GRAVE TALES: AN OSTEOLOGICAL ASSESSMENT OF HEALTH AND LIFESTYLE FROM 18TH AND 19TH CENTURY BURIAL SITES AROUND CAPE TOWN

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Thesis submitted to the Faculty of Health Sciences, Department of Human Biology, University of Cape Town, in fulfilment of the requirements for the degree of Doctor of Philosophy.

AUGUST 2007

DECLARATION

I declare that this thesis is my own, unaided work. It is being submitted for the degree of Doctor of Philosophy at the University of Cape Town, South Africa. It has not been submitted before for any degree or examination at any other University.

SIGNED: ______________________

DATE: November 2007

To the thousands of people who died at the early Cape, unknown and unrecorded. Your stories are finally being told – this one's for you…

DEDICATION

To my parents, Daphne and Morris Friedling – you have always encouraged me to reach for my dreams. Daddy, our dream is fulfilled!
"Deo Soli Gloria"

ACKNOWLEDGEMENTS

As always, no student is an island when working on a thesis:

To my supervisor, Professor Alan G. Morris – thank you for your guidance and enthusiasm for this project. Thank you for access to your prized "Afrikaaner" collection of books. I did not loose any!

My mother Daphne and sisters Alexandra and Desireé – thank you for your constant encouragement and prayers. You can soon start "standing in line!!" A special thank you to my sister Alexandra, I'm sure that you know more about the early history of the Cape that you ever wanted to – so much for dropping History at school!! Thanks for helping with the editing of the history of the Cape.

My brother-in-law Morne – what can I say? I always seem to be knocking on your door when the computer was doing funny things and making funny noises just before it crashed! Thanks for the advice on the cameras and technical computer stuff – I still don't understand!

The staff of the Medical Library – thank you for your hard work and dedication in tracking down lost and stolen material for me. You are truly my 'Information Warriors'.

Drs Rachel Alexander and Geney Gunston – thank you for always making me feel welcome to 'chill-out' with you when I needed a break from the office. "Cape Town Girls" rule!!!

Prof Graham Louw – I don't know if I should thank you for all the bumps on the head while driving to all the conferences...I'm not sure if it knocked sense into or out of me!

Caroline Powrie who helped with the endless radiographing of the skeletons while I had my operation after more than half the images were lost due to a system malfunction – thanks a million.

Virginia Saunders for help with the LODOX machine during radiographing.

Tim Hart and Dave Halkett from the Archaeology Contracts Office at UCT – thanks for access to your field reports and photographs of the sites.

Dr Antonia Malan for access to her maps of Cape Town.

Barbara Mohr who helped with the embedding of the bone specimens, putting together a little "lab" for me. Thanks for coming to work when you were sick to help out!!

Charles Harrison for cutting the bone for the histology slides.

Bruce Dando for helping with the equipment and the making of special gadgets!

Dr Laurie Kellaway for the use of his microscope

Prof George Maat and Job Aarents for helping with advice on the bone histology even as far away as The Netherlands!

Melanie Petersen for repeatedly attempting to section the embedded bone on the microtome.

David Wilson from the Geology Department for finally cutting the embedded bone sections

A very special thank you to Drs David and Elaine Potter, the Postgraduate Funding Office viz. Linda Vranas, for awarding me the David and Elaine Potter Fellowship to keep life and limb together while studying towards my PhD – without you none of this would have been possible. To Linda's staff, Stacey Lee-Harris and Zerina Davis – thanks for the laughter and encouragement whenever I popped in.

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ABSTRACT

Two unwalled 18th and 19th century colonial burial sites, Cobern Street and Marina Residence, were assessed osteologically and dentally to reconstruct the life histories and activity patterns of the poorer people living at the Cape. This was done to add to the history and knowledge of the descendants of these people, as little other information exists on them. Questions pertaining to diet, stress, activity patterns and trauma were investigated.

Visual (standard and novel macroscopic methods e.g. distal humeri method), metric (femoral neck method) and histological (proximal anterior femur) techniques were tested and employed to estimate age and sex, as the skeletal material was fragmentary and incomplete. Only adults were assessed and analysed (n = 86 and n = 75 for Cobern Street and Marina Residence respectively) as the infant, juvenile and sub-adult skeletal material was too badly preserved and fragmentary to attempt reconstruction.

Mortality profiles reveal that the two study sites were different in community dynamics. They led hard active lives as seen from their muscle marking and degenerative joint disease patterns. Osteoarthritis was not only very frequent within the groups but was found in much of the younger adult skeletal material. Stress and trauma were relatively low within the two populations. Dental disease was relatively high within the two study groups. This was as a result of a carbohydrate rich diet and poor oral hygiene.

Thus the food they were consuming as well as the activities they were involved in had a huge impact on their lives. The first possible cases of syphilis, tuberculosis and Paget's disease at the Cape were found within these two study groups.

The value of osteological analysis in the reconstruction of South African history is confirmed by this work.

Chapter 1

INTRODUCTION

1.1 Historical burials in Cape Town

Generally, the study of a population depends on the existence of written records, but for some of the history of Cape Town, there are none. Thus, exploring part of our past requires the ability to "read" the bones of our ancestors. Historical burials are not only a subject for the learned few, because they are the remains of people who have lived and died in the past – they have associations with people living today. Their history is part of public heritage and should thus be integrated into the history of Cape Town and South Africa. Urban expansion in the Cape Town area has revealed much undiscovered information about life during the early times of the Cape.

Numerous burials, reburials and exhumations were carried out in an increasingly confined space as the town spread outwards and building and periodic rebuilding took place in the area. These events happened in the context of a colonial past. The realities and experiences of people with ancestral and remembered links to life and death in Green Point were, and to an extent still are, under-researched and even denied. The sand dunes around Table Bay were used for disposing of the dead for a long time before the colonists followed suit. The construction of Chavonne's Battery below Gallows Hill in Green Point by the 1720s was probably associated with the establishment of a formal Dutch military burial ground on the road to Moullie Point, on the outskirts of town. The shores of the bay were sites of numerous shipwrecks, and many of the drowned were hastily (and cheaply) buried in the dunes (Malan, 2005).

In 1825 attempts were made to find alternative marginal vacant land for burials (along Somerset Road) from a fast-growing town, but the only suitable places were in the very area earmarked for development in Green Point. This posed a conundrum for the authorities, many of whose financial interests were affected. Nevertheless, land was granted for Protestant churches and their cemeteries in the 1830s, as were Catholics and mission congregations for 'heathens' and freed slaves later on. These walled cemeteries, and the new residential and business developments, were established on top of the old, and now 'forgotten', burying grounds. Terraced houses, tenements, small businesses and harbour-related services proliferated. The emancipation of slaves in 1838 added to the overcrowded living conditions in Cape Town.

A Proclamation of 1904 ordered the Christian cemeteries in Green Point to be exhumed and re-interred elsewhere, such as at Maitland. The new official city burial ground was opened at Maitland. Christian cemeteries were therefore deconsecrated and 'appropriate' buildings were then constructed on top, for example the Salesian Institute on the Catholic cemetery and Prestwich Primary School on the Lutheran cemetery.

The most recent changes to the face of Green Point started in the 1990s, largely as a result of the hugely successful V&A Waterfront development, and its voracious expansion of the properties adjacent to the old harbour. Until recently the run-down Somerset Road area, lies diagonally the rich and trendy fringes of Cape Town - and within the easy reach of the International Convention Centre. Penthouse developments and exclusive shopping areas are favoured.

1.2 Importance of the study

Most of the poor and slaves were illiterate. Even those who could read and write were not encouraged to document their experiences. Thus the written history of the poor and slaves is partial and one-sided. Life back then was almost most certainly hard and early deaths would have been frequent occurrences. But history leaves it marks in more than just written documents, and it can be coaxed from the very graves in which these people were buried. Skeletal material in the form of bones and teeth yields all kinds of important information especially when no other historical records are present. Studying these remains is helping us to broaden our understanding of the lives of these people who laid the foundations of the Cape.

The Marina Residence and Cobern Street burials provide us with a window in time into the lives of the common people in Cape Town during the Dutch and British occupations and could help us to unravel the often complex origins and life experiences of the people living in the Western Cape today.

1.3 Pride in heritage

Saunders (1984) eloquently stated that very little is known about the history of the urban South African settlement. Our history here sadly lacks the study into historical urban culture and the origins of the working class.

Human skeletal remains, besides deserving comprehensive analysis in their own right, can provide complementary finding to historical and archaeological research. Osteological analysis can also provide information that is typically unavailable through other sources. Skeletal indicators of health and disease such as dental pathology and growth interruptions as evidenced by Harris lines and frequencies of infections are not available from usual sources.

1.3.1. Importance of study before reburial

Buzon (2006) states that evidence from human skeletal remains has often been ignored in attempts to reconstruct the lifeways of earlier human populations. Researchers have typically relied on historical text and artefact studies to learn about the past. Books describing life in the Cape Colony exist, like those by Schutte et al., (1982), Schutte, (2003) and Worden & Groenewald, (2005). While they do inform us on the numerous aspects of life most of them are concerned with esoteric religious, political and personal issues and the social elite. Few palaeopathological studies concerning lower status skeletal series have been published about the people of the Cape. The purpose of this study is to address the issue of health of these people during an important time of social transition at the Cape, reflecting the effects of colonialism on the health and well being of the greater portion of the population. This research analyses the human remains excavated from Cobern Street and Marina Residence, both being part of the unwalled cemeteries found around the Cape. This provides a unique opportunity to learn about the health status and living conditions of this important, yet little studied, segment of our forebearers. There are no official records pertaining to these burials and nobody seems to know who was buried there or exactly when they were buried.

How were the people affected by the colonial interaction during this period? Stress, i.e. physical disruption resulting from unhealthy environmental conditions, is an important concept in the study of their adaptation to life at the Cape. A person's cultural environment has a considerable influence on the capacity to resist these physical disturbances and affects health at both the individual and population levels. Not all stressors can be effectively dissipated. When this situation occurs, the duration and magnitude of the insult and the individual's biological reserves for resisting the stressor determine the skeletal response (Goodman et al., 1988). Stressful periods do not always result in skeletal lesions. However prolonged exposure to unhealthy conditions, particularly during childhood, often manifests itself in skeletal remains.

1.4 The purpose of this study

The primary aim is to present a body of information relating to the lifestyle and health of the poorer people living at the Cape during the 18th and 19th centuries.

Research questions are:

- What technical challenges are involved when working with totally unknown population samples that are fragmentary and incomplete?

- Do the remains of these historic unwalled cemeteries reflect the population dynamics of that time?

- What impact does lifestyle have on these people? Is trauma readily visible? What types of activities were they involved in? Are there signs readily visible on the skeletons? Are there signs of sexual dimorphism and asymmetry from the activities they were involved in?

- What was the disease load carried by these people? What pathologies are present within the study groups? Were they living under stress?

- Does their lifestyle have an impact on their diet? Is their type of diet reflected on their teeth?

Chapter 2

BACKGROUND

Introduction

The history of Cape Town has been written and re-written from a descriptive, Eurocentric or anecdotal view. It tends to concentrate on the life and well being of the rich with no credible attempt being made to actually portray the life of the greater mass of the population, the poorer people of the day. Over half the population of the Cape Colony was coloured (this term was indiscriminately applied to anyone who was not European), slaves or both. During the 1830's when slavery was finally abolished, a new chapter started in Cape Town's history with former slaves suddenly having to keep life and limb together on their own without the dubious handouts of their previous slave masters. The general living conditions could not have been good. Related to this, their poverty had to have had a great impact on the living conditions, health and well being of these people.

A problem with discussing the under classed of Cape Town's society is the availability or rather the lack of availability of sources. The poor did not leave written descriptions of their lives and thus most of the information is indirect.

2.1 History of Cape Town

2.1.1. The Dutch

The Portuguese were the first to discover and set foot on the coastal areas of what later became South Africa. In about 1486 –1487, Bartholomew Diaz named it the Stormy Cape and erected a limestone cross in the land that he "discovered" (Bozarth, 1987, Muller, 1981). A decade later, in 1497, Vasco Da Gama following Diaz's earlier route reached India and returned to Portugal thus establishing the first all-water trade route between Western Europe and the Orient. They rarely stopped at the Cape, preferring to make refreshment stops along the East coast of Africa e.g. Mozambique and at St Helena on the way home (Bozarth, 1987).

In 1580, the Spanish (under Phillip II) gained control over Portugal and the closure of Lisbon, the Portuguese port to the Dutch by 1594 prompted the Dutch to obtain their own merchandise from the Orient at its source. By 1601, 65 ships under

14 companies were competing with each other and soon unregulated trade was undermining the profits of the merchants. In 1602 the VOC (Verenigde Oost-Indische Compagnie – United East India Company or Dutch East India Company - DEIC) was organised under the Heeren XVII and chartered by the State's general under the leadership of the Dutch statesman, Johan van Oldenbarnevelt together with the influence of Prince Maurice of Nassau (Bozarth, 1987, Boxer, 1990). The charter granted the VOC the monopoly of the trade between the Cape of Good Hope going east. It also conferred upon the Company the right to declare war, maintain troops, build and defend fortresses and to conclude treaties. This gave the VOC vast powers and it became Holland's major colonising agent (Bozarth, 1987).

