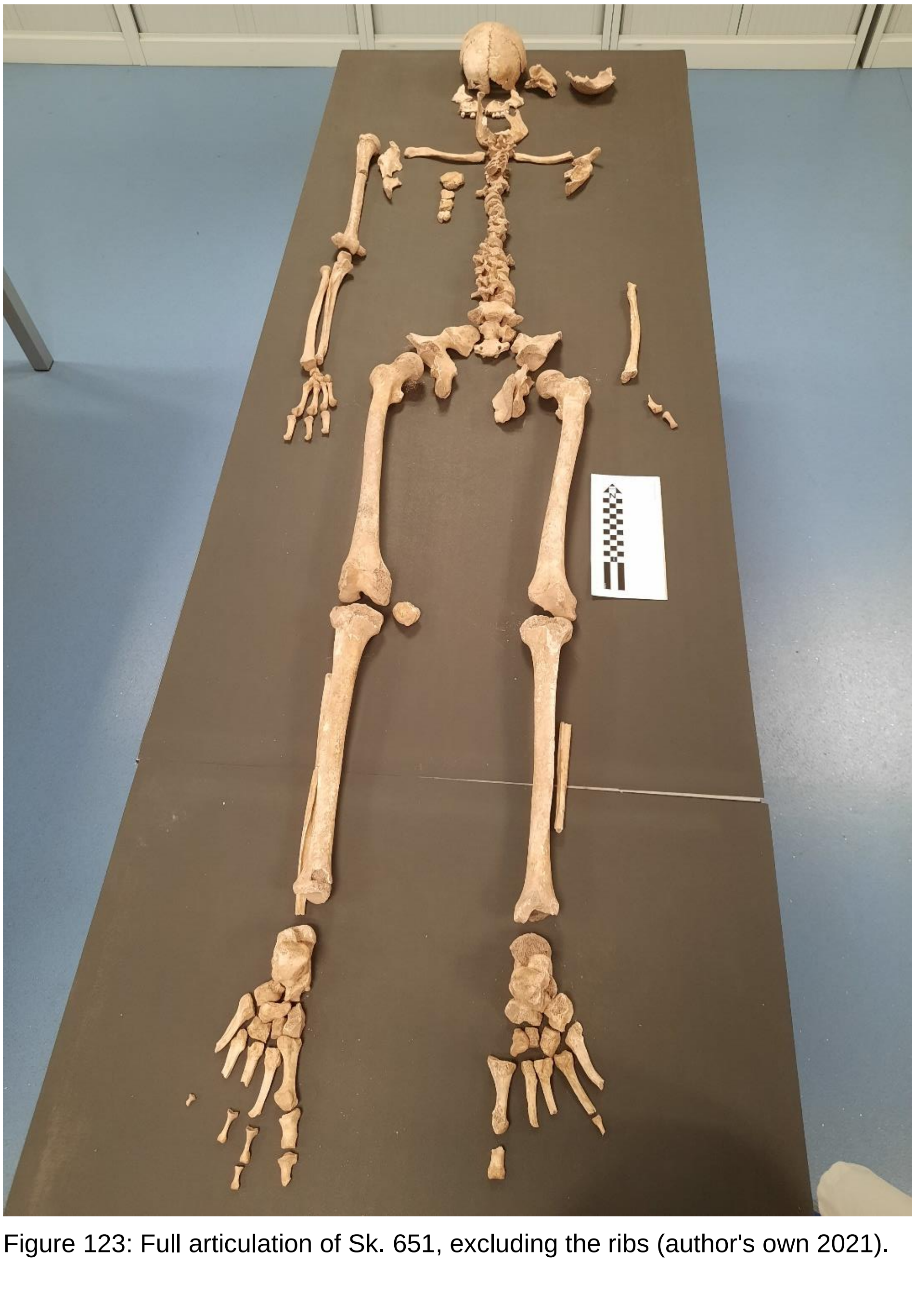


Figure 123: Full articulation of Sk. 651, excluding the ribs (author's own 2021).

I.XII Sk. 677

I.XII.I Background and Material

Individual Sk. 677 was excavated from grave [678] and was found overlaying individual Sk. 680, as a result, Sk. 677 was truncated (C Boston 2021, personal communication, 21 January).

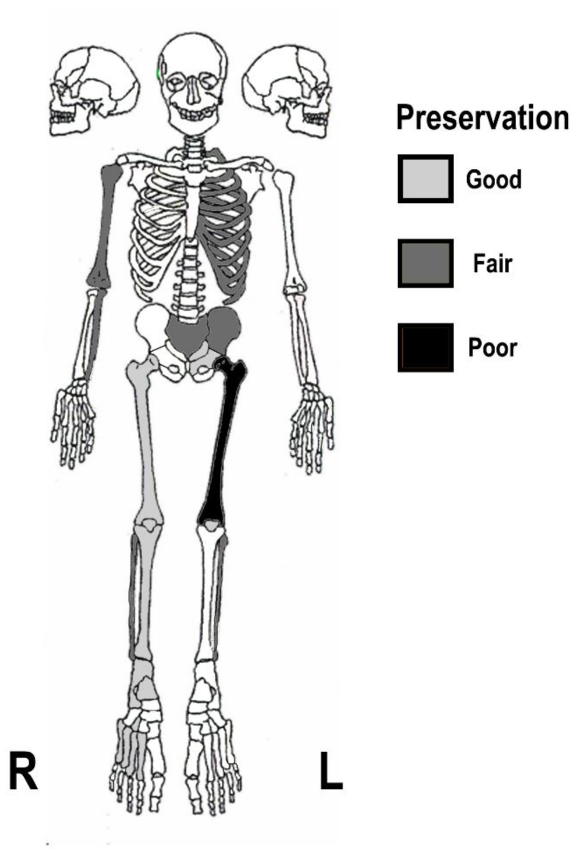


Figure 124: Available skeletal fragments of Sk. 677 and the overall preservation and fragmentation of the human remains (author's own 2021).

I.XII.II Age Estimation

The age assessment for Sk. 677 was conducted by first recognising the unfused long bones and the size of the bones, which immediately indicated this individual was a sub-adult. Table 68 shows the age ranges for the long bones, pelvis, metatarsals, and calcaneus, showing signs of incomplete fusion. Due to the fusion analysis, if the individual is male, he is likely to be no older than 14 years old (Schaefer et al. 2009; Cunningham et al. 2016).

Table 67: Epiphyseal fusion present on individual Sk. 677 and the likely age (author's own 2021).

Bone	Proximal (yrs)	Medial (yrs)	Distal (yrs)	Age (yrs)
Humerus	16-21	16-18	15-18	< 15
Fused	No	No	No	-
Ulna	14-18	N/A	-	< 14
Fused	No	N/A	-	-
Ischium & Pelvis	14-18	N/A	N/A	< 14
Fused	No	N/A	N/A	-
Femur	14-19	N/A	16-20	< 14
Fused	No	N/A	No	-
Tibia	15-19	N/A	16-18	< 15
Fused	No	N/A	No	-
Fibular	16-20	N/A	16-20	< 16
Fused	No	N/A	No	-
Metatarsals	N/A	N/A	14-16	< 14
Fused	N/A	N/A	No	-
Calcaneus	18-20	N/A	N/A	< 18

A measurement of the right tibia was obtained to compare this long bone length to age ranges. Table 69 shows that the tibia of this individual matches the length of that of an eight-year-old male. Therefore, due to the length of the right tibia and the epiphyseal fusion of this individual, this individual was likely around 8-14 years old at the time of their death.

Table 68: Diaphyseal length of the right tibia from Sk. 677 with age correlation studies (author's own 2021).

	Tibia (R)
Diaphyseal Length (mm)	259
Maresh (1970) Age (yrs)	8.5
Gindhart (1973) Age (yrs)	7.5
Mean (yrs)	8

I.XII.III Sex Estimation

Due to the high fragmentation of the pelvis and the absence of the skull, the sex of this individual could not be estimated. As mentioned in the methodology section, estimating the sex of a sub-adult is far less reliable and accurate than estimating in an adult. Therefore, no sex could be estimated reliably on this individual if these skeletal indicators were available (White and Folkens 2005).

I.XII.IV Ancestry Estimation

The ancestry of this individual could not be estimated due to the absence of the skull.

I.XII.V Stature Estimation

Due to the age of individual Sk. 677, it was not possible or advisable to conduct stature estimation using Trotter and Gleser's (1958) or Trotter's (1970) methods.

I.XII.VI Pathology

No pathological markers were detected when analysing this individual, likely due to the highly fragmented and incomplete skeleton.

I.XII.VII Conclusion

Individual Sk. 677's burial was not associated with any grave goods, consistent with most of the assemblage (Hodgins and Salvatore 2009). The burial itself was truncated and found overlaying individual Sk. 680. The overall preservation of this individual was good (grade 2) but highly fragmented and incomplete.

This individual was a sub-adult, likely around the age of 8-14, at the time of their death. No sex, ancestry or stature could be estimated due to the immaturity of the bones. No notable pathological indicators were analysed. The significance of this individual is that they appear to be the youngest individual so far detected among this assemblage. Figures 125 and 126 show the individual articulated.

Figure 125: Individual Sk. 677 rearticulated with the surviving bones (author's own 2021).


Figure 126: Individual Sk. 677 rearticulated with the surviving bones (lower limbs) (author's own 2021).

I.XIII Sk. 757

I.XIII.I Background and Material

Individual Sk. 757 was excavated from grave [755] and was found overlaying individual Sk. 758, as a result, mixing of elements did occur (C Boston 2021, personal communication, 21 January). Figure 2 shows the preservation and fragmentation condition of the skeletal fragments recovered from individual SK. 757.

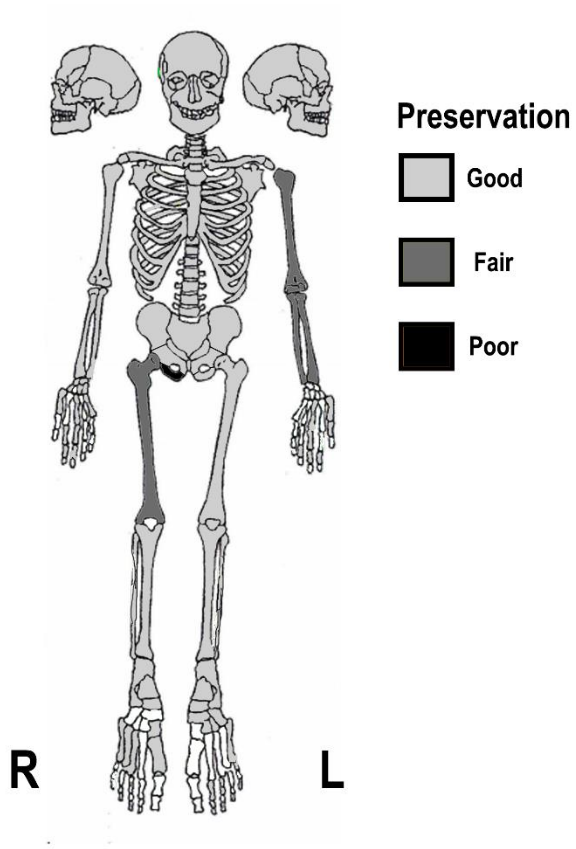


Figure 127: Available skeletal fragments of Sk. 757 and the overall preservation and fragmentation of the human remains (author's own 2021).

I.XIII.II Age Estimation

The age assessment for Sk. 757 was conducted by analysing the pubis symphysis and auricular surface (Brooks and Suchey 1990; Buckberry and Chamberlain 2002). Table 70 shows the scoring for the pubic symphysis, and

Table 70 shows the scoring of the auricular surface and the corresponding age range.

Table 69: Scoring of the pubis symphysis for individual Sk. 757 (Author's own 2021).

Method	Score	Age Range
Pubis Symphysis	5	23-57 years

Table 70: Scoring of the auricular surface for individual Sk. 757 (Author's own 2021).

Method	Characteristic	Score	Age Range
Auricular Surface	Transverse Organisation	4	-
	Surface Texture	3	-
	Microporosity	3	-
	Macroporosity	3	-
	Apical Changes	3	-
			-
Total		**16**	**39-91 yrs**

An average was conducted using the age ranges, with a mean of 40 years for the pubis symphysis and 65 years for the auricular surface; a mean of 52.5 years was then calculated from both results. Scoring the pelvis suggests this individual is around 17.5-19 years old. Boston aged individual Sk. 757 to 45+ years (C Boston 2021, personal communication, 21 January) corresponds with the auricular surface and pubis symphysis results. Instead of pinpointing an exact age, age categories are more reliable and appropriate among this assemblage (except for the sub-adults). Therefore Sk. 757 falls among the 'Old Adults' category; please refer back to Table 35.