The Dutch, put in regularly at Table Bay for water and to barter sheep and cattle with the resident KhoiKhoi after futilely trying to occupy the Portuguese refreshment station of Mozambique. A permanent Dutch settlement was only established after the wreck of the Haarlem in Table Bay 1647 after which the crew was forced to remain at the Cape for a year before their rescue (Bozarth, 1987, Hall, 1993, Wertz, 1997). From their experiences at the Cape, it was soon pointed out that possession of the Cape would ensure a steady supply of fresh water and produce to passing Dutch vessels. By 1650 it was decided by the Heeren XVII to establish a small settlement at the Cape of Good Hope and also to provide hospital facilities to sick crewmembers (Bozarth, 1987, Wertz, 1997). Three ships left for the voyage, the Dromedaris, Reiger and Goede Hoop under the leadership of the merchant, Jan van Riebeeck. They arrived in Table Bay on 6 April 1652, thus marking the beginning of the first permanent European settlement at the Cape (Bozarth, 1987).

Soon after his arrival at the Cape in 1652, Van Riebeeck requested slaves, however the reply came that none could be spared. The rationale that the Dutch colonists used to import slaves was that they found the indigenous people, the Khoikhoi, who were cattle herders, and the San, who where hunter-gatherers, an unreliable work force (Ziervogel, 1944). Thus those already at the Cape (European men) had to work during the day and stand guard at night (De Kock, 1950, Bird, 1966). The first imported slave arrived at the Cape in 1653. The continued importation of slaves would change and reshape the whole society at the Cape (Shell, 1994a, Worden, et al., 1998). By 1657 there were more than a dozen male and female slaves at the Cape, all of who were employed in private homes. In 1658 the first shipload of slaves arrived at the Cape (De Kock, 1950, Bird, 1966, McMagh, 1992).

The VOC imported slaves to the Cape from India, the East Indies, Madagascar and the east coast of Africa from 1658 to 1795 (Reidy, 1997). When van Riebeeck left in 1662, the Cape was on its feet with a thriving Company garden (Wilson & Thompson, 1969).

The Netherlands fell to the French in 1795. Reacting to the weakness of the Dutch holdings, a British army set out for Cape Town in order to secure the colony against the French. In September 1795, the VOC lost the Cape to the British who kept it until February 1803. In terms of the Treaty of Amiens, it was restored not to the Dutch Company, which had ceased to exist, but to the Batavian Republic, which had been established in the Netherlands at the time of the exile of the House of Orange in 1795. The Cape became a British possession in 1806. After the resumption of the Napoleonic War, Batavian rule was ended by the second British attack in 1806 and the Cape was confirmed in British hands in 1815. The British Government then encouraged the settlement of English-speaking people at the Cape (Wilson & Thompson, 1969).

2.1.2. The British

The first British Occupation of the Cape was in September 1795. This brought the end to VOC rule. It did not mark the end of slavery but it did usher in the beginning of its end. After the VOC capitulation to Britain in 1795, the demand for slaves at the Cape was at its height, forcing the British to relinquish their anti-slave trade principles and consent to a limited import of slaves into the colony. This import was under such strict regulation that the British and Portuguese colonial slave merchants began to clandestinely import slaves between 1979 and 1808. This slaves trafficking came to and end with the 1807 Slave Trade Act, but only implemented in 1808. Thereafter only "Negro apprenticeships" (apprenticeship was for a period of 14 years) was implemented from 1808 – 1818. The following years until the abolition of slavery in 1833 was a period of progressive amelioration of the treatment and working conditions of Cape slaves (Wilson & Thompson, 1969, Bozarth, 1987, Reidy, 1997). By 1813, flogging of female slaves was halted. Also that same year a maximum of only 39 lashes could be administered to male slaves. In 1817 a school for slaves was established for all slaves aged between six to twelve. By the 1820's the amount of hours worked per day was regulated and there was a general improvement in slave treatment. Flogging of male slaves was limited to 25 lashes and males over 60 years of age could not be flogged anymore. The end of slavery at the Cape came in December 1834 (Bozarth, 1987, Ramerini, 1998).

Although Britain wanted to regulate slave importation to the Cape, more slaves were imported between 1797 and 1807 than during the VOC period of 1650 to 1795. Over 7200 (about 650 per year) slaves were imported into the colony from 1797 to 1808. During the first British occupation from 1795 to 1803, 2900 slaves were imported, 2288 were imported during the Dutch Administration between 1803 and 1806 and about 2000 were imported to the Cape just prior to the Slave Trade Act of 1807, which became effective in 1808 (Shell, 1994a, Reidy, 1997).

The population increased eight-fold between 1778 and 1870. English and Xhosa were added to the spoken languages and English replaced Dutch as the official language of communication. Education made significant strides. Religious tolerance was extended to non-Reformed and non-Christian creeds. A contrast sprang up between the urban and the pastoral farming areas in that the urban areas became predominantly English speaking and the rural areas predominantly Afrikaans speaking (Wilson & Thompson, 1969).

Quaintly named 'the tavern of the ocean' by Laidler (1926), the eighteenth century Cape was a vibrant and varied intercontinental seaport. Various people passed through or made their homes in this city or the surrounds. The Cape was not only a place for the influx of foreign people; it was also home to the local Khoikhoi society. Although slaves from East Africa and Southeast Asia were brought in to constitute the main labour force at the Cape, many of the Khoikhoi were also drawn into the colonial labour force.

2.2 Slavery

In the creation of the Colony, the VOC purchased slaves for its own purposes. The rationale for importing slaves was the idea of getting a job done with minimal expense and the financial situation at the Cape, led to the introduction of the cheapest form of labour. In 1679 the foundations were laid for the Company Slave Lodge and by 1693 slaves outnumbered free citizens at the Cape. By 1770, the Company's slave force living at the Lodge had grown to 1000 (Bozarth, 1987). All Lodge-born slaves were baptised and the few who survived to their 25th year were routinely manumitted.

There was even a school for those slaves born here. The Lodge survived until 1828 when all its slaves were manumitted. Their emancipation was an example the government set to prepare all Cape slave owners for universal emancipation (Shell, 1994a).

A second lot of slaves belonged to the locally based VOC officials. These were never discussed, as slave ownership by Company officials was not officially allowed. Thus they were never mentioned in communications to Holland and were never included in the Burgher censuses (De Kock, 1950, Bird, 1966, Shell, 1994a).

The third group of slaves belonged to the burghers. They were the largest in number. These included imported slaves as well as some of the local populace (Shell, 1994a).

As already mentioned, slaves at the Cape, in clear contrast to those of the American South or the rest of the African continent were not all African. A large portion of Cape slaves came from the entire perimeter of the Indian Ocean basin. Enslaved persons imported to the Cape came from ancient slave societies. Thus the slave society of the Cape was not only multiracial but also multicultural. Many were creole mulatto Cape slaves i.e. those born at the Cape of partial European descent and were often indistinguishable from their owners (Shell, 1994a, Reidy, 1997). The slave trade at the Cape started in West Africa and turned east after 1706 and finally became re-Africanised after 1780 (Bozarth, 1987, Shell 1994a). Thus the origins of the Cape slaves were quite diverse.

The Company could divide the slaves into four classes: the negroes, the Asiatics in general, the Malays, and those born in the colony. The negroes, who were the least valuable, came from Madagascar and the African coast; they were employed as wood carriers, water drawers, public porters and any employment requiring strong limbs and bodies. The Malays were the most valuable as they soon learnt the various trades required at the Cape e.g. tailors, painters, shoemakers, carpenters and fishermen. However, it was the Cape-born slaves (born of European men and slave girls) that the inhabitants preferred as a class, these were employed in the domestic and most confidential services of the house. They were entrusted with valuables and treated like companions (De Kock, 1950, Bird, 1966).

Between 1652 and 1808, approximately 63 000 slaves were imported into the Cape from the Indonesian archipelago, India, Madagascar and Africa. Imports from West Africa were sufficient to boost the African component of the slave population during the first period (1658 – 1671). In the first 130 years of occupation, however the Cape turned east for most of its slaves. With the rise of maritime commerce around the Cape after 1784, the east coast of Africa and Madagascar became the prime sources of slave importation. The years from 1784 until the British abolished the overseas trade in 1808 mark the period when most of the Cape's slaves were imported (Theal, 1964, Shell, 1994b). Interestingly, Cape slaves were also among the few slave populations to reproduce themselves prior to abolition of the legal oceanic trade (Shell, 1994a). The death rate among the slaves was often high, especially in the 17th century when new arrivals barely kept pace (Boxer, 1965). Some of the high death rates among the slaves were due to contagious disease. Smallpox epidemics broke out in 1713, 1755 and 1767 at the Cape, claiming many lives, including large numbers of slaves both Company owned and privately owned (Bozarth, 1987).

At the end of the 1820's, changes in the law had given 'free blacks' more in common with whites than they had previously. They could no longer be subjected to any compulsory service not imposed on 'others of His Majesty's subjects'. Before they had been required to apply to the police for permission to leave Cape Town for more than a day and to act at the Town's firemen. During the 1830's free blacks began to buy immovable property rather than renting as before (Bozarth, 1987, Reidy, 1997).

Cape slave owners were not all of European descent, but Europeans represented the majority of slave owners. There were also African, Indian, Indonesian and mulatto slave owners. The only group that did not aspire to slave ownership was the native people (Shell, 1994a).

Thus the slaves constituted about a third of the population in Cape Town and made up about two-thirds the coloured population. The effect of slavery abolition, such as maintaining a new cheap labour force and thousands of displaced slaves looking for housing, was bound to be dramatic (Reidy, 1997).

2.2.1. Who else besides the slaves?

It was during the administration of Simon van der Stel that the Company started sending political prisoners to the Cape from the East. These men and women were treated as slaves. While many returned to their homelands after their sentence had been served, many remained and contributed an important legacy to South Africa.

Many were Muslim and as such their religion, language and recreational habits made a unique contribution to the life and culture of the country. The first French Huguenots arrived in April 1688. Though not a large number, their contribution in industry contributed to the struggling Cape economy (Bozarth, 1987).

Continued requests for help with labour at the Cape resulted in the suggestion to get Chinese labour – to no avail. There were no volunteers. The only Chinese found at the Cape at this time were convicts and political exiles. The next idea to use Company sailors and soldiers also did not pan out (Bozarth, 1987).

There were immigrants from Holland, Germany and Belgium that began to arrive in the Cape after 1679 (Muller, 1981) as well as the Company officials, soldiers and free burghers. During the later British occupation, British citizens were also encouraged to immigrate to the Cape.

Large numbers of Khoikhoi lived at the Cape and were killed by the colonists in various conflicts over land and grazing land. Whole tribes of Khoikhoi were severely disrupted by smallpox epidemics in 1713 and 1755.

In 1737 eight ships were wrecked in a single storm in Table Bay, with a loss of over 200 lives. In 1773, once again a ship was wrecked with 200 men on board of whom only 15 were saved (Wilson & Thompson, 1969).

After emancipation, between September 1876 and May 1882, 3202 Mozambican indentured workers were in Cape Town. They were employed as field labour, domestic servants as well as labour at the docks, on the railways and public works. They augmented the 'black' male population of the western Cape by 15%. With the construction of the railways and the expansion of the dockyards, much of the labour formerly employed on the farms in the Western Cape was moved into construction. This placed severe strain on the labour resources especially when many were also being attracted to the higher wages offered in the diamond fields of Griqualand West. As the farmers refused to pay the higher wages which competition with industry and government would necessitate, new sources of labour had to be found. Freelance labour agents attracted many Mozambicans to the Cape. All the workers imported from Mozambique were male. Once immigration ended, many stayed on and married women designated as 'coloured' to avoid racist legislation aimed at repatriating people who did not qualify for urban residence. Initially wages were paid according to age. But from July 1880 no ages were recorded and wages were levelled out. In 1875 the population of the Western Cape consisted of 41 484 'whites' and 44 460 'coloureds' or people who were defined as being other than European, 48% of the 'coloured' population were male (Saunders, 1984).

2.3 Burial Grounds

2.3.1. Eighteenth and nineteenth century burial sites around the Cape settlement

The modern city of Cape Town, like many other cities of some age, is built on layers of its past. Cape Town's humble beginnings as a refreshment stand for passing ships of the Dutch VOC soon became a bustling little town with graveyards being one of the earliest features in this settlement as they record the development of communities. In Cape Town's early days, those burials not occurring in churches or churchyards were outside the city walls (Langham-Carter, 1973).

According to Bozarth (1987), during the early history of the Cape, the slaves were usually buried in the same cemetery or churchyard with Europeans. But by the early 18th century a cemetery was used for the Company's soldiers, sailors and the slaves. A burial ground was later established just for slaves near the "wheel and gibbet" close to Table Bay. Company slaves were buried in gunnysacking material or a blanket, which was sewn around the body like a bag. The deceased soldiers and sailors were also buried in a similar fashion without a wooden coffin for a while. This practice was stopped for them (soldiers and sailors) by 1710 but was continued for slaves till about 1778 when the expense became too much for the Company.

Some information on 18th and 19th century formal walled burial grounds can be found in the literature on the history of Cape Town. These 'official' burial grounds were walled and demarcated on maps (Select Committee Report, 1904) (Figure 2.01). However references to the unwalled or "slave" burial grounds are vague and often obscure. The 1790 Gordon panorama is the only picture from the time clearly identifying the "slaaven begrafplaats" (Figure 2.02). The picture clearly shows the walled "Burgher Kerkhof" (Civilian cemetery) and the "Soldaten Kerkhof" (Soldier's cemetery) (Cape Archives: ARTOPO 120F, ARTOPO 1585). The 1776 Schumacher panorama from Signal Hill also shows the formal and informal burial grounds but does not label them (Hallema, 1951) (Figure 2.03). This begs the question: "What was the criteria for burial in the formal graveyards and what was the criteria for being buried in the informal or unwalled graveyard?" A pat answer could be that perhaps because these people were not seen as rich (thus unable to afford the cost of a burial)

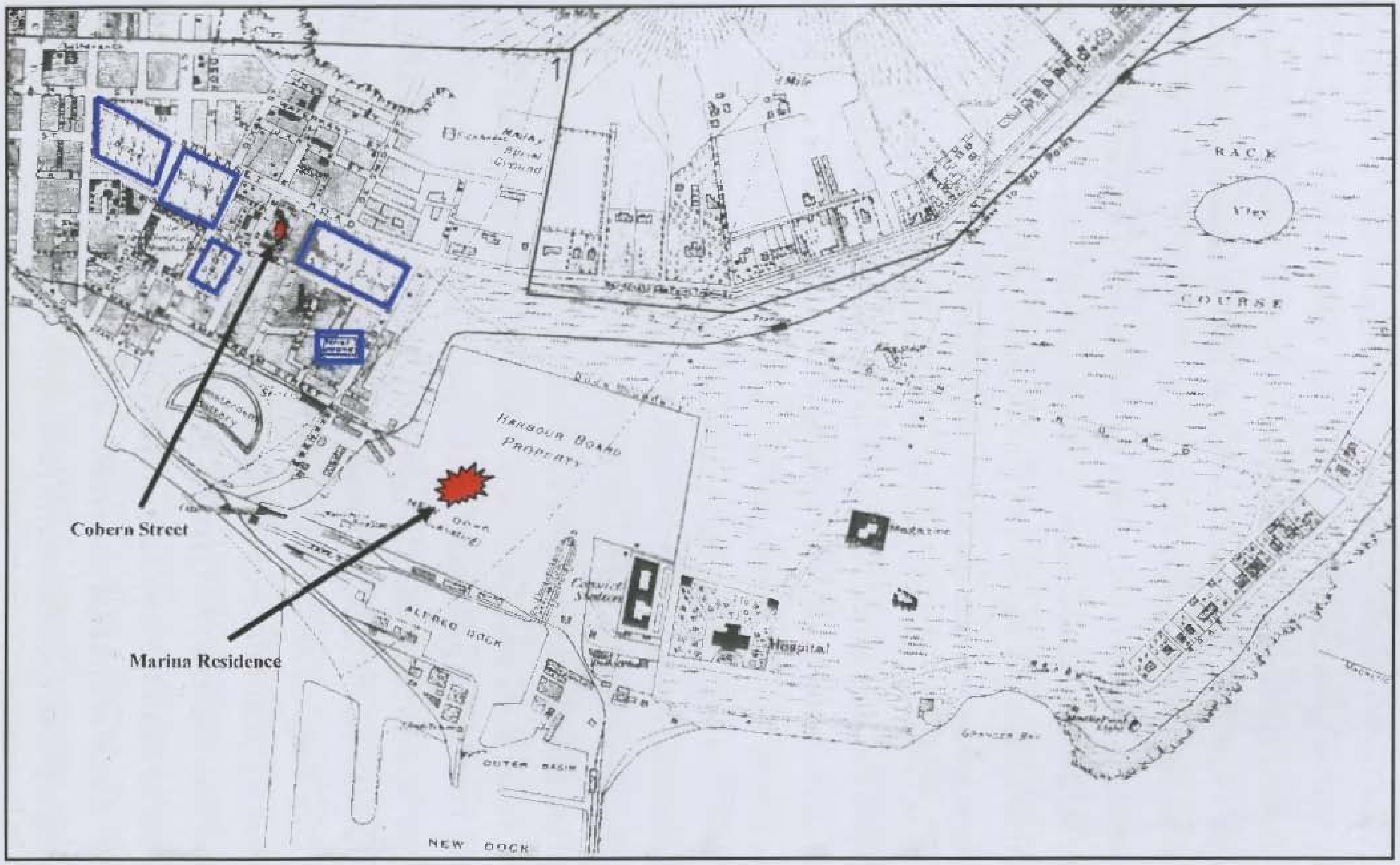

Figure 2.01: Plan of the Cape of Good Hope from 1884 showing walled burial grounds (Todeschini & Japha, 1989)

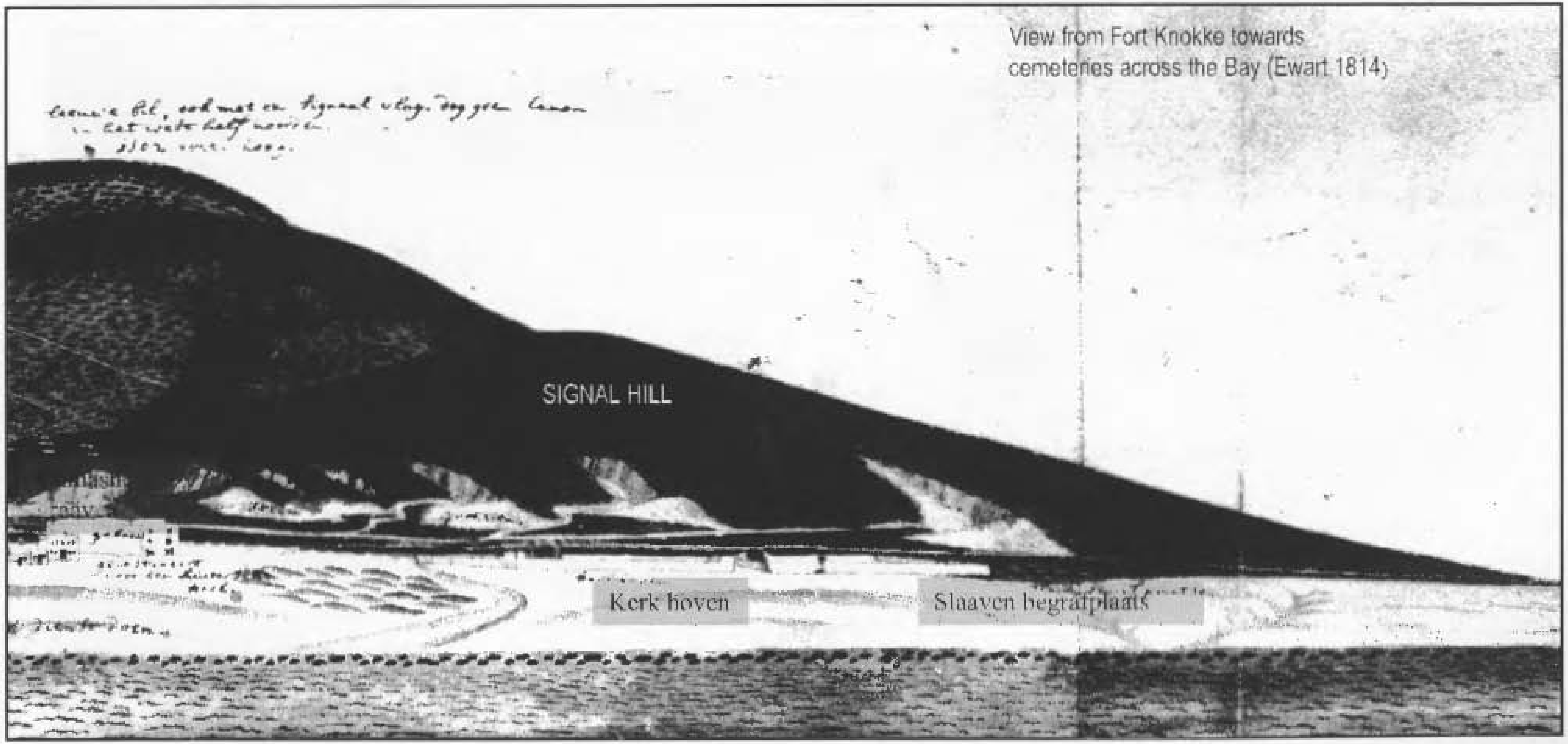

Figure 2.02: Gordon panorama circa 1790 (Ewart, 1814)

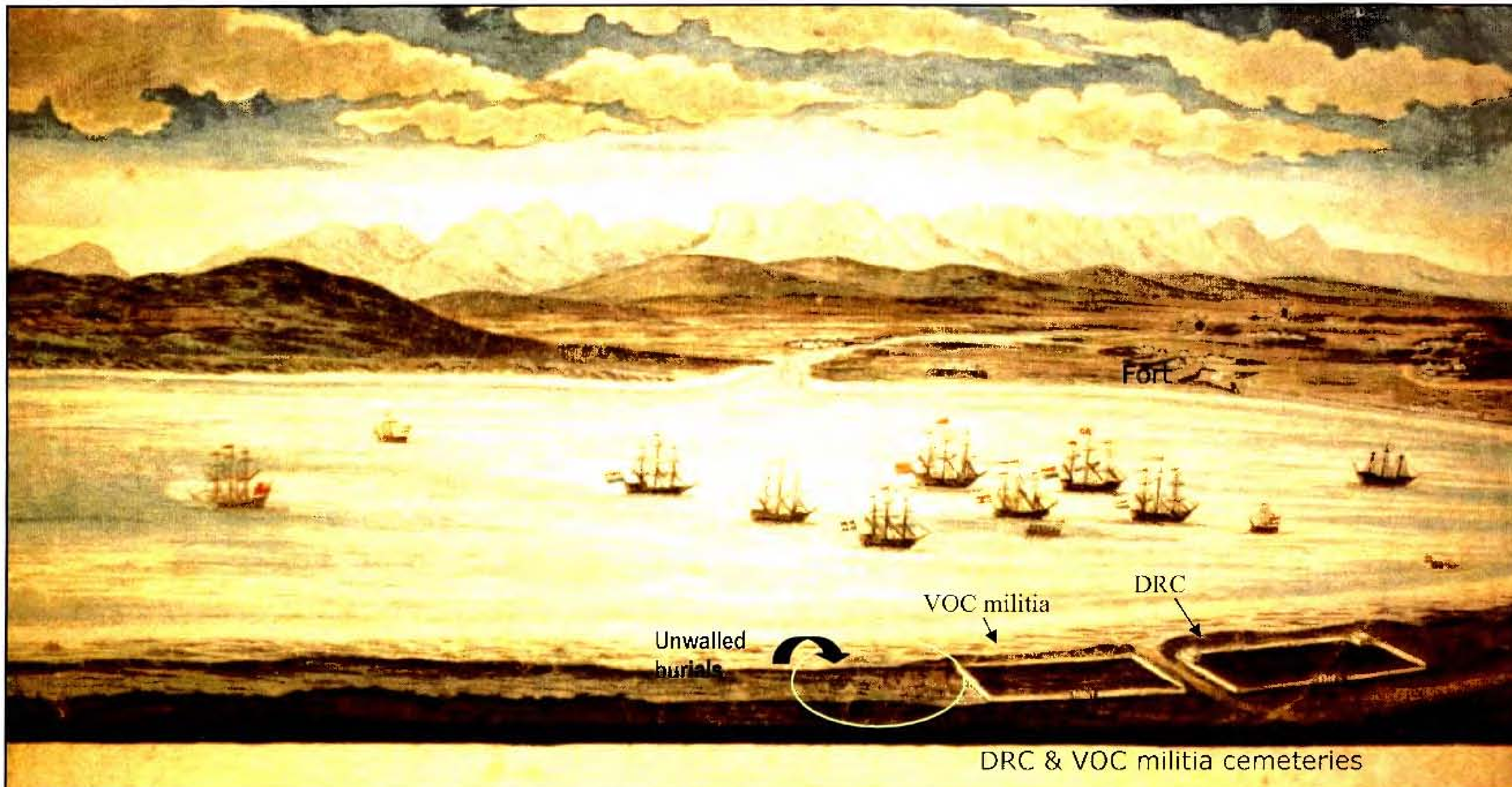

Figure 2.03: The walled VOC militia and DRC cemeteries shown in the 1776 Schumacher panorama of Cape Town with outlying "unwalled" graves (Hallema, 1951)

or important and thus literally became the lost people of Cape Town. To be able to understand who was buried where one has to understand the social order and religions in the Cape of the day.

The Dutch Reform Church (DRC), to whom the majority of the earlier settlers belonged, buried those of Dutch descent and those belonging to the Church. So great was the influence of the DRC that the early Catholics at the Cape were also married, baptised and buried by the DRC (Davids, 1992).