I.XIII.III Sex Estimation

Table 71 shows the numerous sex indicators from the skull, and the pelvis analysed and scored to determine the sex of individual Sk. 757. Table 71 shows that the indicators scored primarily scored 4 and 5 and therefore SK. 651 was likely a male due to the features' masculinity (Phenice 1969; Walker 1994; Mays 1998; White and Folkens 2005).

Table 71: The scoring of the sex estimation analysed for individual Sk. 757 (author's own 2021).

Region	Indicator	Score
Cranial	Nuchal Crest	5
	Mastoid Process	5
	Supraorbital Margin	5
	Supraorbital Ridge/ Glabella	5
	Mental Eminence	-
Pelvic	Ventral Arc	4
	Subpubic Concavity	-
	Medial Aspect of the Ischiopubic Ramus	-
	Greater Sciatic Notch	3

I.XIII.IV Ancestry Estimation

The skull of Sk. 757 showed excellent preservation (grade 1). Due to the excellent preservation, a Fordisc3.1 assessment was available to explore.

I.XIII.IV.I Results from Fordisc3.1 (Forensic Databank sample – 20th Century sample)

Table 72 shows that Sk. 757 has a 47.3% probability of being a Black male, a 36.9% probability of being a White male and a 15.8% probability of being a Hispanic male. The distance from the mean for these results are further away than one would like for accuracy; however, they are closer to 0 than individual Sk. 617. Figure 128 shows that Sk. 757 is a close match between the Black and White male samples, with the Hispanic further away.

Table 72: Distance from the mean and posterior probability including Typ F, Chi and R variations of Sk. 757's Fordisc3.1 results (author's own 2021).

Group	Distance	PProb	Typ_F	Typ_Chi	Typ_R
Black Male	10.88	0.473	0.384	0.367	0.456
Hispanic Male	13.08	0.158	0.233	0.219	0.229
White Male	11.38	0.369	0.341	0.329	0.331

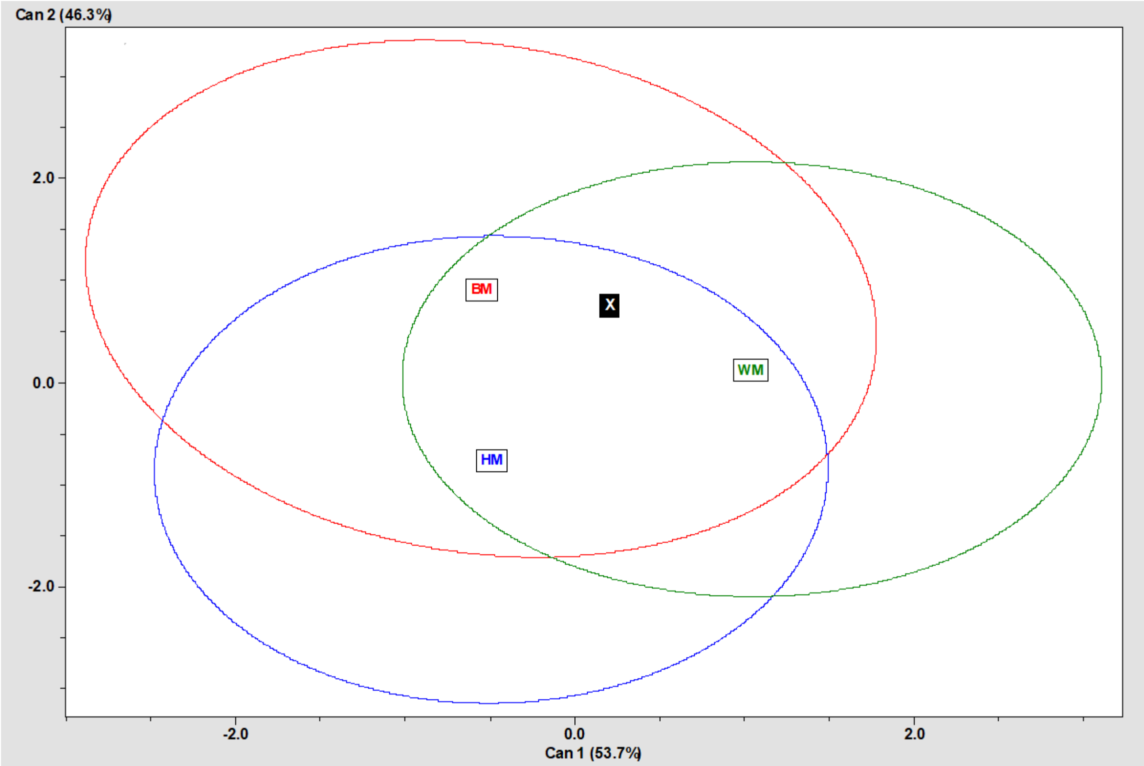


Figure 128: Graph showing the distance of the reference groups in relation to the test sample: Sk. 757 (author's own 2021).

I.XIII.IV.II Results from Fordisc3.1 (Howells Dataset – Historical & Archaeological sample)

Table 73 shows the relationship of the current sample to reference groups. The distance from all the groups is reasonable. Figure 129 shows the individual is very likely a black male, closely matching the sample of a 20th-century black male.

Table 73: Distance from the mean and posterior probability including Typ F, Chi and R variations of Sk. 757's Fordisc3.1 (Howell's) results (author's own 2021).

Group	Distance	PProb	Typ_F	Typ_Chi	Typ_R
Black Male (20th Century)	2.9	0.620	0.424	0.414	0.389
Black Male (19th Century)	3.8	0.380	0.293	0.280	0.289

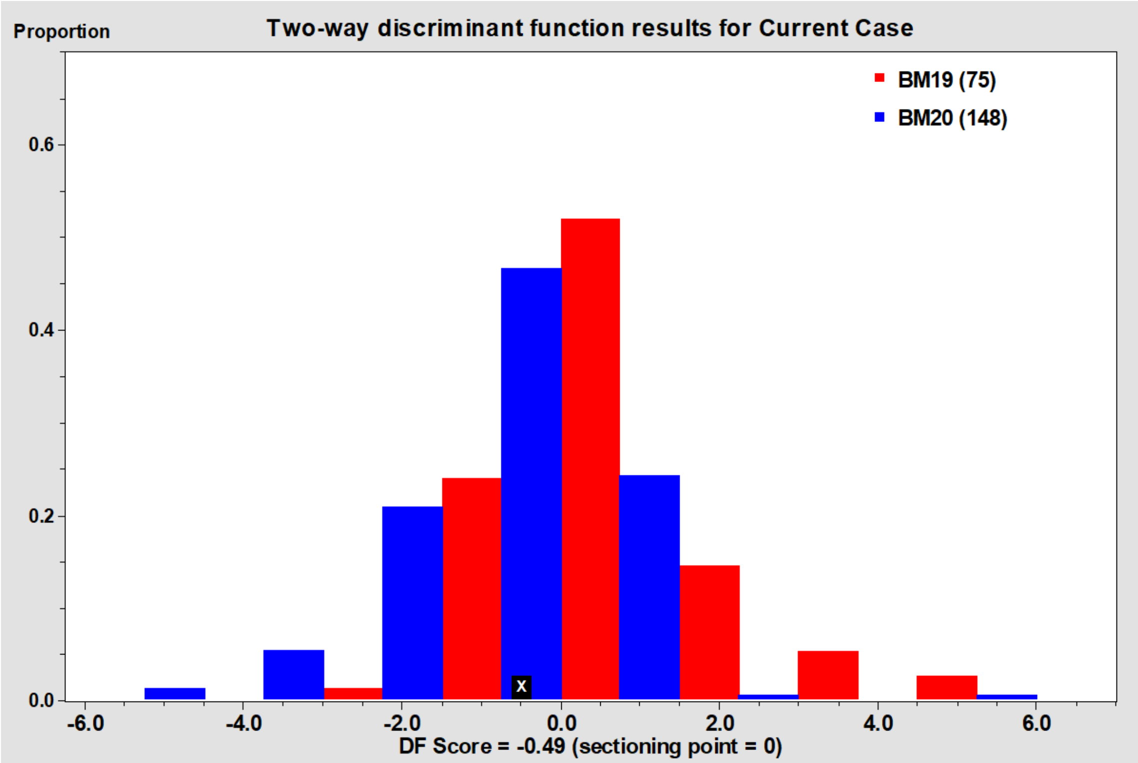


Figure 129: Two-way discriminant function results for Sk. 757 (author's own 2021).

I.XIII.IV.III Results from craniomorphological analysis using HefneR

This model states that Sk. 757 has an 85.26% chance of being of African descent, 12.08% of being of Asian descent, 2.02% of being of American Indian descent and 0.63% of being of European descent (Figure 130).

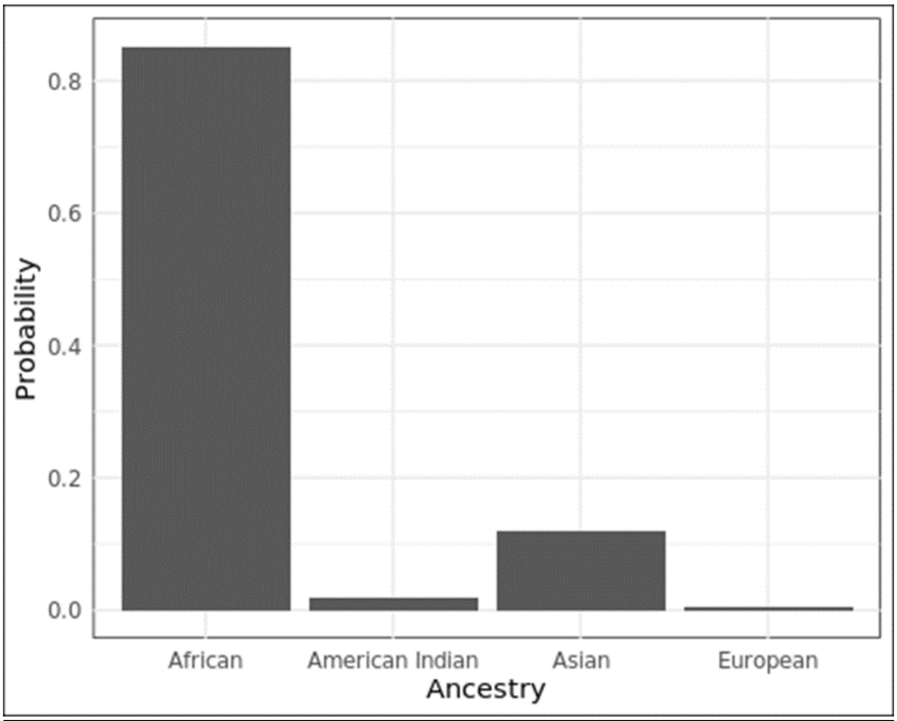


Figure 130: Morphological analysis results for Sk. 757 using HefneR (author's own 2021).

I.XIII.V Stature Estimation

Due to the excellent preservation (grade 1) of the right humerus, right ulna, left femur, left tibia (measurement did not include the malleolus) and right fibula, a stature estimation was obtained (Trotter and Gleser 1958; Trotter 1970). Table 74 shows that all the stature estimations broadly correspond with one another. However, since the femur, tibia, and fibula directly impact stature, a mean of 160.60cm was calculated from all three measurements. Furthermore, since morphologically, this individual could be of African heritage, it is likely Sk. 757 was around 5ft 3inches tall at the time of his death.

Table 74: Measurements of Sk. 757's long bones, which were intact, with the stature estimation for each one, following Trotter and Gleser's (1958) equation and Trotter's (1970) equation (author's own 2021).

Burial SK. 757	**Length (mm)**	**Stature Estimation (cm)**
Right Humerus	302	**159.65 ± 4.43**
Right Ulna	271	**166.74 ± 4.42**
Left Femur	418	**157.65 ± 3.94**
Left Tibia	356	**162.53 ± 4.04**
Right Fibula	351	**161.62 ± 4.08**

I.XIII.VI Pathology

Figures 131 and 132 show fractures to both the left and right nasal bones. In addition, the photos show how distorted the nasal bones look distally.

Figure 131: Fractured nasal bones of individual Sk. 757 (author's own 2021).

Figure 132: Fractured nasal bones of individual Sk. 757 from a different angle (author's own 2021).

The cranium of individual Sk. 757 also has a depressed lesion in the frontal bone. The lesion is located approximately half a cm in diameter in the middle of the frontal bone. Figure 133 shows the depressed lesion; the ring circles the lesion.