The military cemetery along Somerset Road was formalised first – by about 1720 because of the military installations – and the formal DRC cemetery opened during the 1755 smallpox epidemic. The large number of deaths at the Cape during June 1751 filled the churchyard cemetery and a piece of ground adjoining the soldier's cemetery (429 roods in extent) was opened to serve as a general graveyard. It was soon needed (Laidler & Gelfand, 1971). Further annexes to the DRC cemetery (enlarging the original cemetery) were opened in 1801 and 1802 (Select Committee Report, 1904). The right of burial was confined to Europeans but included Europeans of other denominations as well. VOC rule ended with the First British Occupation of the Cape in 1795 also ending the dominance of the DRC. Other forms of Christianity were allowed. The South African Missionary Society opened its burial grounds in 1813 although the Society was established in 1799. It was not on Somerset Road but found along Ebenezer Street. By the 1820's the growing English community was unhappy with the Dutch burial grounds and the fees being charged for burial plots were deemed too high. They were given their own burial site northwest of the military ground and had it consecrated in 1827 even though the site was only formally granted to them on 7 September 1832 by the Governor (Select Committee Report, 1904, Langham-Carter, 1973). All Anglican burials were to occur there and nowhere else (Langham-Carter, 1973) (Figure 2.04).

As the minority religions grew sufficiently, the need for special graveyards warranted the opening of new cemeteries: each one obviously further out of the town than the earlier ones. Both the Lutheran Church and Scottish Church cemeteries were opened in 1833 and both the Roman Catholic Church and the Ebenezer Church cemeteries were opened in 1840. The Roman Catholic Church and the Scottish Church cemeteries were established on the original military cemetery next to the DRC cemetery (Select Committee Report, 1904). Thus in less than 100 years, a large area from Buitengracht Street to the Green Point Common was graveyards. Access to

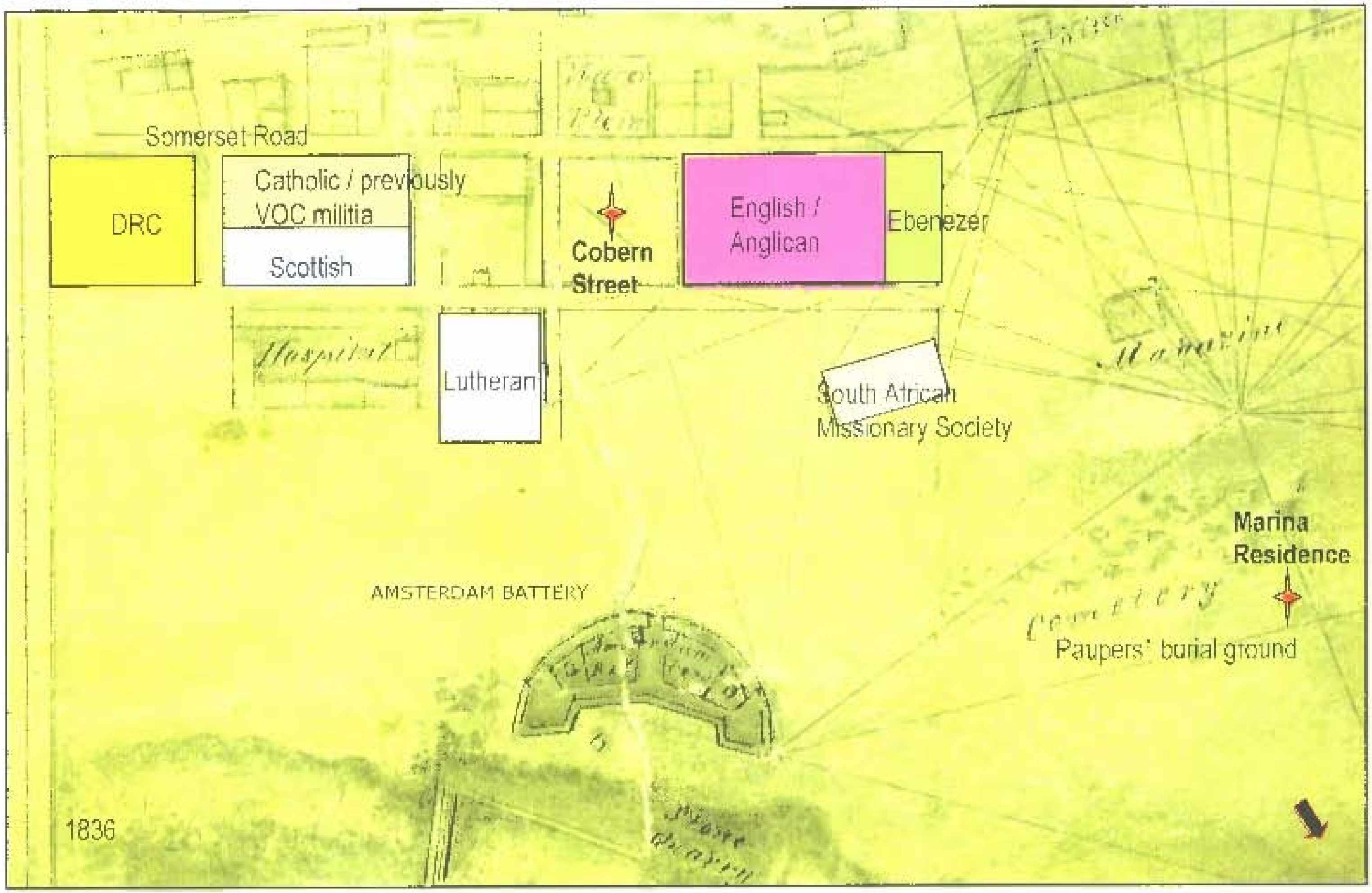

Figure 2.04: Burial grounds in 1836 showing the Pauper's burial ground.

these burial grounds was all from Somerset Road, this being the main road leading out of the town. Thus, they were often called the Somerset Road burial grounds (Langham-Carter, 1973). On the mountainside of Somerset Road, were the burial grounds of the Moslem and Chinese and on the shore side were the Christian burial grounds (Laidler, 1926).

According to Laidler (1926), when the slaves died they were buried outside the town in the "slaves resting place just beyond the Chavonnes Battery". In 1715 the official gravedigger complained that the freemen usurped his job and buried their dead slaves in so "imperfect a manner" that their bodies were soon exposed. He requested the Council forbid the practice (Laidler, 1926).

Many of the dead of the coloured (these were anyone not European) community were interred in the Ebenezer Road Cemetery, but the majority of non-Europeans were buried elsewhere with their cemeteries lying even further out of town to the northwest. There was the Mozambique ground which was originally for slave burials but were also used for free persons who where neither Christian nor Muslim. It lay near the corner of Ebenezer Road and between the Chavonnes and Mouille Batteries (Murray, 1964, Langham-Carter, 1973). Even further out was the graveyard for coloureds on Portswood Road, which had been opened in 1819 (Laidler, 1926, Langham-Carter, 1973). Van Heyningen (1989) refers to an unwalled burial ground used by paupers as "the white sands (obviously referring to the sand dunes) a piece of wasteland on which pauper burials took place with no registration or control". According to Laidler & Gelfand (1971), corpses from the Company hospital were buried in the dunes outside town, near the shore of Table Bay (this sounds suspiciously like the Marina Residence burials). No maps show the locations of these cemeteries.

Many of the graveyards – walled and unwalled – were neglected and soon became very dilapidated. By early 1858 a report went out that the burial grounds along Somerset Road were all full and many over-full and were soon to be closed. Burials however continued at an unsettling pace as clandestine internments occurred at night. The procession would quietly scale the wall, pass the coffin over, rapidly dig a grave, deposit the remains and leave as quickly as possible (Laidler, 1926). A signalman stationed on Signal Hill reportedly witnessed 1843 burials in 16 months between 1867 and 1869 (Langham-Carter, 1973). The closures of the burial grounds were reinvestigated in 1875, and in 1882 a site near the seventh milestone on the road to Bellville was accepted for all Christian burials. This burial ground was Maitland. The last day for legal burials occurring on Somerset Road was 15 January 1886. Maitland Cemetery was opened on the same day. Many objected that Maitland was too far away and burials continued in the old cemeteries and in vacant, isolated plots (Langham-Carter, 1973).

With disuse, the old cemeteries continued to deteriorate as nothing was done to preserve them. Between 1894 and 1900 it was decided that the grounds would be used for other purposes. Descendants were notified and they began to remove their ancestors to the newer graveyards and others were moved to Maitland because of their historic interest e.g. Lady Anne Barnard's husband. The remains of the Gallows Hill criminals were moved when the hill was levelled in 1900. The Disused Cemeteries Act of 1906 allowed the Cape Town City Council to purchase listed graveyards if they had not been appropriated by their lawful grantees. Some even sold their land to the Provincial Administration e.g. the Anglican Cemetery was sold by St Georges for £11 500 in terms of the Ordinance 23 of 1920. In 1921 the family tombs on Somerset Road were dismantled, most simply broken up but some (about 455) with inscriptions were moved to Maitland. The remains were reportedly dug up by coloured convicts and put into a mass grave at Maitland. Building development then commenced along Somerset Road (Laidler, 1926, Langham-Carter, 1973).

2.3.2. Old burial grounds, new building grounds

Green Point is flanked on the one side by Lion's Head and on the other by the Atlantic Ocean. It currently has land and property values among the highest in the country. The proximity to Cape Town makes it quite popular. With all the construction happening around Green Point, it is hard to imagine it being the seaside settlement of the 18th and 19th centuries (Kagan, 1975).

In the 18th and 19th centuries, Green Point was the cattle grazing ground of the old settlement. The slaves gathered there on Sundays and fished for 'klipfish" with nets. It was a bare sandy plain in summer and ablaze with flowers after the winter rains (Laidler, 1926). Today Green Point still lies on the edge of the city centre, between Signal Hill and the V & A Waterfront. It is a vibrant and lovely area. During the last 13 years of urban renewal in the Green Point, accidental discoveries of various parts of this unwalled burial ground has brought to light this forgotten part of Cape Town history.

According to Kagan (1975) the origin of the name "Green Point" has been the subject of much debate. The most believable suggestion appears that navigators who rounded the Cape gave the name. When the sea was viewed from a ship on its way into Table Bay, Green Point, especially in winter and spring when the ground was covered in growth would have been an appropriate name. The site was granted to Jan van Riebeeck in 1657 by Commissioner Van Goens and named "Groenpunt". By 1675, Green point possessed its name in the English form as published in the Atlas Maritimus in London in 1675.

The one feature that tended to place Green Point on the map, were the public hangings that occurred at Gallows Hill from the early 18th century. These hangings ended in 1869 when and act of Parliament decreed that executions should occur only inside prison gates (Kagan, 1975).

Precise dating for the Marina Residence and the Cobern Street cemeteries a well as the identification of those buried there, remains unknown. However, the presence of copper items and copper oxide stains on some bones suggests that this burial ground dates to the 18th and 19th centuries (Halkett, 2000) (Figure 2.05). No references to either of these burial sites are mentioned in the Cape Archives. This plus the lack of coffins – especially for the Marina Residence cohort – as well as the chaotic layout of the burials could lead one to the conclusion that they were from the poorest sector of Cape society.

Those buried at Marina Residence and Cobern Street could include slaves (as seen from the dental modifications), the poor burghers, blacks, sailors, convicts, patients from the hospital, victims from the various epidemics, those who died aboard the ships sailing into the port and shipwreck victims.

2.4 Construction of identity

The strategic value of the Cape settlement became apparent to the VOC in the late 17th century following the war with France. Immigration to the Cape was encouraged under the rule of Simon van der Stel. Seeking freedom from religious prosecution, immigrants from Holland, Germany, Belgium and French Huguenots began to arrive in the Cape after 1679 (Muller, 1981). The European community at the Cape started small; at first they were mainly VOC employees and a free burgher community. This

Figure 2.05: Copper jewelry found with some skeletal material helped to age the burial site (Picture by Archaeology Contracts Office, 2000).

community increased and by 1750, a unique cultural identity existed at the Cape (Malan, 1993). Instead of being a discrete category of people culturally and religiously as in the first few decades of the colony, the distinctions of the Khoikhoi, European colonists and slaves had blurred by the 1770's. To varying levels, different communities intermarried and some slaves and free blacks converted to Christianity, but more commonly to Islam. The main divisions, by the later part of the 18th century, were based on religious affiliation (Elphick & Shell, 1989).

Identities and stereotypes are not based on 'race mixture' but on cultural creativity shaped by South African history of colonialism and slavery. This conceptualisation undermines the common sense view that perceives the products of miscegenation as something produced by the mixture of other 'purer' cultures (Erasmus, 2001). Pickle (1997) adds to this by saying that race uses biological characteristics for collective identification and divides populations in terms of stock or the collective heredity traits, the most common being phenotypical difference such as skin colour. Cultural traits are thus treated the same as biological traits.

The construction of social categories contributes to achieving a positive social identity and can be understood as one of the most basic human activities employed to simplify a complex social world so that it can be better understood (Tajfel, 1978, 1984, Turner, 1987). Group identities do not evolve in a linear or predictable way and should not be reified as permanent (Goldin, 1987). Ethnicity and community are often used as synonyms even if the spatial boundaries of a community are not always clear and might change over time (Bickford-Smith, 1995).

Tajfel (1978, 1984) states that conceptually, social identity has varied influences, such as varied living circumstances and complexities in social interaction patterns. Identity (of self and the community) is complex as it influences ones behaviour. In essence, different identities are activated by varying situational cues and then become influential in those circumstances. People compare the world around them to what they know and that automatically categorises people into various social groups as gleaned from the sensory cues they have observed. This process allows people to act more smoothly and effectively as social beings because it allows them to predict how others will act in response to certain situations and behaviours and gives a certain order to life. Thinking of people as having social identities offers conceptual advantages over thinking of them as members of racially identified groups. Thus, identity is constructed as part of a never-ending process influenced by personal, social and environmental forces. It is a complex web of interrelated concepts that people hold about who they are, how they live and what they want from life. Identity, like culture is a silent influence that people do not notice because it is always present, in their homes, within families and the community. Pickel (1997) agrees in that, even though ethnicity is a construct, it can gain meaning for individuals and for groups at certain points in time.

Religion was also used to create identities. Pagan, Christian and Muslim identities predominated in colonial South Africa. In South Africa religion, clothing, geographic origin and civic identities also were used to create a sense of difference. By the 19th century, race was decisively folded into the social order when the word 'coloured' was applied by self-styled whites to the descendants of slaves. Race was not a constant part of Cape slavery, but race did become a convenience for Cape slave owners. In the 17th, 18th and early 19th centuries 'race' was different from its late 20th century meaning. Identity at the Cape was not based on race as such but on descent (Shell,).

From 1652 through 1819, the legal line of descent for both slaves and free citizens was matrilineal. Offspring of free man and slave women remained slaves. Offspring off slave men and free women were free but termed "bastards" (people without religious or civic identity). Many bastards were enserfed. As slave populations increased, a process of creolisation occurred. More slaves were born locally, more slaves were born in the houses of their owners and more slaves were born whose fathers were also their owners (Shell, 1994). Of all the slaves imported to the Cape, only the slaves who belonged to the Company can be said to have shared a common culture. They were mostly from the same religious background and the same geographical areas. By the 1820's, the origin of the slave was no longer recorded in the official slave transfers. The system based on individual origins changed to one based on descent and race. The household construction came to be based on ethnicity, not origin alone (Bozarth, 1987, Shell, 1994, Reidy, 1997).

Most of today's descendants of the premodern, immigrant South African population do not know where they come from. South Africa's most potent identity, that of "Afrikaner" has served persons claiming descent from Dutch, English, French, German and also "free black" origins. Yet the Afrikaner identity can be shown to have originated from the richly textured, syncretistic, domestic creole culture of the Cape's slave population. The complexity of the early Cape culture was in part the result of a constantly changing oceanic slave trade to the Cape. Slaves were drawn from a multitude of starkly different geographic and cultural origins, constituting easily the most diverse population of any recorded slave society. A changing slave trade, which imported many languages and cultures into the Cape, set in motion a complicated demographic and cultural creolisation process that transformed the whole colony (Shell, 1994b).

The lack of European women at the Cape resulted in miscegenation very early at the Cape. It was the product of both marriage and illicit sexual relations. The problem was partially solved when the Slave Lodge was segregated into three partitioned sections i.e. for married slaves, single females and single males. The Company also tried to put an end to illicit sexual relations between the Dutch and female slaves by stating that a lot of the children produced by these liaisons would prove an economic loss to the Company as they had to be set free from their servitude at the prescribed times. This was unsuccessful. An edict was later passed that anyone found to be involved with a slave was to be "bound to a pole and severely beaten". The practice simply continued as attested by the number of edicts still being passed in later years. Miscegenation also occurred among the various slave groups, Europeans and the indigenous people of the Cape i.e. the Khoikhoi. The result of this miscegenation in its various forms and combinations occurring at the Cape was the emergence of the present-day "Cape Coloured" population (Bozarth, 1987). Slavery lasted nearly 180 years in South Africa. The descendants of slaves were neither white nor African nor Asian so many was officially classified as Coloured, a category of people of mixed descent. As racial distinctions became more complex, the racial hierarchy became more entrenched.

2.5 Disease at the Cape

When Van Riebeeck first arrived at the Cape, they were soon plagued by dysentery even the sheep were affected. The cold weather and draught retarded the first crops planted and consequently many were malnourished. To add to this, two ships put into the Cape with many on board suffering from scurvy and dysentery. A tent was pitched on the shore and this in essence became the first 'hospital' at the Cape on 15 May 1652. Thus, the story of disease at the Cape is more one of those coming in on ship than ashore. Diseases often found on board ship were beri-beri, tetanus, smallpox, dysentery, hepatitis, cholera, measles, bubonic plague, typhus, ulceration of the colon, pulmonary tuberculosis and liver abscesses (Laidler & Gelfand, 1971). These were caused by nutritional deficiencies as well as living conditions. It is thus understandable that the continually passing ships were the cause of most of the afflictions that beleaguered the Cape.

During 1661, 1662, 1663 an unknown epidemic broke out among the whites, Khoikhoi and slaves. Many intestinal illnesses were frequent that resulted in severe fevers and swelling of the throat (Elphick, 1977). Many epidemics swept through the settlement, the first in 1687 was a burning fever killing both slaves and whites. Two years later a virulent influenza-like disease swept through. Leprosy was also rife at the Cape. The indigenous populations of South Africa were particularly prone to this disease. The earliest European case at the Cape occurred in 1756. Apart from these infectious conditions there was no established pattern of diseases in the Cape Colony. The people were remarkably healthy except for those sailors in the hospital wards who had scurvy or syphilis. Childhood ailments were mild and few were fatal (Burrows, 1958).

It is known that many people, including slaves and Khoikhoi died in the smallpox epidemic of 1713 (Wilson & Thompson, 1969). In 1736, a measles epidemic swept through the Cape, leaving many dead. A second smallpox epidemic in 1755 resulted in a large new Dutch Reformed Church cemetery being opened alongside the older military burial ground. A second measles epidemic broke out in 1816. There was a third outbreak of smallpox in 1776 and endemic typhoid in 1882. In 1901 there was an outbreak of plague (Laidler & Gelfand, 1971, Shell, 1994a, Malan, 2005). Thus in 188 years, there were seven major epidemics, which must have had an enormous effect on those living at the Cape during those times. This could possibly account for many of the burials in the unwalled burial grounds.

The Slave Lodge was overcrowded, under-ventilated and unsanitary breeding-ground and reservoir for infection that swept through the Cape with devastating results (McMagh, 1992). Known documented infectious disease at the Cape included smallpox, measles, typhoid and plague. None of which has been identified in any skeletal material to date.

2.5.1. Smallpox

Smallpox is a very old disease and together with measles, it had prevailed in China and India for centuries. During the 18th century, three smallpox epidemics swept through the Cape. The first in 1713 was brought to the Cape by a vessel from India. The passengers who had had it had recovered but the spores were still present in their bed linen, which was sent to the Slave Lodge to be washed by the slaves. The washerwomen were the first to die. Twenty percent of the slaves and fourteen percent of the rest of the population died (McMagh, 1992). When the first smallpox epidemic swept through almost none of the families at the Cape was left unaffected. Among the Hottentots, whole kraals were affected and the Strandloper tribes almost ceased to exist (Burrows, 1958). When the first smallpox epidemic hit the Cape, so many died that they ran out of wood to make coffins and many individuals were buried without (Laidler & Gelfand, 1971). Another epidemic arrived from the East in 1755. Over two thousand died at the Cape, the majority being slaves. This epidemic also almost completely decimated the Hottentot tribes. The third outbreak in 1767 was milder (McMagh, 1992), a Danish ship introduced this epidemic of smallpox. After 1769, smallpox visited the cape every seventh or tenth year (Laidler & Gelfand, 1971). Once smallpox entered the Cape it was not confined to the town, it soon spread north causing devastation in various settlements (Elphick, 1979).

Virally induced diseases are acute and highly contagious. They are known to decimate large portions of previously unexposed (virgin) populations in a very short period of time. Death after the initial infection is usually rapid and thus virus induced bone infection is very rare. In epidemics, 2-5% of children and adolescents develop osteomyelitis and arthritis variolosa 2-3 weeks after the skin lesions appear (Kelley, 1982). In those that survive, the bone changes tend to disappear after several months. Skeletal lesions are not seen in adults (Ortner & Putschar, 1985). Thus smallpox is extreme difficult to identify on skeletal material especially with poor bone preservation.

2.5.2. Measles

Skeletal involvement in measles is very rare except in severe cases of rubella (German measles). It is a common, acute and contagious viral disease that usually affects children and young adults. A number of older adults may also be susceptible to this disease. Congenital malformations appear in 20 –25 % of mothers infected with rubella in the first trimester of pregnancy.

Skeletal changes occur in 35% of cases and involve the metaphyses of long bones, especially the femur and tibia and the long bones of the upper limb. The mechanism of production of the skeletal abnormalities is not completely understood and may be due to metabolic or nutritional disturbances or a viral inflammatory process. The lesions can only be seen radiologically as poorly mineralised and coarsened trabecular bone with longitudinal streaks of alternating sclerosis and lucency (Ortner & Putschar, 1985, Aufderheide & Rodriquez-Martin, 1998). The diaphysis are not involved and periostitis is absent. The bone changes appear at about 2-3 months of age (Aufderheide & Rodriquez-Martin, 1998).

2.5.3. Typhoid fever

In 1666 typhus was introduced to the Cape. Mortality was high especially among the Hottentots. In 1687 typhus once again broke out. The European population was reduced by half and as well as the Hottentot population (Laidler & Gelfand, 1971).

The prevalence of this disease is influence by socio-economic factors. Transmission of the bacterium is by the fecal-oral route especially in areas were sanitation is a problem. A few days after ingestion, the organism gains access to the bloodstream and is widely spread. This generates symptoms of fever, chills and even vascular collapse in some individuals. By the end of the first week a blotchy skin rash may occur. The liver and spleen enlarge. Perforation of the intestinal may also occur (Aufderheide & Rodriquez-Martin, 1998).

Osteomyelitis is a complication, but occurs in only 1 % of infected individuals. Most commonly the ribs, tibia and lumbar vertebrae are involved. In the long bones, the lesions appear as a diaphyseal abscess near the periosteum. In the vertebrae, the lesions involve the vertebral bodies of adjacent vertebral plates by narrowing the intervertebral discs (Aufderheide & Rodriquez-Martin, 1998).

2.5.4. Plague

Plague also called Peste and Black Death, is a specific zoonosis affecting rodents and their fleas. It is an acute and severely infectious bacterial disease caused by the *Yersinia pestis* bacterium that can affect humans in three forms: bubonic, septicemic and pneumonic plague. The bacterium is unique in that it can develop in both aerobic and anaerobic conditions. Transmission to humans occurs via bites from the rat's fleas. The flea is thus the vector. After the bite, the infection becomes drained through the lymph vessels into the lymph nodes. Average mortality is 25 – 50 % in untreated cases within 48 hours to five days. Transmission from person to person is also possible via the inhalation of aerosolised droplets by people affected with pneumonic plague. With rapid death after the initial onset, the skeleton is not involved (Aufderheide & Rodriquez-Martin, 1998).

2.5.5. Treponemal disease

Venereal syphilis was already at the Cape on the arrival of the English. Some inhabitants date its arrival from the period when the French troops were at the Cape in 1782 (Bradlow & Bradlow, 1979). Jochelson (2001) also states that European settlers, sailors and soldiers introduced sexually transmitted syphilis to South Africa.

The recognition of syphilis as a separate disease started in the 1490's (Baker & Armelagos, 1988). Treponemal infections are chronic and subacute and are manifest in four clinically different syndromes i.e. yaws (also called frambesia, pian, tropical frambesia, bubas and parangi), bejel (also called endemic syphilis, treponarid, dichuchwa, njovera and nonvenereal syphilis), syphilis (also called acquired syphilis and lues) has a significant congenital variant, and pinta (also called carate, overia, lota, mal azul and mal del pinto) (Aufderheide & Rodriquez-Martin, 1998, Ortner, 2003).

A fundamental question is whether one or more different bacteria cause the four different clinical syndromes of treponematosis. If a single pathogen is responsible for all four syndromes, the differences between the syndromes must then be explained by other factors that can affect the expression of infectious disease. On the host side, these include the age of onset, the age of the host, sex differences in immune reactivity, host exposure to pathogens, the immune response of the host, general health of the host, route of pathogen entry and the effectiveness of treatment. On the pathogen side, these include the biology of the pathogen, the size of the innoculum, the pathogen's reaction to the host's immune system and the reproductive strategy of the pathogen (Aufderheide & Rodriquez-Martin, 1998, Ortner, 2003).

If, however, more than one pathogen is responsible for some of the clinical variation between the syndromes, differences in the pathogen become a more important factor in understanding the clinical differences between the syndromes. The current majority opinion is that each of the syndromes is a distinct disease caused by a different pathogen. With the exception of syphilis, which today can be found in any geographical area, the syndromes are relatively limited to their geographical range. Only syphilis, bejel and yaws affect the skeleton (Aufderheide & Rodriquez-Martin, 1998, Ortner, 2003) and thus only they will be described.