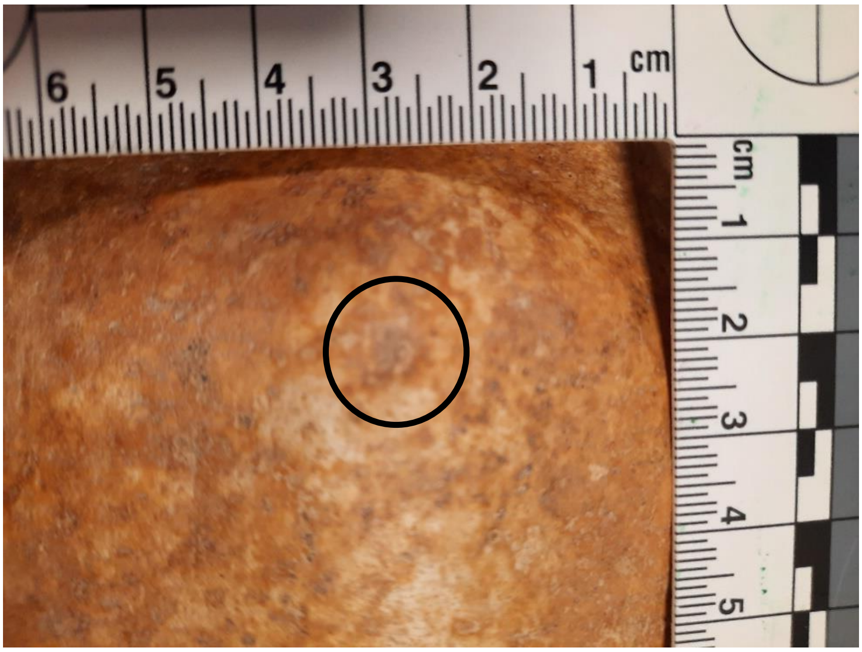


Figure 133: Depressed lesion of the frontal bone on individual Sk. 757 (author’s own 2021).

The post-cranial skeleton shows various pathological markers. For example, Figure 134 shows a fracture to the left acetabulum rim. The fracture is roughly 1cm in size and is located distally on the acetabular rim.

Figure 134: Fracture to the left acetabulum rim of individual Sk. 757 (author's own 2021).

Figure 135 shows a shepherd's fracture to the right talus. The ring shows the location of the fracture, which is on the posterior process (Moore and Harger 2018).

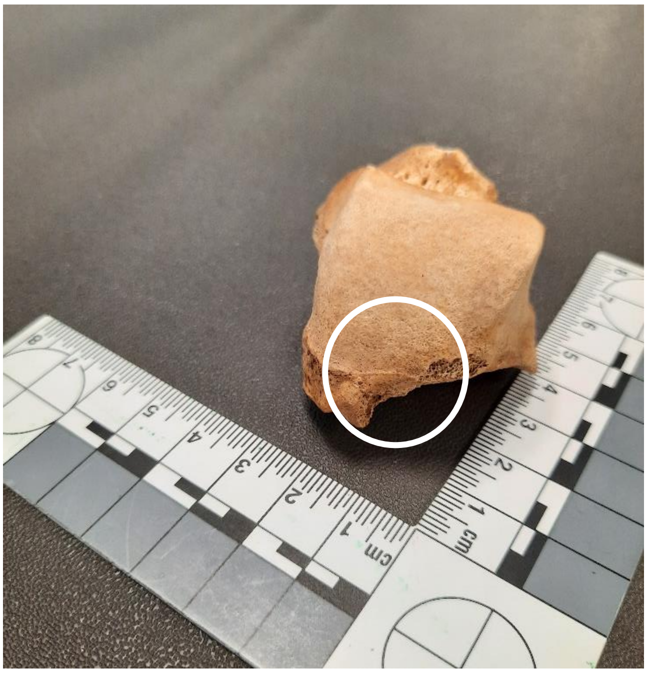


Figure 135: Shepherd’s fracture to the right talus (author’s own 2021).

Figure 136 shows the patterning of pathology and trauma on individual Sk. 757.

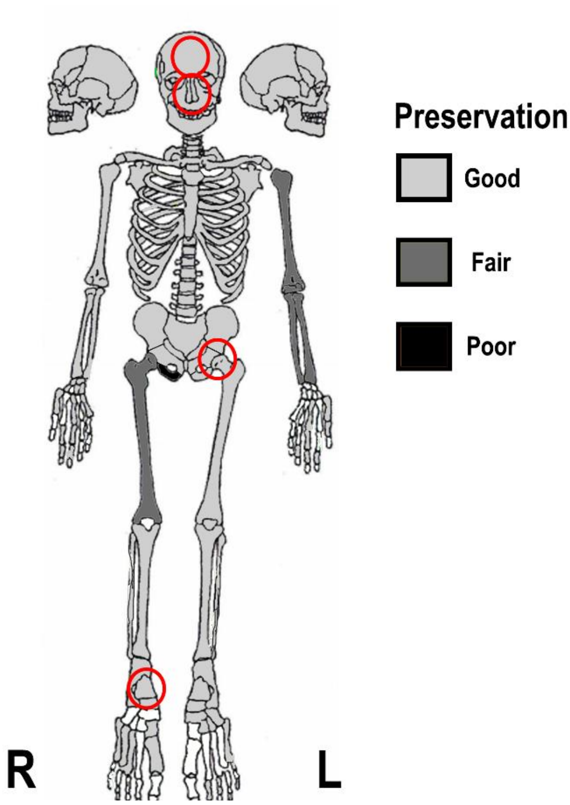


Figure 136: Pathology and trauma patterning on individual Sk. 757 (author’s own 2021).

I.XIII.VII Conclusion

Individual Sk. 757's burial was not associated with any supporting artefacts, consistent with most of the assemblage (Hodgins and Salvatore 2009). The burial itself was exhumed in a single grave, buried over individual Sk. 758. The overall preservation of this individual was excellent (grade 1).

This individual was an older individual, over the age of 40, at the time of his death. The ancestry analysis shows that it is doubtful this individual was of European descent; however, the individual was likely of African descent. Sk. 757 was roughly 5 ft 3". The pathology shows Sk. 757 had multiple fractures located in his cranium and post-cranial body. Fractures to the nose and head may have resulted from a brawl onboard, but it is also entirely possible they resulted from an accident involved in his daily duties of shipboard life. Additionally, the fracture to his talus suggests that this individual would have been in pain when he walked (Moore and Harger 2018). Figures 137 and 138 shows the individual articulated.

Figure 137: Articulation of Sk. 757 excluding the lower body (author's own 2021).

Figure 138: Full articulation of Sk. 757 (author's own 2021).

I.XIV Sk. 844

I.XIV.I Background and Material

Burial Sk. 844 was discovered in a double burial along with individual Sk. 845. A double burial is likely due to the lack of space in the cemetery and convenience. An iron nail was recovered within this burial and therefore suggests this individual was buried within a coffin (C Boston 2021, personal communication, 21 January). Situated in grave [843], Figure 139 shows the preservation and fragmentation condition of the skeletal fragments recovered from individual Sk. 844.

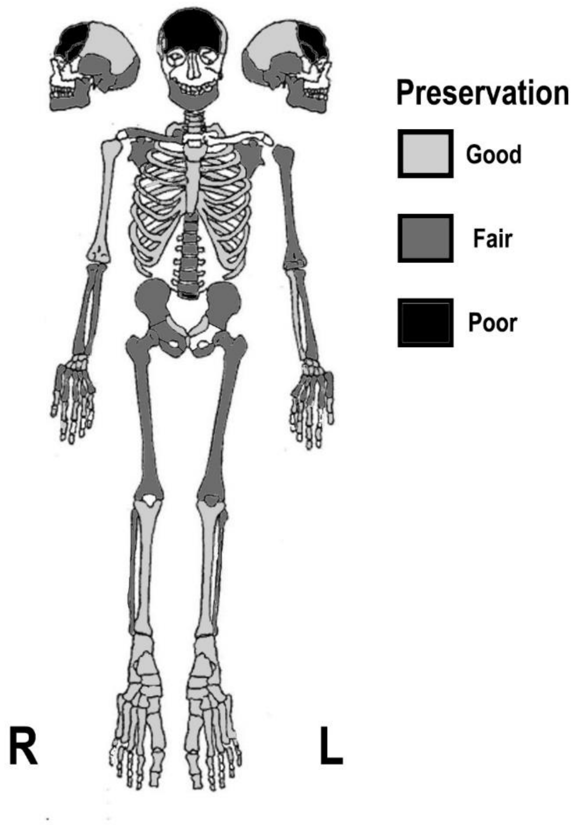


Figure 139: Available skeletal fragments of Sk. 844 and the overall preservation and fragmentation of the human remains (author's own 2021).

I.XIV.II Age Estimation

The age assessment for Sk. 844 was conducted by analysing the pubic symphysis and the auricular surface (Brooks and Suchey 1990; Buckberry and

Chamberlain 2002). Table 75 shows the scoring for the pubic symphysis and the auricular surface and the corresponding age range.

Table 75: Scoring of the auricular surface and pubic symphysis for individual Sk. 844 (author's own 2021).

Method	*Score*	*Age Range*
Auricular Surface	7	21-38 yrs
Pubis Symphysis	2	19-34 yrs

An average was then conducted using the age ranges, with a mean of 29.5 years for the auricular surface and 26.5 years for the pubic symphysis. Due to the pubic symphysis being the more reliable method out of the two for this assemblage (Hoppa 2000; Falys et al. 2006), 26.5 years appears to be more of an accurate age. When comparing Boston's unpublished, raw data for the individuals at the time of their initial excavation, she aged Sk. 844 to 35-45 years of age (C Boston 2021, personal communication, 21 January). Whilst the mean ages do appear to be a little younger than Boston aged Sk. 844, the age ranges for both techniques combined extend to 19-38 years; in that case, the ages roughly correspond with each other. As mentioned previously, instead of pinpointing an exact age, age categories are more reliable and appropriate among this assemblage (except for the sub-adults). Therefore Sk. 844 falls among the 'Middle Adults' category; please refer back to Table 35.

I.XIV.III Sex Estimation

Table 76 shows the numerous sex indicators from the skull, and the pelvis analysed and scored to determine the sex of individual Sk. 844. Table 76 shows that most indicators had a score of 5; this score indicates that Sk. 844 was likely a male due to the masculinity of the features analysed, particularly the pelvis (Phenice 1969; Walker 1994; Mays 1998; White and Folkens 2005).

Table 76: The scoring of the sex determination analysed for individual Sk. 844 (author's own 2021).

Indicator	*Score*
Nuchal Crest	2
Mastoid Process	5
Supraorbital Margin	-
Supraorbital Ridge/ Glabella	-
Mental Eminence	-
Ventral Arc	4
Subpubic Concavity	2
Medial Aspect of the Ischiopubic Ramus	5
Greater Sciatic Notch	5

I.XIV.IV Ancestry Estimation

The skull of Sk. 844 shows mixed preservation; the upper crania show good and poor (grade 1 and 4) preservation, whereas the lower crania show fair (grade 3) preservation and fragmentation. Unfortunately, the skull was too fragmented and incomplete for any morphological assessment.

I.XIV.V Stature Estimation

Due to the fair preservation of some of the humerus and ulna of Sk. 844, a stature estimation was obtained (Trotter 1970). However, due to the fragmentation of the other long bones, they could not be measured correctly or included in the equation for stature estimation. Table 77 shows that the humerus and ulna stature estimations give similar stature estimations; therefore, due to the absence of the lower, long bones, a mean was calculated from the humerus and ulna results. The mean calculated from the humerus and ulna is 171.30cm. Furthermore, if one assumes this individual is of European descent, then it is likely Sk. 844 was around 5ft 6inches tall at the time of his death.

Table 77: Measurements of Sk. 844's long bones, which were intact with the stature estimation for each one, following Trotter's (1970) equation (author's own 2021).

Burial	*Right Humerus*	*Left Ulna*
SK. 844	320mm	269mm
Stature Estimation (cm)	169.01 $\pm$ 4.05	173.58 $\pm$ 4.05

I.XIV.VI Pathology

The cranium showed multiple lesions, such as a healed sharp force trauma on the right temporal bone (Figure 140) (Smith 2017).

Figure 140: Healed sharp force trauma on the right temporal bone (author's own 2021).

There are also multiple active periostitis elements on the cranium, such as new bone growth on the left orbit (Figure 141), known as *cribra orbitalia* (Waldron 2009) and on the endocranial surface. *Cribra orbitalia* is not characteristic of a specific disease, but it is a symptom of several diseases, including scurvy (Ortner 2003; Stirland 2005).

Figure 141: New bone growth (cribra orbitalia) on the left orbit of the frontal bone (author's own 2021).

The overall appearance of the skull also appears to be thickened (Figure 142). Skull thickening is common in haemolytic anaemias, *hyperostosis frontalis interna* and Paget's disease (Waldron 2009).

Figure 142: Thickened skull fragment of Sk. 844 (author's own 2021).

The postcranial skeleton shows active periostitis in the left rib (Figure 143), which can be an indicator of scurvy; this individual also has active periostitis on the cranium is also typical for a scurvy diagnosis (Melikian and Waldron 2003).


Figure 143: Active periostitis in the left rib of Sk. 844 (author's own 2021).

The lower long bones show a mild bowing (Figure 144), which may result from mild rickets, though due to the maturity of this individual's bone, it is likely *osteomalacia* (Ortner 2003; Waldron 2009).


Figure 144: Very mild bowing of the tibiae and fibulae of Sk. 844 (author's own 2021).

The first, distal phalanx on the right foot, has a crush-like fracture (Figure 145), likely to result from a traumatic injury such as a ballistic injury (Smith 2017).

Figure 145: Crush fracture to the first distal phalanx of the right foot (left in photo) along with the non-fractured phalanx from the opposite foot (author's own 2021).

Figure 146 shows the patterning of pathology and trauma on individual Sk. 844.

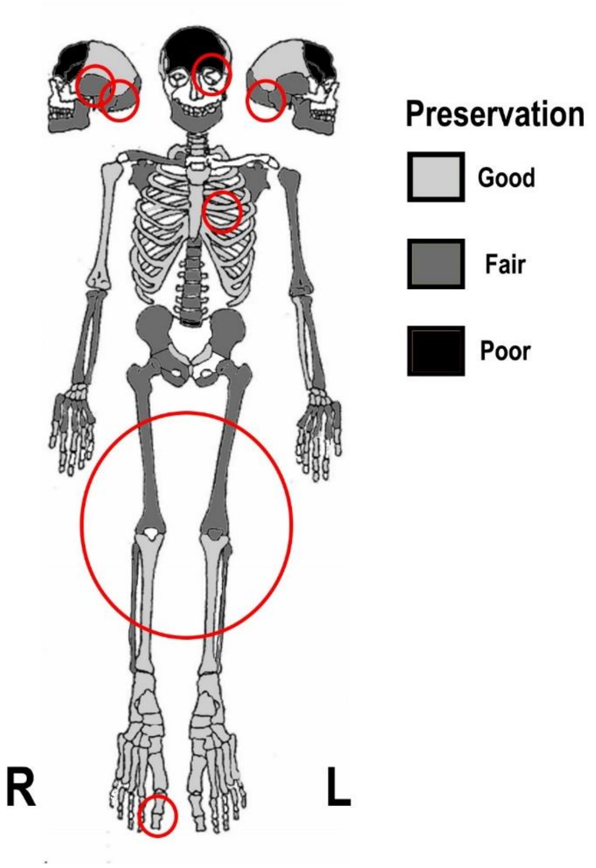


Figure 146: Pathology and trauma patterning on individual
Sk. 844 (author’s own 2021).

I.XIV.VII Conclusion

Individual Sk. 844's burial was not associated with any grave goods, consistent with most of the assemblage (Hodgins and Salvatore 2009). However, the burial is a little different to the others because it was a double burial – rather than a single burial. The reason for a double burial is unclear; however, it is not unreasonable to assume it was to conserve space to allow further burials to take place. In addition, the recovery of an iron nail supports the likeliness that this individual was initially buried in a coffin, contemporary with the other adult burials in this assemblage.

Due to this individual's age, a man in his 30s-40s (middle age), he likely served over two decades in the Royal Navy, if not more, before his death at the Royal Naval Hospital. The evident trauma on this individual’s bones, such as a crushed big toe and sharp, healed, blade-like cut to his right temporal bone (near his right ear), is tempting to suggest he had been involved in battles, with the scars to prove it. Though that diagnosis is tempting, it is just as likely these marks resulted from injuries sustained accidentally on-board maintaining the ship (Rodger 1986; Adkins 2008). The individual's stature is pretty average for a man of the 18th century. There are signs to implicate this individual had suffered from a mild vitamin-D deficiency resulting in the mild bowing of his legs. This individual's bones also show a vitamin-C deficiency is also likely, resulting in scurvy – similar to other individuals in this assemblage and indeed throughout the 18th century Royal Navy (Lind 1753; Lloyd 1965; Adkins 2008). Figure 147 shows the individual rearticulated.

Figure 147: Sk. 844 rearticulated (author's own 2021).

I.XV SK. 875

I.XV.I Background and Material

Burial Sk. 875 was excavated in a coffined burial beneath coffined burial Sk. 874 (C Boston 2021, personal communication, 21 January). The burial was discovered in grave [876]. Figure 148 shows the skeletal fragments which were recovered from burial Sk. 875 and the overall preservation of the fragments.

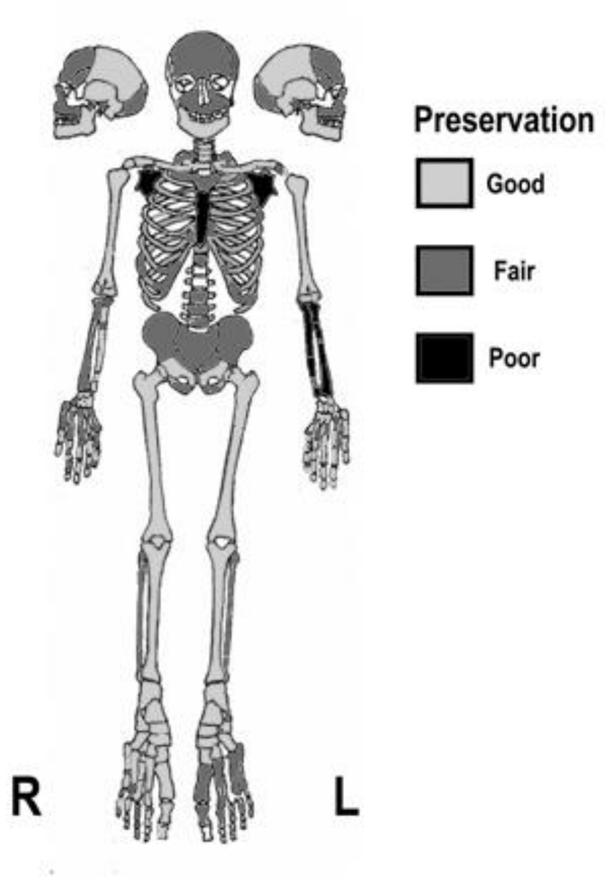


Figure 148: Available skeletal fragments of Sk. 875 and the overall preservation of the human remains (author's own 2021).

I.XV.II Age Estimation

The age assessment for Sk. 875 was undertaken by analysing the pubic symphysis and the auricular surface (Brooks and Suchey 1990; Buckberry and Chamberlain 2002). Table 78 shows the scoring for each the pubic symphysis and the auricular surface, and the corresponding age range.

Table 78: Scoring of the auricular surface and pubic symphysis for individual Sk. 875 (author's own 2021).

Method	*Score*	*Age Range*
Auricular Surface	13	29-88 yrs
Pubis Symphysis	3	21-46 yrs

An average was then conducted using the age ranges, with an average of 58.5 years for the auricular surface and 33.5 years for the pubic symphysis. Due to the pubic symphysis being the more reliable method out of the two for this assemblage (Hoppa 2000; Falys et al. 2006), 33.5 years appears to be more of an accurate age. When comparing Boston's unpublished, raw data for the individuals at the time of their initial excavation, she aged Sk. 875 to 30-40 years of age. Therefore, the ages do roughly correspond with each other. Instead of pinpointing an exact age, age categories are more reliable and appropriate among this assemblage (except for the sub-adults). Therefore Sk. 875 falls among the 'Middle Adults' category; please refer back to Table 35.

I.XV.III Sex Estimation

Table 80 shows that numerous sex indicators from the skull and the pelvis were analysed and scored to determine the sex of individual Sk. 875. Table 80 shows that the majority of indicators had scores of 3, 4 or 5. The scores indicate that Sk. 875 was likely a male due to the masculinity of the features analysed (Phenice 1969; Walker 1994; Mays 1998; White and Folkens 2005).

Table 79: The scoring of the sex determination analysed for individual Sk. 875 (author's own 2021).

Indicator	*Score*
Nuchal Crest	3
Mastoid Process	5
Supraorbital Margin	3
Supraorbital Ridge/ Glabella	4
Mental Eminence	3
Ventral Arc	5
Subpubic Concavity	4
Medial Aspect of the Ischiopubic Ramus	3
Greater Sciatic Notch	4

I.XV.IV Ancestry Estimation

The skull of Sk. 875 shows fair preservation, and therefore only a few ancestry indicators could be analysed by using Rhine's (1990) and Gill's (1995) non-metric methods. However, the skull was too fragmented for any CRANID or Fordisc3.1 assessment.

I.XV.V Stature Estimation

Due to the excellent preservation of some of the long bones of Sk. 875, a stature estimation was obtained (Trotter 1970). However, due to fragments in the left radius, left femur, ulnae, fibulae, and tibiae, they could not be measured correctly or included in the equation for stature estimation. Table 81 shows that the humerus and femur's stature estimations give similar stature estimations, whereas the radius produces a slightly taller stature. Therefore, in the case of stature estimation, the lower long bones are more reliable because they are directed connected to the stature. Therefore, this individual’s stature was dependant on the right femur (White et al. 2012). Furthermore, if one assumes this individual is of European descent, then it is likely Sk. 875 was around 5ft 3inches tall at the time of his death.

Table 80: Measurements of Sk. 875's long bones, which were intact with the stature estimation for each one, following Trotter's (1970) equation (author's own 2021).

Burial	*Right Humerus*	*Left Humerus*	*Right Radius*	*Right Femur*
SK. 875	306mm	301mm	263mm	424mm
Stature Estimation (cm)	164.70 ± 4.05	163.16 ± 4.05	178.42 ± 4.32	162.32 ± 3.27

I.XV.VI Pathology

Upon examination of the skull, an 'orange-peel' like porosity is evident on the exterior of the skull (Figure 149), as well as a possible abscess in the frontal diploe and sinuses (Barlow 1883; Boston (2021, personal communication, 21 January); Šarkić and Redžić 2017). The sphenoid was not present in Sk. 875 and can be a good indicator in scurvy (Melikian and Waldron 2003; Ortner 2003).

Figure 149: Orange peel like porosity on the exterior of the cranium (author's own 2021).

The abscess in the frontal diploe (Figure 150) could result from subperiosteal haemorrhages (Ortner 2003), which is also related to scurvy and common on the frontal bone and hyperostosis of the diploe has been previously linked to scurvy by Hooton (1930).

Figure 150: Abscess in frontal diploe (author's own 2021).

The mandible shows signs of new bone, which could be linked to the possible healing of scurvy (Figure 151). The issue surrounding scurvy is that typically the scurvy indicators diminish over time with age; therefore, the signs are more prevalent in sub-adult skeletons than in adult skeletons. Another issue surrounding diagnosing scurvy is that it shares similar lesions found in bones to anaemia (Ortner 2003; White et al. 2012).

Figure 151: New bone growth on the mandible of Sk. 875 (author's own 2021).

The postcranial skeleton shows active periostitis on the right rib, consistent with scurvy diagnosis (Melikian and Waldron 2003). The left and right tibiae also showed signs of healed periostitis (Figure 152), which may have resulted from subperiosteal haematomas caused by scurvy. Subperiosteal haematomas often affected the tibia's diaphysis, and the lesions are usually bilateral; this is consistent with the striations and widespread subperiosteal bone deposition found on the tibiae of Sk. 875 (Van Der Merwe et al. 2010).

Figure 152: Healed periostitis on the left tibia (author's own 2021).

The individual suffered an amputation on the left femur (Figure 153); this is evident due to the straight, precise cut through the midshaft of the left femur. Cut/ seriation marks are also present on the bone, which was likely caused by a surgical saw. There is no sign of healing on the bone. Therefore, it is likely that the individual died shortly after or during the amputation process (Kirkup 2007; Skaar 2014); the presence of his left tibia and fibula in his burial also supports this theory.

Figure 153: Amputation of the right femur of Sk. 875 (author's own 2021).

Figure 154 shows the patterning of pathology and trauma on the bones.