Treponeme bacteria mainly affect skeletal elements with minimal overlaying soft tissue. Yaws affects populations with a low level of hygiene in tropical and subtropical humid areas. Bejel is present in rural populations in temperate and subtropical non-humid regions like the Middle East and Africa. Venereal syphilis is the most ubiquitous, occurring primarily in urbanised populations in all geographical regions (Aufderheide & Rodriquez-Martin, 1998, Ortner, 2003).

The pathological changes of the three are identical. Transmission of one syndrome to another can occur when there is alteration to the climate and / or living conditions due to the individual moving: when people in hot and humid regions infected with yaws move to cooler regions, they loose the generalised lesions of yaws and develop the restricted lesions of bejel (Steinbock 1976). Thus treponematosis is adapted to its physical environment and socio-cultural status (Aufderheide & Rodriquez-Martin, 1998). One can thus deduce that yaws has somewhat more generalised the skeletal lesions than either bejel or syphilis. Yaws and bejel are acquired during childhood and thus the most active lesions are seen in children and adolescents. The lesions are similar to congenital syphilis. Syphilis transmitted through sexual contact is acquired in young people between 15 and 30 years with a peak between 20 and 24 years of age, the most sexually active period of life. Following the infective contact, a distinctive primary lesion usually develops at the point of entry after an incubation period of several weeks. The primary stage ends with the migration of the organisms to the regional lymph nodes. The secondary stage begins with the distribution of the organisms through the bloodstream. This is characterised by transitory skin rash and mucous membrane lesions. The tertiary stage is characterised by progressive syphilic involvement of different organs including the skeleton. It is at this stage that the tissue reaction may assume a distinct granulomatous appearance of nodular foci and central liquefying necrosis (gumma)

(Hackett, 1975, Baker & Armelagos, 1988, Ortner, 2003). The character of the inflammation at all stages is more chronic with lymphocytes and plasma cells predominating. There is no significant formation of pus and hypervascularity is usually marked. Tertiary syphilic bone lesions usually develop between 2 and 10 years after the infection, but may occur earlier or later. Often more than one bone is affected and involvement tends to be bilateral. The tibia, cranial vault and nasal cavity area represent about 70% of all tertiary syphilic bone lesions. The inflammation may begin on the bone periosteum or in the bone. The bone lesions are characterised by excessive osteosclerotic response to the infection (Hackett 1975, Baker & Armelagos, 1988, Aufderheide & Rodriquez-Martin, 1998, Ortner, 2003).

Some lesions may be nongummatous and these include periostitis, osteitis and osteoperiostitis. Bilateral involvement of the type of lesion is strong evidence of tertiary syphilis especially on the tibia, femur and in the skull. Since asymptomatic bone lesions usually go undetected in early syphilis, skeletal involvement may be underestimated (Baker & Armelagos, 1988, Aufderheide & Rodriquez-Martin, 1998).

2.5.6. Tuberculosis

By 1781, consumption (only later called tuberculosis) had arrived at the Cape but was not very common. It affected more females than males (Laidler & Gelfand, 1971).

Tuberculosis is a chronic infectious caused by one of the species of *Mycobacterium*. *Mycobacterium bovis* is linked to tuberculosis transmitted to humans by products of cattle, primarily contaminated milk. The primary focus will form in the intestinal wall and mesenteric lymph nodes. Direct transmission of tuberculosis between humans is caused by *Mycobacterium tuberculosis*. This route of infection is usually through the respiratory tract, leading to the formation of a primary focus in the lung (Aufderheide & Rodriquez-Martin, 1998).

The pathogenesis depends on the size of the innoculum, the virulence of the organism and the resistance of the host. If the primary complex fails to heal, the lung lesion progresses and tubercle bacilli may be disseminated through the bloodstream to other organisms and tissues including the skeleton (Ortner, 2003). The immune system quickly recognises the pathogens and initiates what can be a very aggressive immune response (Aufderheide & Rodriquez-Martin, 1998). This response attacks the pathogen but can also destroy normal organ tissues that are nearby (Ortner, 2003).

Tubercle bacilli circulating in the bloodstream locate within the skeleton, particularly areas of hemopoietic (red) marrow, which has a high circulatory and metabolic rate. These are the areas of cancellous bone rather than the cortex or medullary cavity. The morphology of tuberculosis lesions in dry bones is not specific and overlaps considerably in appearance with manifestations of other bone infections. However, there are general characteristics that are of diagnostic value. In its exudative phase, the tuberculous process permeates the marrow spaces, devitalising areas of cancellous bone. This leads to the formation of centrally located sequestra of cancellous bone (caries). In its proliferative phase, the process leads to local destruction and cavitation in the cancellous bone. Periosteal reactive bone is limited or absent in adults (Ortner, 2003). Vertebral tuberculosis is the most common and characteristic skeletal lesion for in 40% of cases (Aufderheide & Rodriquez-Martin, 1998, Ortner, 2003). The organisms arrive at the spine from a primary extraspinal focus in the lungs. Spinal tuberculosis infrequently involves more than one to four vertebrae. Destruction of the skeletal tissue is the most common feature and bone regeneration is rare (Aufderheide & Rodriquez-Martin, 1998). The part of the vertebra involved is almost exclusively the anterior portion of the vertebral body. Often leading to extensive destruction of one or several adjacent vertebral bodies. The destruction of the vertebral body is lytic, leading to cavitation (Ortner, 2003). Rib lesions are also common. They often present as diffuse periostitis on the internal surface (Aufderheide & Rodriquez-Martin, 1998) at the vertebral end of the rib (Santos & Roberts, 2006).

The spread of tuberculosis is favoured by overcrowding in cities and towns. In the 1800's wealthy English people suffering from pulmonary tuberculosis started flocking to the Cape. The result was that more people were infected (Collins, 1982). Laidler & Gelfand (1971) wrote that in the late 18th century pulmonary consumption was uncommon among the Dutch and English in the Cape but frequent among the Hottentots.

Chapter 3

MATERIALS

This research project examines skeletal material from two archaeological sites. Both are within the Green Point area in Cape Town and both were accidentally discovered during the "urban renewal" phase that has enveloped this area in the past 13 years. Both sites date from the 18th and 19th centuries and reflect the poorer sector of Cape society at that time. The skeletal material is being temporarily housed in the Department of Human Biology at the University of Cape Town before reburial.

Previous work in the Green Point area, especially the area between Somerset Road and the Amsterdam Battery have showed that this was a principal burial area during the 18th and 19th centuries.

3.1 Marina Residence

The Marina Residential burials were exposed in 2000 when the site was undergoing residential development (Figure 3.01). During a routine police patrol, a human skull was observed lying next to the building site fence, which immediately prompted an inquiry as to its origin. It was discovered that the earthmoving contractors had uncovered a part of a disused cemetery (Halkett, 2000). The Marina Residential site at the V & A Waterfront in Cape Town forms part of a sequence of historic sites in Cape Town documenting the lives and deaths of the poorer sectors of the local community in the 19th century.

The density of the interments Marina Residence appeared to be high with most burials having some form of overlap and even on top of each other (Figure 3.02). Thus many burials yielded one or more distinct individuals (Figures 3.03 and 3.04). Because of frequent burying and reburying activities in the past, many scattered and out of context skeletal remains were also exhumed.

Fifty-seven nearly complete burials were exhumed and 10 partial burials were recovered in a 50-metre wide area (Halkett, 2000). The remains of about 11 individuals buried in a single box were also recovered. These are believed to be a secondary burial i.e. exhumed elsewhere and reburied at Marina Residence. The author using standard techniques, as set out by Buikstra and Ubelaker (1994) and described in the "Methods Chapter", visually determined the age and sex of the individuals. There are 64 adults – with twice as many males as females, 4 sub-adults, 1 juvenile and 1 infant. At least 8 of the adults could not be aged. Many disturbed skeletal remains were also recovered (Tables 3.01 and 3.03).

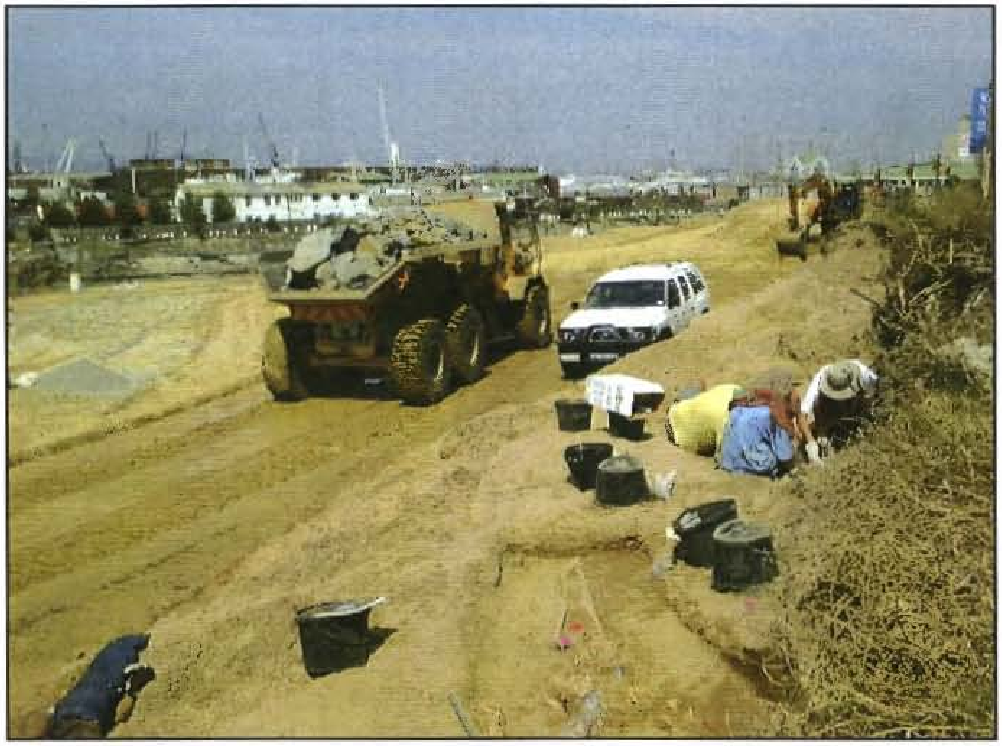

Figure 3.01: Proximity of the Marina Residence excavation site to the building site (Picture by Archaeology Contracts Office, 2000).

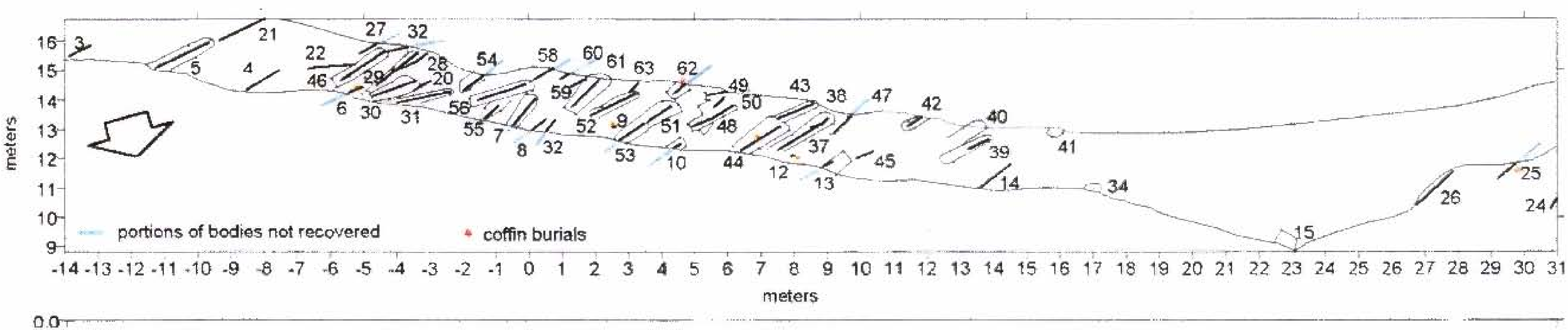

Figure 3.02: Burial layout of Marina Residence (Halkett, 2000). The number of the burial on the map corresponds to the MR (Marina Residence) numbers in the text.

Figure 3.03: A multiple burial from Marina Residence (MR 51) (Picture by Archaeology Contracts Office ACO, 2000).

Figure 3.04: Another multiple burial from Marina Residence (MR 41 and MR 50) (Picture by Archaeology Contracts Office, 2000).

3.2 Cobern Street

Human remains were found while digging the foundation at a construction site of an office building during September / October 1994. This site was situated on Cobern Street in Green Point just off Somerset Road.

Excavation of these remains occurred between December 1994 and January 1995. The excavation had to be quite hasty but thorough, as only a short time had been granted to the excavators in which to remove all the skeletal material (Cox, 1999).

Over 65 formal burials in 108 square meters were found (Figure 3.05). Most of the burials were positioned on their backs and most but not all, in wooden coffins, a few were buried without coffins positioned on their sides and two burials were found below the cemetery level. These were in a flexed seated upright position. Most of the formal burials were intact along with some disturbed / disarticulated skeletal material. The remains of about 121 individuals were recovered from the 70 formal burials. The age and sex of the individuals was visually determined using standard techniques. There are 88 adults with similar numbers of males and females and 33 sub-adults and juveniles (Tables 3.01 and 3.03) (Constant and Louw, 1997).