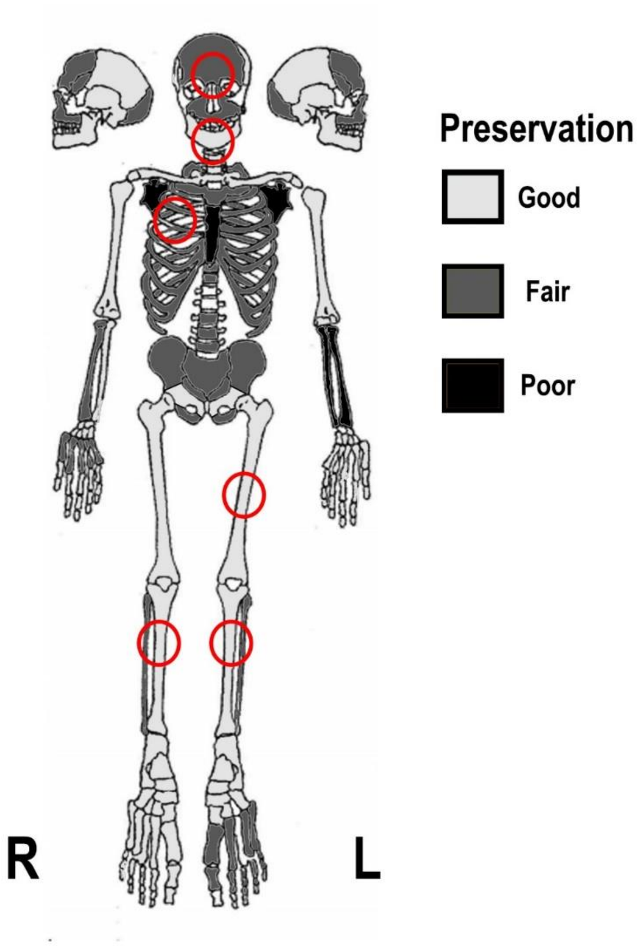


Figure 154: Pathology and trauma patterning on individual Sk. 875 (author’s own 2021).

I.XV.VII Conclusion

The burial of Sk. 875 was not associated with any grave goods typical of the Royal Navy during the 18th century (Rodger 1986; Adkins 2008; Hodgins and Salvatore 2009). However, the burial itself seemed consistent with the rest of the assemblage: coffined and truncated. Therefore, this individual was likely not of significant importance in the Royal Navy's social hierarchy.

Due to this individual's age, a man in his 30s-40s, he likely served over two decades in the Royal Navy, if not more, before his death at the Royal Naval Hospital. However, there are no extensive injuries present, except the amputation on his left femur. The individual's stature is slightly shorter than the average for a man of the 18th century (Stirland 2005). However, there is no sign of stunted growth or any notable malnutrition signs, except a likely vitamin-C deficiency resulting in scurvy. Though signs of healing are present, which could indicate the individual had a more balanced diet towards the end of his life. The prevalence of scurvy and vitamin-c deficiency is highly documented throughout the Royal Navy during the 18th century (Lind 1753; Lloyd 1965; Adkins 2008). Figure 155 shows the individual rearticulated.

Figure 155: Sk. 875 rearticulated (author's own 2021).

Appendix II – Exhibition Panels and Design Work

II.I Exhibition Panels – 50 x 116cm

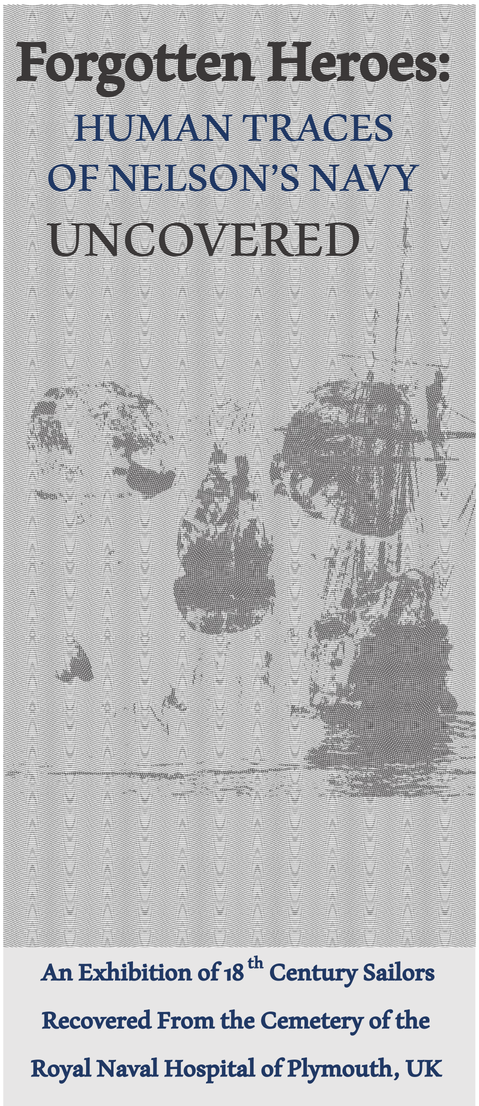


Figure 156: 'Forgotten Heroes' title panel (author's own 2021).

Figure 157: The Hardy Monument memorial panel (panel 7) (author's own 2021).

II.II Exhibition Panel – 29.7 x 42cm

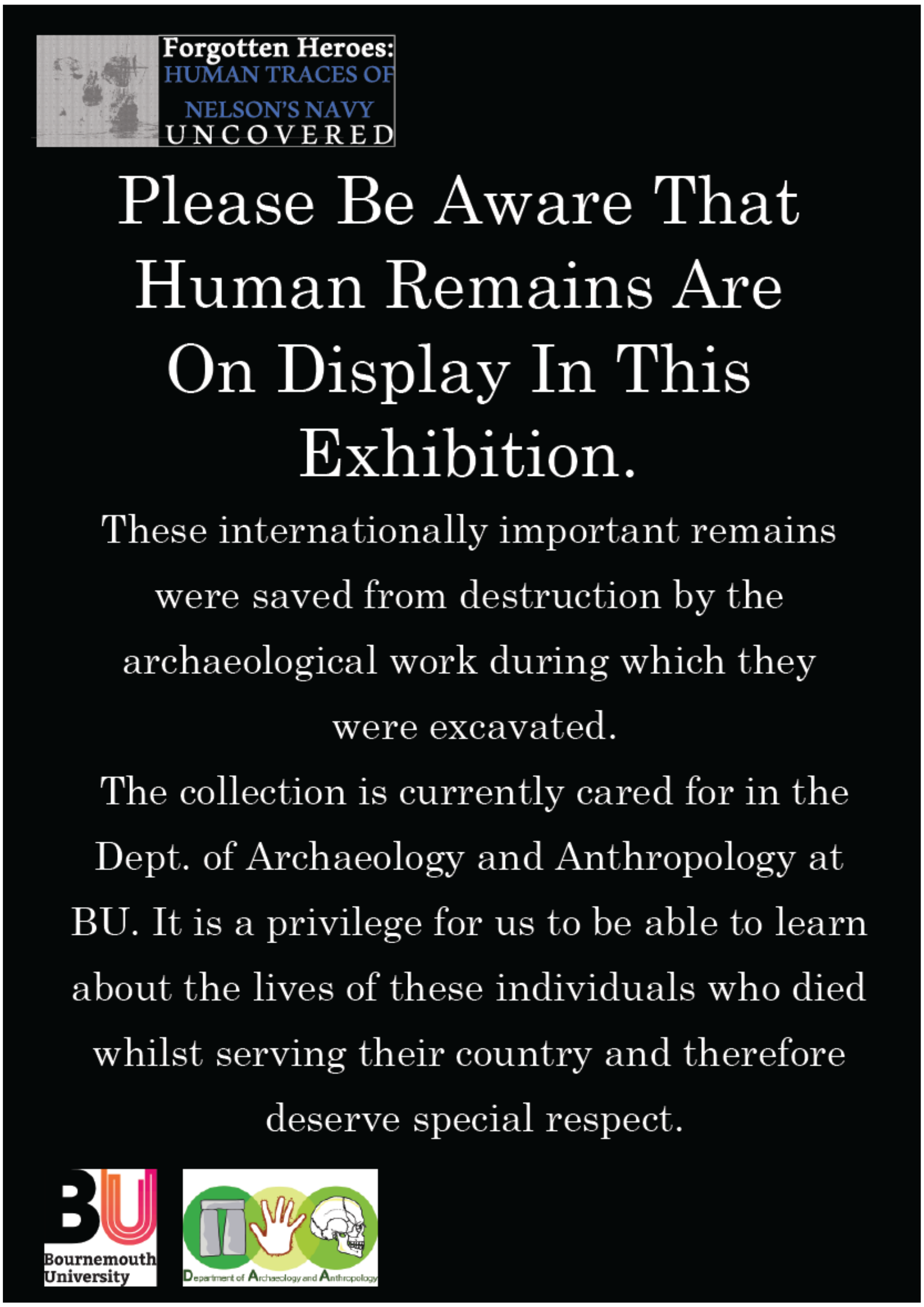


Figure 158: Human remains warning exhibition panel (author's own 2021).

II.III Exhibition Panels – 42 x 60cm

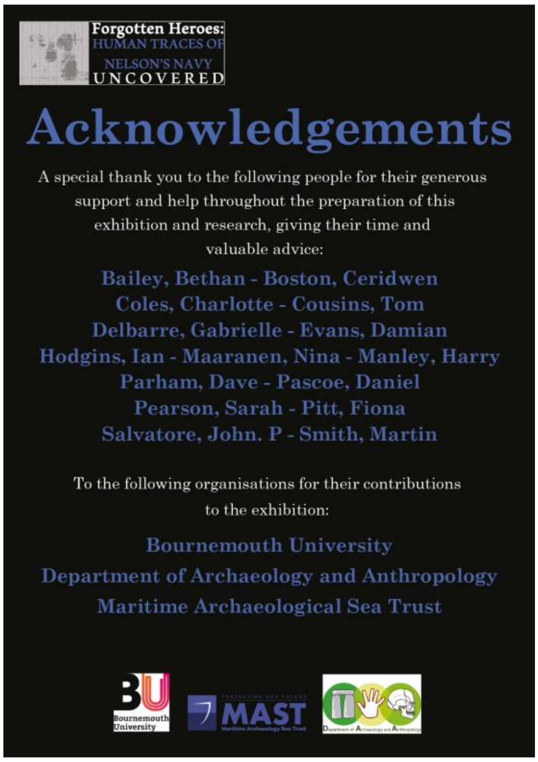


Figure 160: Acknowledgement's exhibition panel (author's own 2021).

Figure 159: About the research exhibition panel (author's own 2021).

II.IV Exhibition Panels – 82 x 116cm

Journey back with us to the 18th century when Admiral Horatio Nelson commanded the British fleet. Britain was frequently at war during this period, including the seven years war (1756-1763), the American war of independence (1775-1783), the war with the French republic (1783-1801), the Napoleonic wars (1805-1815) and the Anglo-American war (1812-1815). It was arguably the time when the Royal Navy held the greatest importance in British national history.

In 2007, over 150 graves were discovered in the grounds of Athenaeum Place, then a former car showroom in Plymouth, Devon. The site had previously been a graveyard for the 18th century Royal Naval hospital Stonehouse.

This exhibition presents the remains of selected individuals from the naval hospital graveyard, giving us insights into the lives of these men and boys who ultimately died serving their country.

"Fifteen uniformed men, each of different rank in the Royal Navy, on the deck of a ship. Coloured lithograph, c. 1859", by London (25 Berners St., Oxford St.) ; Paris (8 Rue de Bruxelles) : E. Gambart & Co., 1 June 1859 (M & N Hanhart lith. impt), licensed under CC BY 4.0

Figure 161: The introduction panel designed for the exhibition (panel 1) (author's own 2021).

Becoming a Sailor & Joining The Crew

Decreasing mortality rates led to population growth in Britain during the 18th century. Average life expectancy increased from the 17th century 39.7 years to 49.4 years. In 1771, around 26,000 men (including marines) were recruited by the Royal Navy; this rose to about 95,000 men by 1781. The men who joined the navy were mostly volunteers, although some were 'pressed' into service. The skeletons from Stonehouse, Plymouth were all aged under 50 years at death, and some were particularly young (under 16). The young age was not unusual, as many sailors were recruited as young as six years old.

For men growing up in 18th century Britain, joining the navy would have had profound benefits, especially for someone from a lower-class background. Incentives included food to eat, somewhere to sleep, an income, and the possibility of a pension.

While many British men who crewed the ships were of European ancestry, the human remains show that men with African heritage may have also served in the British navy at this time. All sailors had the same diet, pay and conditions, regardless of their origins.

Facts: an account from William Lovett, 1812, about a young boy 'pressed' into service: "about five years ago, a child of Mr. Sheppard, belonging to one of the coach offices in this town, but who is since dead, was stolen from his parents. Every possible enquiry was made after him, at the time, without success, and he was given up for lost. He has, a few days since, made his appearance in the Hebe frigate, just arrived in England. The boy has not the most distant recollection how he was enticed away; but remembers he was put onboard the Royal William, and afterwards sent to sea in the Laurel. He has been 25 months in a French prison".

Figure 162: 'Becoming a Sailor' exhibition panel (panel 2) (author's own 2021).

Daily Life in the Fleet

The daily life of a sailor was arduous and tiresome. Days started by rolling up hammocks and then doing laborious chores involving the ship's maintenance. We can see that most sailors have robust bones and large muscle attachments – these men were well built.

An 18th-century sailor's diet included a mixture of biscuit, beer, beef, bacon, pork, peas, fish, and cheese. Although, they were fed well, most of these sailors' bones show signs of scurvy because of insufficient vitamin C.

Cramped and damp living conditions mean that it is not surprising to find that various diseases, such as tuberculosis, were common among sailors.

Although life was hard, the men had allocated time to relax. They spent their leisure time by repairing and making clothes and shoes.

Facts: a newly built 74-gun ship had a crew of around 600-700 men who spent most of their time on the second (gun) deck; this included sleeping in cramped hammocks and eating their meals on hinged tables that rested between the guns.

Vitamin Deficiencies

A long-term lack of a vitamin, which is caused by not enough intake of that specific vitamin.

Vitamin deficiencies can affect the body in various ways and can lead to conditions such as anaemia (lack of B-12 and vitamin C), scurvy (lack of vitamin C) and rickets (lack of vitamin D). Vitamin C can be found in citrus fruits such as lemons and oranges, whereas vitamin D is absorbed through direct sunlight, it can also be found in some foods such as oily fish (salmon, sardines and mackerel) and red meat.

Figure 163: 'Daily Life in the Fleet' exhibition panel (panel 3) (author's own 2021).

Physical Injuries at Sea

Physical injuries were a day-to-day occurrence of life at sea. Many skeletal remains show examples of injury, such as a crushed toe, a healed gunshot wound to the back of the head, and fractures to the hands and arms. Many of the skeletons showed spinal injuries and most likely suffered from slipped discs.

Physical injuries may have resulted from accidents onboard, battles at sea and punishment inflicted on the sailor for 'wrongdoings,' such as slacking off, desertion, or suspected homosexuality.

Facts: more deaths occurred from falling off masts and rigging, and suffocation from the hold's toxic vapours than from battle itself.

The left and right upper arms (humeri) of individual Sk. 633. The right arm (left in photo) shows a healed fracture which has caused the bone to distort, when compared to the left arm.

Figure 164: 'Physical Injuries at Sea' exhibition panel (panel 4) (author's own 2021).

Life and Death at Stonehouse Royal Naval Hospital

Stonehouse was built between 1756-1762 and rented Athenaeum Place as the burial ground for the sailors who died under its care. Its block system was the first of its kind, later praised by Florence Nightingale. Two physicians (Dr Farr and Dr Walker) and two surgeons (Mr Geach and Mr Fuge) were employed at Stonehouse during this period.

Injured or diseased sailors in active service were sent to Stonehouse for immediate care. However, depending on the ship's voyage, sometimes it could take weeks or months for a suffering patient to arrive at the hospital.

Some sailors show signs of leg amputation above the knee (femur), below the knee (tibia) and upper arm (humerus). Out of all eight of the amputees, only one amputation showed signs of healing - the other individuals died either during surgery or in the following days and weeks, either from blood loss, shock or infection.

The hospital's reputation is debated. Some accounts suggest the nurses were thieves and drunks, while others praise the low mortality rate compared to other naval hospitals such as Haslar, Gosport, Hampshire. Between 1793-1797, 2,262 patients died at Haslar, whereas 861 died at Stonehouse.

Facts: amputations were performed fast, sometimes in less than a minute, and without anaesthetic. Time was crucial when amputation was required; sometimes, they were conducted on ships amid battle.

Figure 165: 'Life and Death at Stonehouse Royal Naval Hospital' exhibition panel (panel 5) (author's own 2021).

The hospital was at its peak during the 18th-19th centuries. Athenaeum place, also known as ‘Stray Park', was abandoned 68 years after the navy board commissioned the building of the hospital in 1756, and a new burial ground was designated, known as 'no place field'. Unlike ‘Stray Park', the Royal Navy purchased this new burial ground rather than renting. Over time the use of ‘Stray Park' became forgotten and unknown, along with the men once buried there. The royal naval Stonehouse hospital finally closed its doors in 1995.

The Hardy monument, in the village of Portesham Dorset, was built in 1844 in memory of vice admiral sir Thomas Masterman Hardy, flag captain of HMS Victory at the battle of Trafalgar. This local landmark is visible in the Dorset landscape for miles. May the monument remind us of all those individuals who lost their lives in active service, protecting their country -for whom this exhibition and research is dedicated to.

Figure 166: Memorial text exhibition panel (panel 6) (author's own 2021).

II.V Exhibition Panel – 110.5 x 106cm

Figure 167: Sk. 617 rearticulated photograph panel (author's own 2021).

II.VI Exhibition Panel – 110.5 x 78.74cm

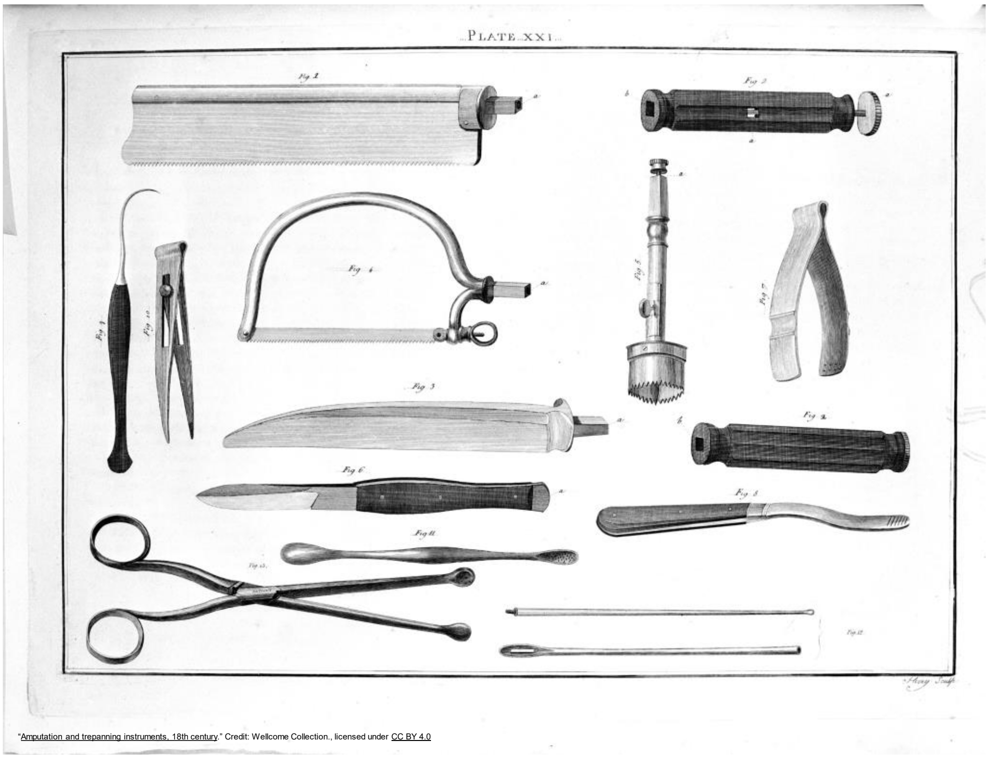


Figure 168: 18th-century surgeon tools for an amputation photograph panel (Wellcome Collection 2021a).

II.VII Exhibition Panels – 50 x 50cm

Sk. 617

Sk. 617 was likely an adult male of European ancestry. He was probably around 40-50 years at the time of his death, making him one of the oldest people found at the hospital graveyard. This individual was well built with a robust physique.

Sk. 617 is likely to have been around 5ft 4inches tall (1.66m) – an average height for a man of his age for this period. It was likely he suffered from vitamin-C deficiency which resulted in scurvy - like many men in this collection. There were notable injuries to the spine, probably due to a lifetime of manual labour. These spinal injuries likely caused back problems and pain.

At 40-50 years old, this man would have been among the older crew members who could have looked forward to his pension had he lived a little longer.

Figure 169: Sk. 617 osteobiography exhibition panel (author's

Sk. 844

Due to this individual's age, a man in his 30s-40s, he likely served over two decades in the Royal Navy, if not more, before his death at the Royal Naval Hospital. He had several injuries, such as a crushed big toe and a healed, blade-like cut near his right ear (on the right temporal bone). Though it is tempting to suggest he had been involved in battles, with the scars to prove it, it is just as likely these marks were the result of injuries sustained accidentally on-board maintaining the ship.

The individual's stature (5ft 6inches (1.71m)) is average for a man of the 18th century. There are signs to implicate this individual had suffered from a mild vitamin D deficiency, resulting in the mild bowing of his legs. Vitamin C deficiency is also likely, resulting in scurvy – similar to other individuals in this assemblage and indeed throughout the 18th century Royal Navy.

Figure 170: Sk. 844 osteobiography exhibition panel (author's own 2021).

Sk. 844

Figure 171: Sk. 844 rearticulated photograph exhibition panel (author's own 2021).

Sk. 624

Sk. 624 was an adolescent, likely 11-13 years of age, with an amputated left leg. Due to the young age of this individual, estimating the sex for Sk. 624 is unreliable. It produces less accuracy than in an older individual. However, it is plausible this individual is a male due to the nature of this assemblage. This individual may have already served a fair amount of years in the Royal Navy, despite the individual's tender age. The bones indicate ongoing malnutrition and possible scurvy, consistent with life on board an 18th-century ship. This individual could have been recruited as early as six years old.

Sk. 624's long bones show this individual was small for his (or her) age, which may attest further to a laborious upbringing onboard a ship. Sk. 624 likely suffered from scurvy, but the bones show the condition was healing; this could mean that this individual sustained a richer vitamin C diet whilst a patient in the hospital. The lack of healing on the amputated limb attests that either he succumbed to death during or quickly after the procedure.

Figure 172: Sk. 624 osteobiography exhibition panel (author's own 2021).

Sk. 624

Figure 173: Sk. 624 rearticulated photograph exhibition panel (author's own 2021).

Sk. 581

Sk. 581 was likely a young adult male in his 20s at the time of his death. Due to the absence of this individual’s skull, there is no current way of knowing the ancestry of this individual. He was likely around 5ft 7inches (1.76m) tall. Saw marks to his neck (vertebrae) shows he was decapitated, likely by a surgeon at the hospital, after he had died.

The decapitation raises various questions, such as why was the man decapitated? It is likely the individual’s head was deemed interesting enough as a specimen for a surgeon’s personal collection or larger establishment such as the Hunterian museum in London. Due to the missing skull, it is impossible to know why it was taken, however it could have been due to an unusual disease or physical condition, or even ancestral difference.

The left arm and shoulder for this individual was also missing and the right arm and sternum show that he may have undergone a radical forequarter resection (a procedure that involves amputating the arm and shoulder). He had fractures to his right thumb (metacarpal 1, proximal), pelvis (acetabulum) on the left side and right foot (proximal phalange 1) which may have resulted from physical altercations, whether it be at battle or amongst his fellow sailors, or by accident. The fracture of the thumb, also known as a Bennett’s fracture, can result from falls, but was also common from fist-fighting.

Figure 174: Sk. 581 osteobiography exhibition panel (author's own 2021).

Figure 175: Sk. 581 rearticulated photograph exhibition panel (author's own 2021).

II.VIII TV Exhibition Slides

Figure 176: Slide one, a painting of a Royal Naval squadron (Atkins 2012).

Figure 177: Slide two, an engraving of HMS Vengeance (1774) a 74 gunship (Stevens 2018).

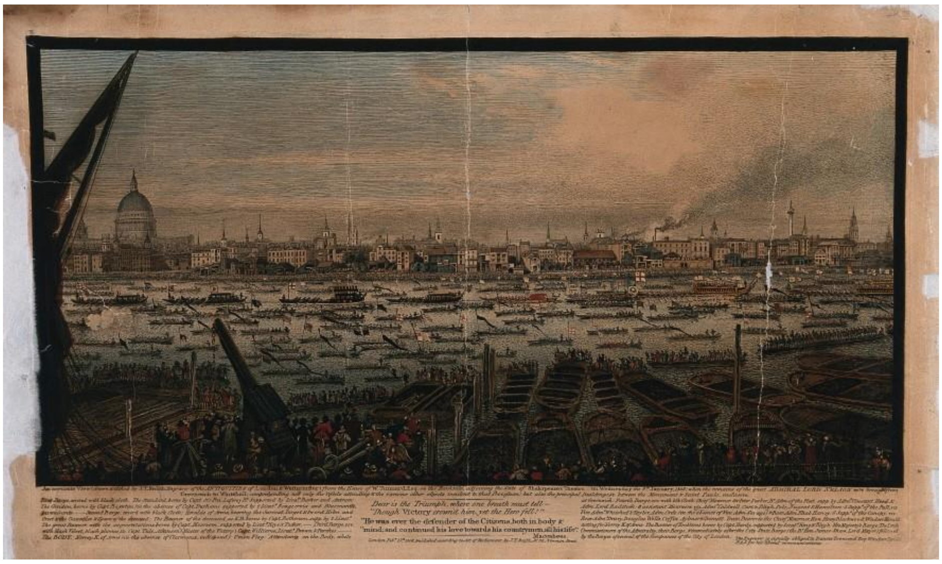
Admiral Nelson

1758-1805

"England expects that every man will do his duty Thank God, I have done my duty."