Therefore, three formal and two informal (bone scatters and unclassified) burial styles were identified at the Cobern Street site. The principal formal burial style represented Christian burial practices with the graves orientated East to West with those interred in a supine position (Figure 3.06). The second formal style of burial was the five individuals (UCT 526, UCT 555, UCT 557, UCT 562 and UCT 563) interred lying on their right sides (Figure 3.07). These burials were orientated perpendicularly to the rest of the burials. The two burials found below the cemetery were identified as Later Stone Age (LSA) burials and represented the third formal style of burial (Figure 3.08) (Cox, 1999). Each LSA interment was a double burial (UCT 531, UCT 532, UCT 539 and UCT 540) with associated grave goods e.g. flaked stones, grindstones, shells and pottery. Radiocarbon dating done on the skeletal material from these LSA burials place at about 1000 BP and thus they are unrelated to the historic cemetery above them and not analysed as part of the study sample (Apollonio, 1998).

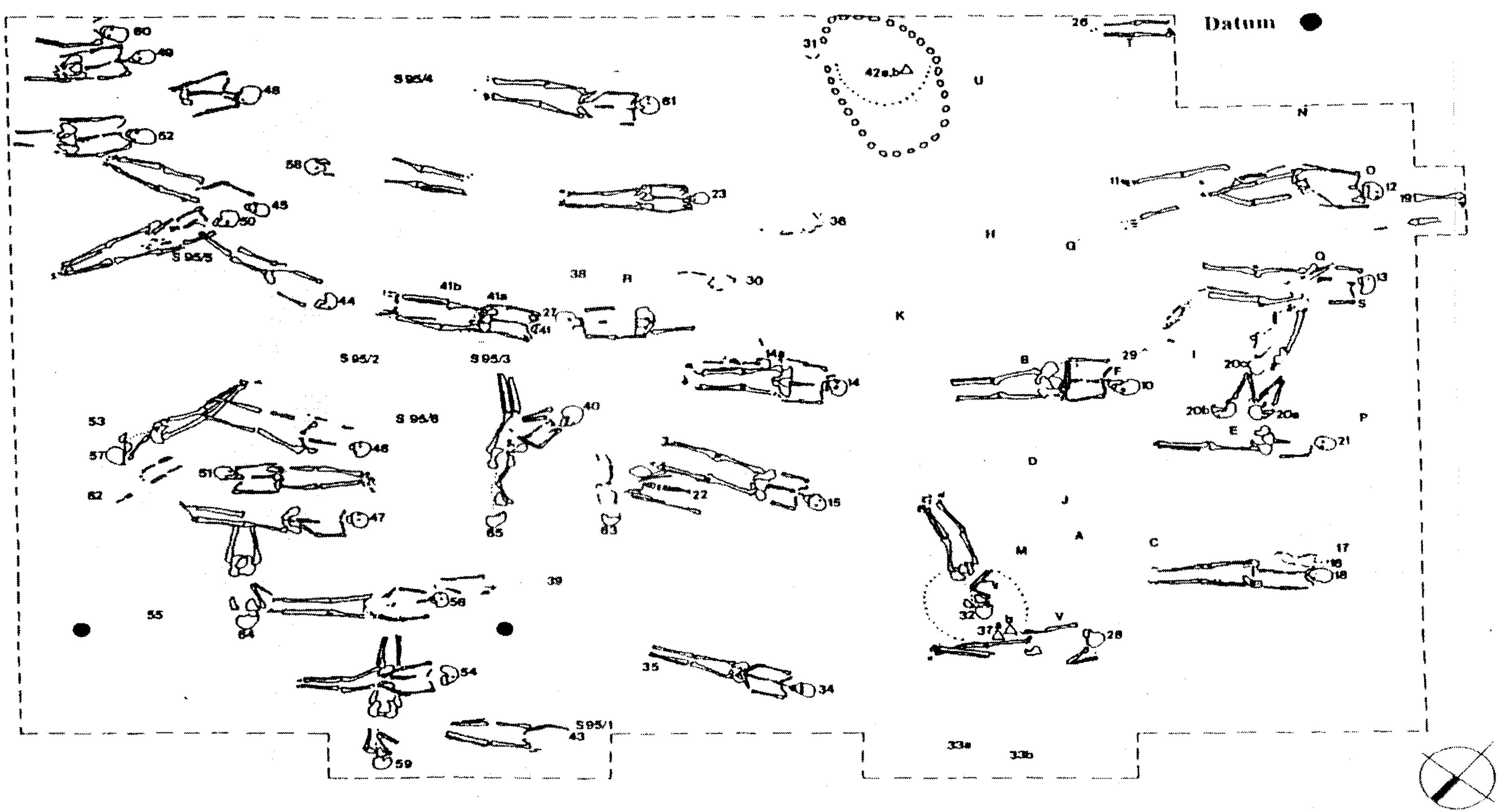

Figure 3.05: Burial layout of Cobern Street (Powrie, 1999). The burial numbers also have UCT acquisition numbers linked to them - cf Appendix 1.

Figure 3.06: Principal burial style at Cobern Street - interred on the back (UCT 516) (Picture by Archaeology Contracts Office ACO, 2000).

Figure 3.07: Cobern Street – an individual buried on their side (UCT 526) (Picture by Archaeology Contracts Office ACO, 2000).

Figure 3.08: One of the Later Stone Age burials at Cobern Street (UCT 531) (Picture by Archaeology Contracts Office ACO, 2000).

Figure 3.09: An example of a disturbed burial from Cobern Street (UCT 488) (Picture by Archaeology Contracts Office ACO, 2000).

The disorganized character of the graves at both sites (Figures 3.02 and 3.05) supports the assumption that they were informal unwalled burial grounds used by the people who did not have access to the formal walled cemeteries. The disturbed burials (Figure 3.09) at both Marina Residence and Cobern Street consisted of mainly semi-articulated and disarticulated skeletal material. The unclassified burials were those of disassociated skeletal material, usually just a few fragmentary pieces of bone. The bone scatters and unclassified material often had little or no contextual reference appearing to be the result of disturbed older burials making room for the newer burials from the immediate area or other surrounding areas.

The bad preservation status of the juvenile and infant skeletal material has rendered this part of the study sample immeasurable. The skeletons are so fragmentary that reconstruction was not attempted. Observations on this material are thus unreliable and not included in the analyses except for the sex and age distributions and age-at-death profiles.

The Later Stone Age burials are only included in Table 3.01 as they were found deep to the Cobern Street burials. They do not form part of further analyses. The secondary burial at Marina Residence was so fragmentary that reconstruction was not attempted and the material is thus not included in the analysis except where large enough pieces of femora were available for the histological ageing done in this study.

3.3 In summary

The historical information on both Cobern Street and Marina Residence is limited. The Cobern Street site appears to be the older of the two sites as it is a known fact that terrace houses were built over the site by 1862. Artefacts associated with these graves dates the Cobern Street site from 1755 to 1797, although burials could have occurred prior to 1755. A Mr GH Meyer bought the property for development in 1827 (Deeds Office: Grant Volume 1, Number 79, 92.2.1827; Diagram 15/1827). This is the earliest deed found for the Cobern street site. If the site was bought for development in 1827, it is highly unlikely that further burials would have occurred after this date

Even less is known about the Marina Residence site. No precise dating can be applied here. The site reports allude to the fact that because copper bracelets were found on some individuals, the site dates to the latter part of the 18th century and well into the 19th century. It could be said to be the 'younger' of the two sites by virtue of it being further away from the centre of the Town. It is known that by 1858, the burial grounds in the Green point area were full and some even overfull. The new official cemetery opened at Maitland in 1886 after which no further burial occurred in the Green Point area.

The disorganized nature of the burials at Cobern Street and Marina Residence supports the supposition that these were informal burial grounds used by the poor citizens of the early Cape.

Site	Burial Type	Infant	Juveniles	SA	YA	OA	A	Totals
MR	**Burial**	1	1	4	20	26	8	60
	Scatter	0	0	0	3	6	1	10
	Secondary	0	0	0	4	6	1	11
	Subtotal	**1**	**1**	**4**	**27**	**38**	**10**	**81**
CS	**Burial**	9	10	4	25	16	7	71
	LSA	0	1	0	0	3	0	4
	Scatter	3	8	2	11	7	17	48
	Subtotal	**12**	**19**	**6**	**36**	**26**	**24**	**123**
	Grand Total	**13**	**20**	**10**	**63**	**64**	**34**	**204**

Table 3.01: Summary table of study samples.

Key: MR – Marina Residence
CS – Cobern Street
Burial – formal burials
Scatter – disturbed burials
Secondary – disturbed reburials
LSA – Later Stone Age burials
Infant – birth to 5 years old
Juvenile – 5.1 to 15 years old
SA – sub-adult – 15.1 to 20 years old
YA – young adult – 20.1 to 40 years old
OA – old adult – 40.1+ years old
A – osteologically adult but unable to be aged

Burial Types	Position	No. interments	No. individuals	% of total interments
A	Vertically flexed	2	4	2.2
B	Extended on the back	63	71	67.7
C	Extended on the right side	5	5	5.3
D	Bone scatters	21	41	22.6
E	Unclassified	2	2	2.2
TOTALS		**93**	**123**	**100**

Table 3.02: Types of burials and associated numbers of individuals found at Cobern Street

Burial Types	Position	No. interments	No. individuals	% of total interments
B	Extended on the back	57	60	83.8
D	Bone scatters	10	10	14.7
F	Secondary burial	1	11	1.5
TOTALS		**68**	**81**	**100**

Table 3.03: Types of burials and associated numbers of individuals found at Marina Residence

Chapter 4:

METHODS

A wide variety of techniques were employed to collect and analyse the data for this research. Although the standards set out by Buikstra & Ubelaker (1994) formed the basis for the analyses, other sources viz. Rogers (1999), Seiderman, et al., (1998), Igarashi, et al., (2005) and Maat, et al., (2002, 2003) were also referenced and applied for greater insight of observation and increased accuracy.

4.1 Preservation and condition of the skeletal remains

The preservation and condition of each skeleton for this study is recorded. Cranials and post cranials are recorded separately. When a complete skeleton is present i.e. both the left and the right bones, measurements are recorded on the left side. When the skeleton is incomplete, the available bones are measured. No fragmented or distorted bones were measured.

The condition of the skeleton is recorded as follows:

- Complete skeleton – all bones present
- Incomplete with cranial and post cranial – some bones missing
- Cranium / mandible only
- Post cranials only

The preservation of the skeletons is recorded as follows:

- Highly fragmented - reconstruction not possible
- Fair condition – some reconstruction required
- Good condition with most bones complete – little or no damage to the bones

The skeletons from the two study sites were equally preserved with some preservation better than others. Only individually intact skeletons were analysed for paleopathological and physical anthropological purposes. Co-mingled bones and very fragmentary bones were noted but not used for further analysis.

The standard of living resulted in many varied pathological processes that are readily seen in these people. Archival or any other form of documentation is not readily available. Thus, in essence, they are the "forgotten generations" of Cape

Town's forbearers and we know about their existence from accidentally discovered burials during urban renewal in Cape Town.

4.2 Estimation of Sex

Although the standard techniques as set out by Buikstra and Ubelaker (1994) formed the basis for sexing the skeletal material, several other methods for the estimation of sex were also used. These were done because many of the skeletons were either very badly preserved or incomplete with only a few bones present. One must always be aware that there is substantial overlap in the extent of robusticity in male and female skeletons, which can complicate the estimation of sex especially when using the femoral neck method. However, it must also be noted that size alone is not the greatest marker of sex.

4.2.1. Macroscopic method:

Sexual differences begin to develop in the skeleton before birth (Boucher, 1957). Through infancy, childhood and into adolescence, sexual dimorphism in both shape and size becomes more marked and thus sexing skeletal remains become more accurate. Adult skeletons i.e. those older than 20 years old and the better-preserved sub-adult skeletons i.e. those between 15 and 20 years old, were sexed.

The fact that females mature earlier than males makes it necessary to also consider age when estimating sex in sub-adults.

1. Adults – look at the pelvis, skull and long bones
2. Sub-adults – look at the stage of union of epiphyses of the postcranial skeleton

The pelvis is one of the most sexually dimorphic areas in the human skeleton and thus one of the most reliable regions for sexing adults especially in the subpubic region. The most common features used are the ventral arc, the subpubic concavity and the ischiopubic ramus ridge (Figure 4.01), obturator foramen shape and acetabulum size (Putschar, 1976, Buikstra & Ubelaker, 1994). The width of the greater sciatic notch of the pelvis (Figure 4.02) increases faster in females during foetal growth (Boucher, 1957, Saunders, 2000). Thus the greater sciatic notch is also used to estimate sex. The general morphology of the pelvis as well as the pre-auricular sulcus was also used.