"Rear-Admiral Sir Horatio Nelson, 1758-1805", by Lemuel Francis Abbott c. 1799, Public domain, via Wikimedia Commons.

Figure 178: Slide three, portrait of Admiral Sir Horatio Nelson (1758-1805) (Francis Abbott 1799).



"The funeral procession on the River Thames of Lord Nelson seen from Bankside. Coloured etching by John Thomas Smith, 1806." Credit Wellcome Collection Attribution 4.0 International (CC BY 4.0).

Figure 179: Slide four, coloured etching of Lord Nelson's funeral procession (Smith 1806).

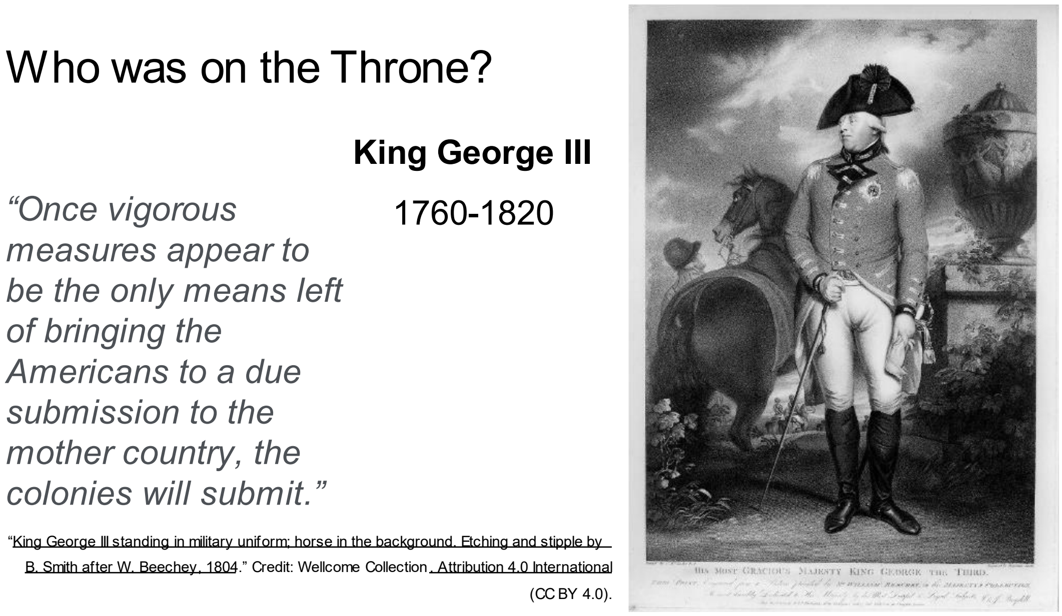


Figure 180: Slide five, etching of King III, who was on the English throne during 1760-1820 (Beechey 1804).

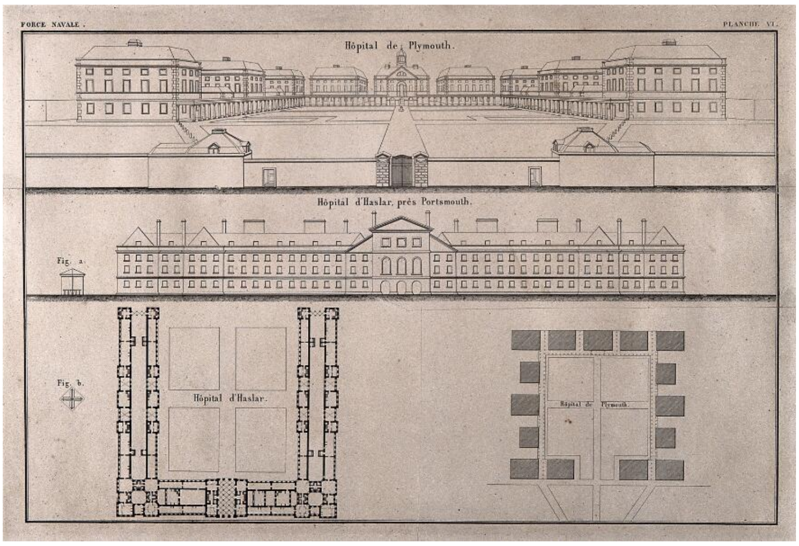
Figure 181: Slide six, British Empire map through the centuries (Gerrynobody 2007).

"Amputations of arm and leg with diagrams to illustrate how to perform the operations. Engraving by F.Sesoni, 1749." Credit: Wellcome Collection. Attribution 4.0 International (CC BY 4.0).

Figure 182: Slide seven, diagrams illustrating the 18th century amputation process (Sesoni 1749).

"Old photo of Royal Naval Hospital, Stonehouse" by unknown author, public domain via Wikimedia Commons

Figure 183: Slide eight, etching of Naval hospitals at Plymouth and Haslar (Wellcome Collection 2021b).



"Naval hospitals at Plymouth and at Haslar, near Portsmouth facades and plans. Etching." by Wellcome Library no. 23650i, licensed under CC BY 4.0

Figure 184: Slide nine, a photograph of the Royal Naval Hospital: Stonehouse, 1897 (Dormskirk 2016).

II.IX Summary of Osteobiographies

Table 81: Summary of the fifteen osteobiographies compiled into a single table (author's own 2021). ***Please note that these osteobiographies were printed before the ancestry analysis was carried out on three individuals and, therefore, the text regarding the stature and ancestry of individuals Sk. 605, 617 and 757 are now incorrect.***

Osteobiographies
'*Sk. 581 was likely a young adult male in his 20s at the time of his death. Due to the absence of this individual's skull, there is no current way of knowing the ancestry of this individual. He was likely around 5ft 7inches (1.76m) tall. Saw marks to his neck (vertebrae) shows he was decapitated, likely by a surgeon at the hospital, after he had died.* *The decapitation raises various questions, such as why was the man decapitated? It is likely the individual's head was deemed interesting enough as a specimen for a surgeon's personal collection or larger establishment such as the Hunterian museum in London. Due to the missing skull, it is impossible to know why it was taken, however it could have been due to an unusual disease or physical condition, or even ancestral difference.*

The left arm and shoulder for this individual were also missing and the right arm and sternum show that he may have undergone a radical forequarter resection (a procedure that involves amputating the arm and shoulder). He had fractures to his right thumb (metacarpal 1, proximal), pelvis (acetabulum) on the left side and right foot (proximal phalange 1), which may have resulted from physical altercations, whether it be at battle or amongst his fellow sailors, or by accident. The fracture of the thumb, also known as a Bennett's fracture, can result from falls, but was also common from fist-fighting.'

'Sk. 617 was likely an adult male of European ancestry. He was probably around 40-50 years at the time of his death, making him one of the oldest people found at the hospital graveyard. This individual was well built with a robust physique.

Sk. 617 is likely to have been around 5ft 4inches tall (1.66m) – an average height for a man of his age for this period. He likely suffered from a vitamin-C deficiency, which resulted in scurvy - like many men in this collection. In addition, there were notable injuries to the spine, probably due to a lifetime of manual labour. These spinal injuries likely caused back problems and pain.

At 40-50 years old, this man would have been among the older crew members who could have looked forward to his pension had he lived a little longer.'

'Sk. 624 was an adolescent, likely 11-13 years of age, with an amputated left leg. Due to the young age of this individual, estimating the sex for Sk. 624 is unreliable. It produces less accuracy than in an older individual. However, it is plausible that this individual is a male due to the nature of this assemblage. This individual may have already served a fair amount of years in the Royal Navy, despite the individual's tender age. The bones indicate ongoing malnutrition and possible scurvy, consistent with life on board an 18th-century ship. This individual could have been recruited as early as six years old.

Sk. 624's long bones show this individual was small for his (or her) age, which may attest further to a laborious upbringing onboard a ship. Sk. 624 likely suffered from scurvy, but the bones show the condition was healing; this could *mean that this individual sustained a richer vitamin C diet whilst a patient in the hospital. The lack of healing on the amputated limb attests that either he succumbed to death during or quickly after the procedure.'*

'Due to this individual's age, a man in his 30s-40s, he likely served over two decades in the Royal Navy, if not more, before his death at the Royal Naval Hospital. He had several injuries, such as a crushed big toe and a healed, blade-like cut near his right ear (on the right temporal bone). Though it is tempting to suggest he had been involved in battles, with the scars to prove it, it is just as likely these marks resulted from injuries sustained accidentally onboard maintaining the ship.

The individual's stature (5ft 6inches (1.71m)) is average for a man of the 18th century. There are signs to implicate this individual had suffered from a mild vitamin D deficiency, resulting in the mild bowing of his legs. Vitamin C deficiency is also likely, resulting in scurvy – similar to other individuals in this assemblage and indeed throughout the 18th century Royal Navy.'

Appendix III

III.I 'Forgotten Heroes' Exhibition Photographs

Figure 185: The entrance to the forgotten heroes' exhibition (author's own 2021).

Figure 186: Close up of the Plymouth assemblage banner designed by author and Bournemouth University's design team (author's own 2021).

Figure 187: The research and acknowledgements panels located on the outside of the exhibition, next to the entrance (author's own 2021).

Figure 188: Introduction panel (panel 1) and the first cabinet containing organic material (author's own 2021).

Figure 189: The first two cabinets with organic materials and porcelain (author's own 2021).

Figure 190: Cabinet 1 with the fragments of two different sized shoes on display, two types of metal buckles and a wooden writer's kit, all loaned material from MAST (author's own 2021).

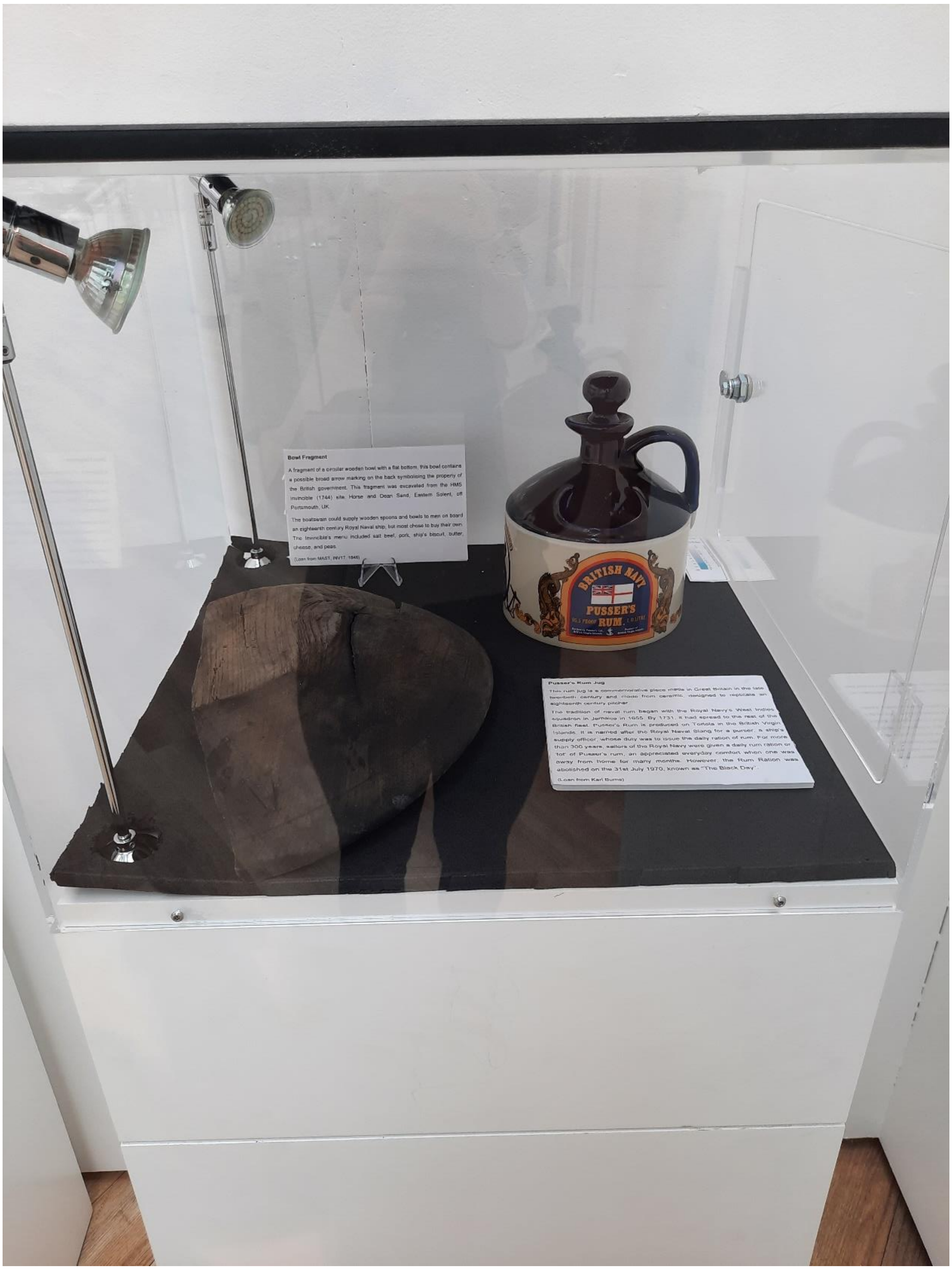


Figure 191: Cabinet 2, a wooden bowl fragment and porcelain rum jug on display loaned by MAST and a private collector (author's own 2021).

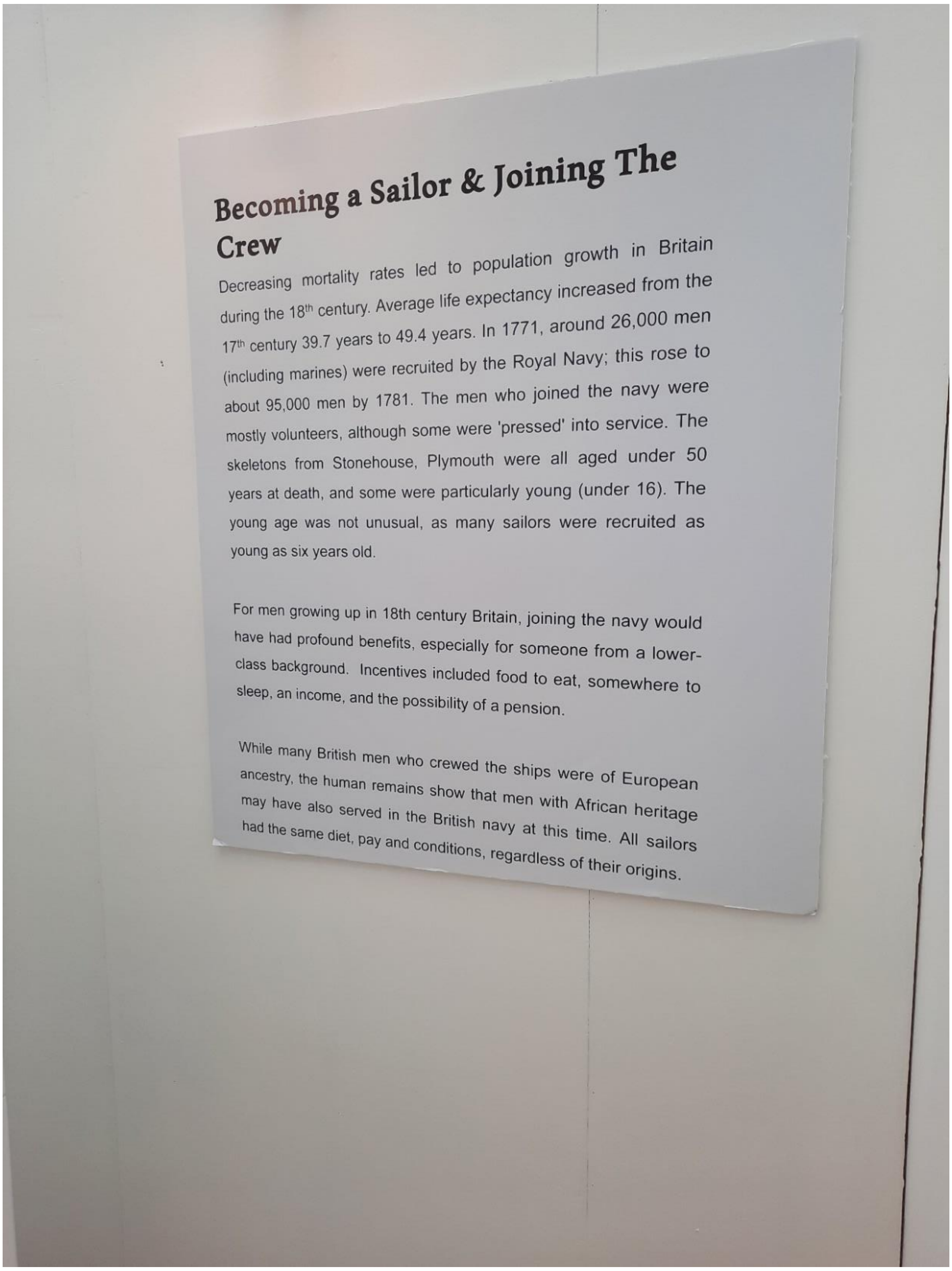


Figure 192: Panel 2, 'Becoming a Sailor' on display (author's own 2021).

Figure 193: Panels 3 (Daily Lift in the Fleet) and 4 (Physical Injuries at Sea) on display (author's own 2021).

Figure 194: Panel 4 and Cabinet 3 on display (author's own 2021).

Figure 196: Cabinet 4 contains various long bones with examples of mild rickets, periostitis and Cribra femora (author's own 2021).

Figure 195: The bottom shelf of Cabinet 4 contains three examples of healed and unhealed amputations, tuberculosis to the spine and decapitation marks on a vertebra, along with replica surgeon tools (author's own 2021).

Figure 198: Close up of the replica 18th century surgeon tools to help illustrate how amputations were performed (author's own 2021).

Figure 197: Articulated photographs of some of the individual's on display, as well as their accompanying osteobiographies (author's own 2021).

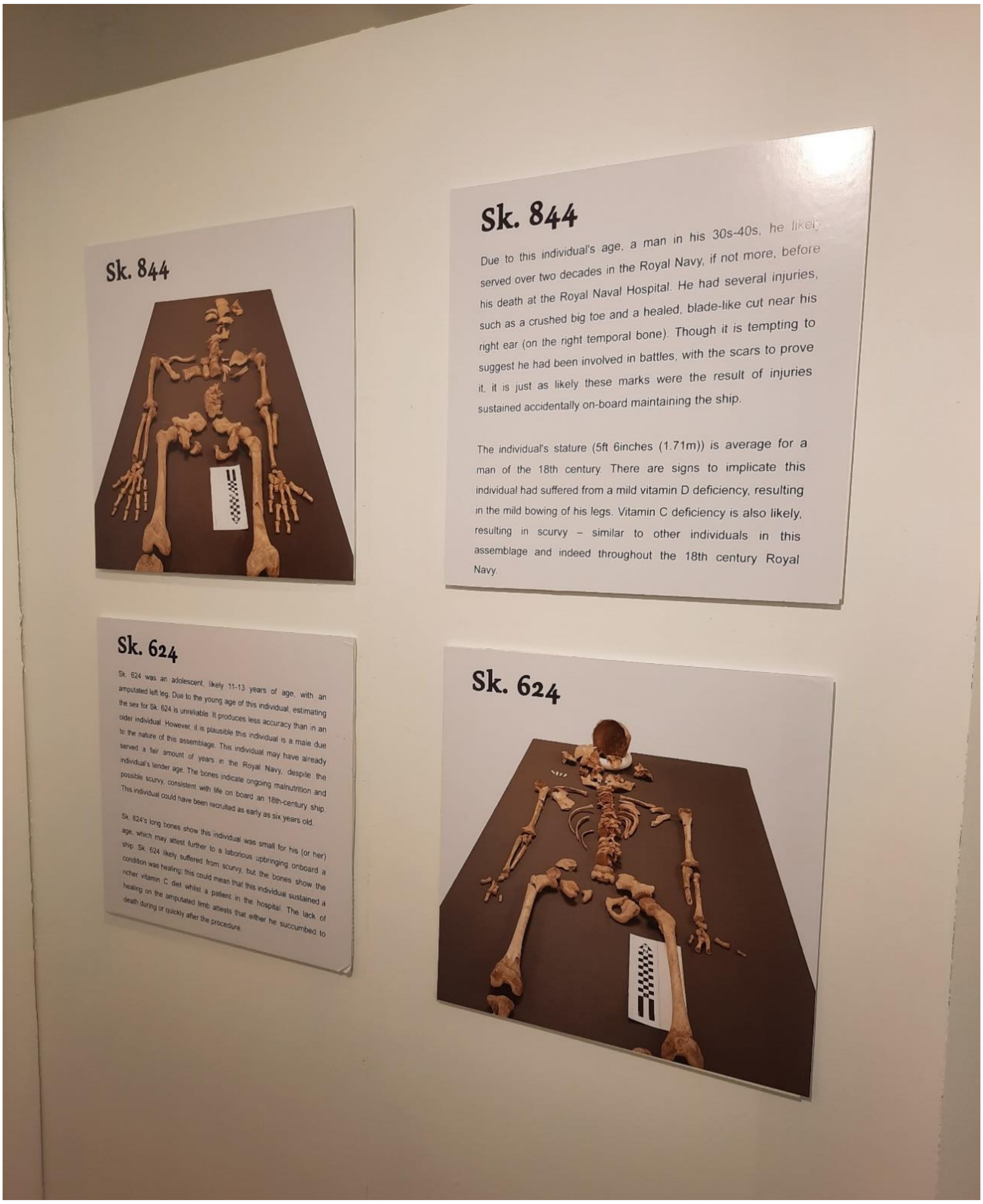


Figure 199: Close up of the photographs of Sk. 844 and Sk. 624 and their accompanying osteobiographies (author's own 2021).

Figure 200: Panel 5 (Life and Death at Stonehouse) and Cabinet 4 along with the TV screen with rotating slides (author's own 2021).

Figure 201: Cabinet 4 close up containing Sk. 100's skull (author's own 2021).

Figure 203: The final text panel (Panel 6) and Cabinet 5 on display (author's own 2021).

Figure 202: Another angle of Cabinet 4 with Sk. 581 photograph and accompanying osteobiography on display (author's own 2021).

Figure 204: Cabinet 5, which contains a replica of Napoleon's 18th-century pistol, two lead shots, two gun flints, one gun wad (all loaned by MAST) and the occipital bone of Sk. 651 with a projectile injury (author's own 2021).

Figure 205: The feedback stand where the visitor could provide feedback (author's own 2021).

Glossary

Ancient DNA (**aDNA)**

Bayesian classifier: a probabilistic model that predicts the most likely outcome for a new situation. The Bayes Theorem, which provides a systematic means of computing a conditional probability, is used to describe it.

Chi-square distribution: is the sum of the squares of *k* independent standard normal random variables' distribution.

Cronbach Alpha: a metric for internal consistency, or how closely a group of objects are related.

delta-N-15 (**d15N)**: The ratio of the two stable isotopes of nitrogen, 15N:14N, is measured by delta-N-15.

Discriminant Function Analysis (**DFA**): a statistical approach for classifying unknown individuals and determining their likelihood of being classified into a specific group (such as sex or ancestry). The assumption in discriminant function analysis is that the sample is normally distributed for the trait.

Her Majesty's Ship (**HMS**)

Hotelling's T distributions: a multivariate probability distribution that is closely connected to the F-distribution and is best known for originating as the distribution of a collection of sample statistics that are natural generalisations of the Student's t-statistics distribution's.

Leave-One-Out-Cross-Validation (**LOOCV**): The number of folds equals the number of instances in the data set in this special example of cross-validation. As a result, the learning process is applied only once for each instance, with all other examples serving as a training set and the chosen instance serving as a single-item test set.

Likert-type: a survey scale of some sort. It is a question with several options to choose from, spanning from one extreme to another, with a middle or neutral choice usually included. It is also known as a satisfaction scale because it is excellent for gauging customer satisfaction with a product or service.

Maritime Archaeological Sea Trust (**MAST**)

Posterior Probabilities (**PPs**): after considering new information, the revised or updated probability of an event occurring.

Scanning Electron Microscope - **SEM**

Statistical Package for the Social Sciences - **SPSS**

Treponematosis: a group of non-venereal diseases.