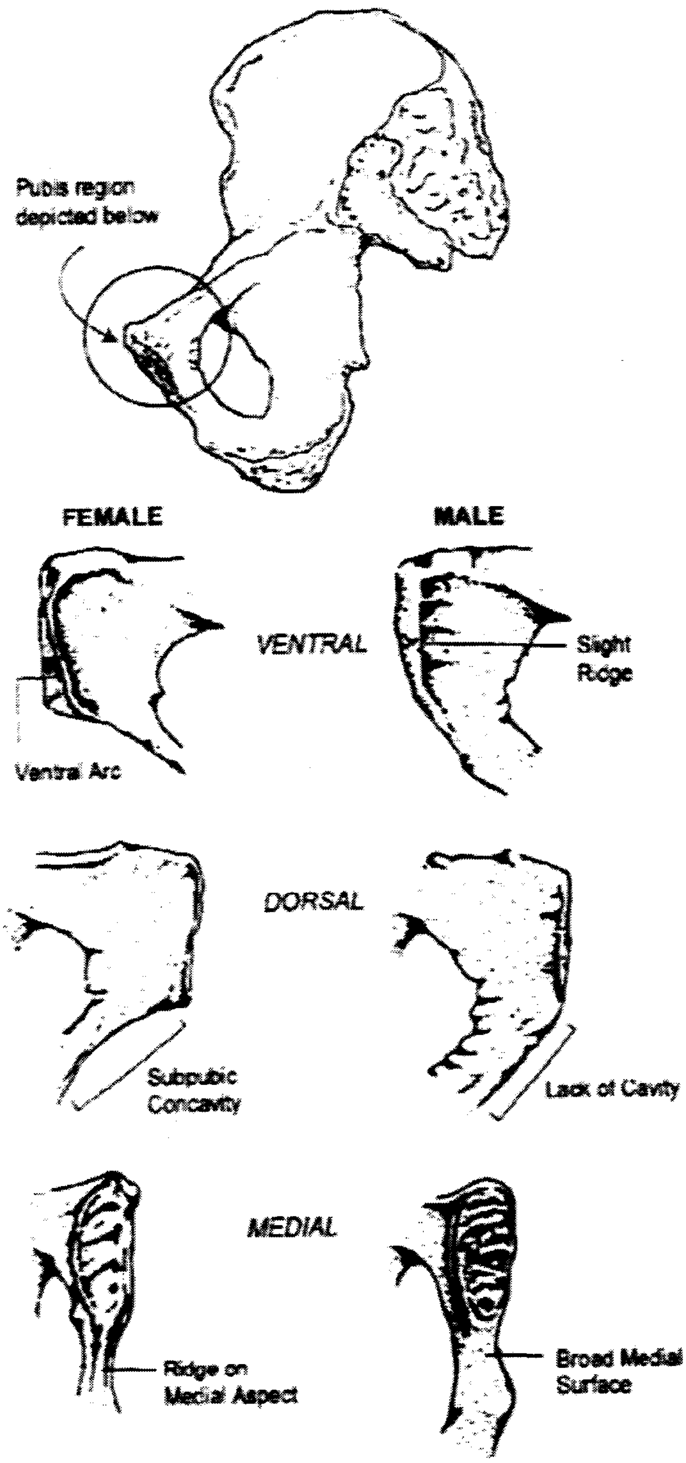

Figure 4.01: Sex estimation from the pubic symphysis (Buikstra & Ubelaker, 1994:17)

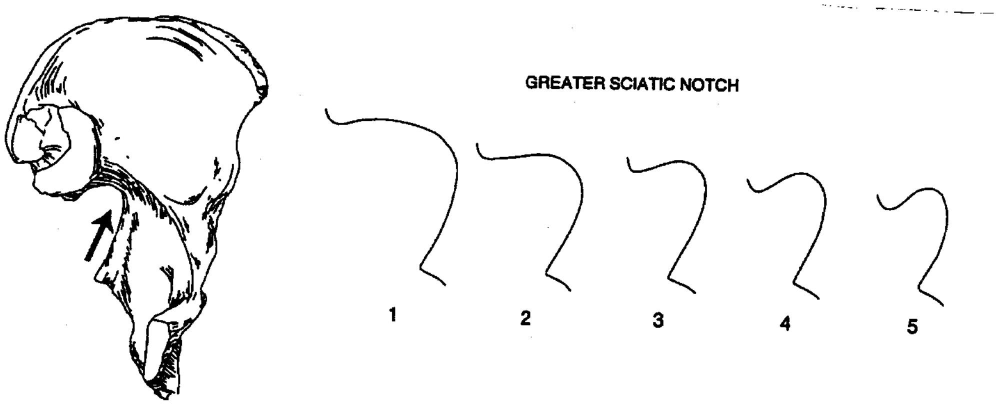

Figure 4.02: Sex estimation from the sciatic notch (Buikstra & Ubelaker, 1994:18)

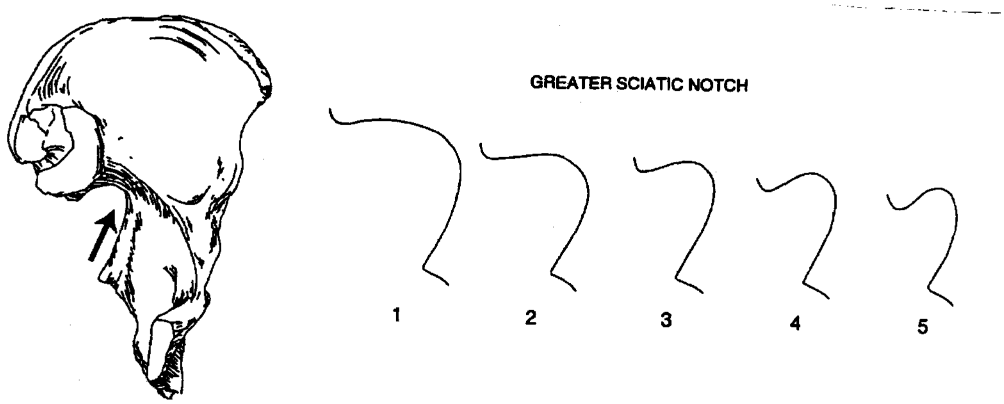

Figure 4.02: Sex estimation from the sciatic notch (Buikstra & Ubelaker, 1994:18)

In cases where the pelvis was too fractured for reconstruction or absent, the sizes of the femoral head (when this feature was preserved intact) as well as the general robusticity of bones were employed aid in the estimation of sex.

Cranial and mandibular elements were also used for sexing the adult skeletons. In general, males tend to have larger and more robust crania than females. However because of the amount of variation within populations, caution should be exercised when estimating sex from the crania alone. This is corroborated by Konigsberg & Hens (1998). The areas used were the nuchal crest, mastoid process, supraorbital margin, glabella prominence, mental eminence and gonial eversion (Figures 4.03 & 4.04).

Long bones play an important role in the determination of sex (İşcan & Miller-Shavitz, 1984). The most recent being that by Rogers (1999) studying the distal humeri, also used in this study and listed below. The primary assumption when using long bones for sexual determination is that males are larger in size than females. In 1978, Black postulated that the sexual dimorphism in long bones viz. the femur, could be better assessed from the circumference than the length as the circumference reflects the musculo-skeletal development, purported to be greater in males than in females, whereas the length reflects size differences.

4.2.2. Distal humerus method:

Often excavated material is very fragmentary and the elements most often used to sex and individual i.e. the skull and pelvis, is too fragmentary to reconstruct or is completely missing. Thus in conjunction with the standard methods of sexing on the skull and pelvis, this method developed by Rogers (1999) was also employed to determine sex. It is a visual method for sexing.

Rogers (1999) assumes that human beings today show discernible sexual dimorphism. Thus, small differences in morphology and robusticity make it possible to determine sex. The most successful proponents of sex determination are the skull and pelvis. However if these are absent, the ability to establish sex is more difficult. The method put forth by Rogers in 1999 uses only the distal humerus to determine sex. It is based on the carrying angle of the arm. The carrying angle refers to the lateral deviation of the human forearm from the humeral axis. It is approximately 10-

15 degrees in males and 20-25 degrees in females (Grabiner, 1989). Thus this trait is sexually dimorphic.

The Rogers (1999) method is based on 5 traits examined on the distal humerus:

1. The orientation of the medial aspect of the trochlear relative to the humeral shaft – it runs parallel to the shaft in males and angles across the shaft in females (Figure 4.05).
2. Trochlear constriction – less constricted in males than in females where it is spool-shaped (Figure 4.05).
3. Trochlear symmetry – asymmetrical in males and more symmetrical in females (Figure 4.06).
4. Olecranon fossa shape – triangular in males and oval in females (Figure 4.06).
5. Angle of the medial epicondyle - flat in males and slightly raised in females (Figure 4.07).

The prediction is that this method should be at least 80% accurate in determining sex as the technique relies on the differences in shape rather than size of the distal humerus and should complement existing procedures. In their 1996 paper Loth & Henneberg state that most sexually dimorphic traits can also be applied across populations while other techniques tend to be population specific.

4.2.3. Femoral neck method:

The femoral neck is a flattened region of bone that unites the femoral head with the shaft. Unlike the other anatomical landmarks of the proximal end of the femur, the neck is not the result of epiphyseal ossification. Instead it is considered to be an upward growth of the shaft and actually develops from the diaphyseal center (Seiderman, et al., 1998).

The femoral neck has a higher rate of intact preservation than the femoral head, making it ideal for use in estimating sex in adults (Seiderman, et al., 1998). The supero-inferior diameter (SID) is measure with sliding callipers across the narrowest part of the femoral neck (Figure 4.08). This measurement is then placed into various equations. Scores above zero are males and thus scores below zero are female. The equation for people of unknown ancestry (the case for both Marina Residence and Cobern Street) is:

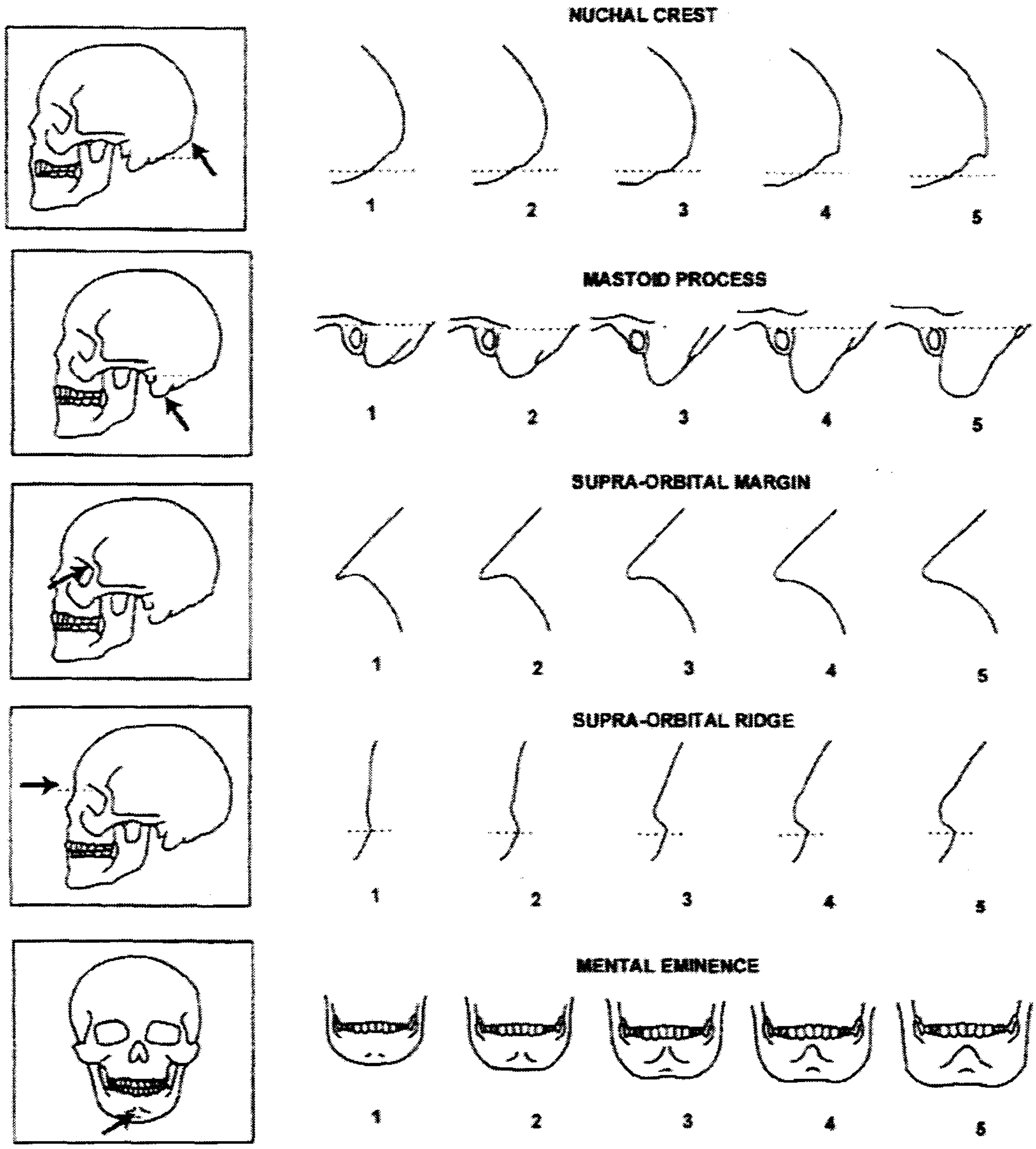

Figure 4.03: Cranial areas used for estimating sex (Buikstra & Ubelaker, 1994: 20)

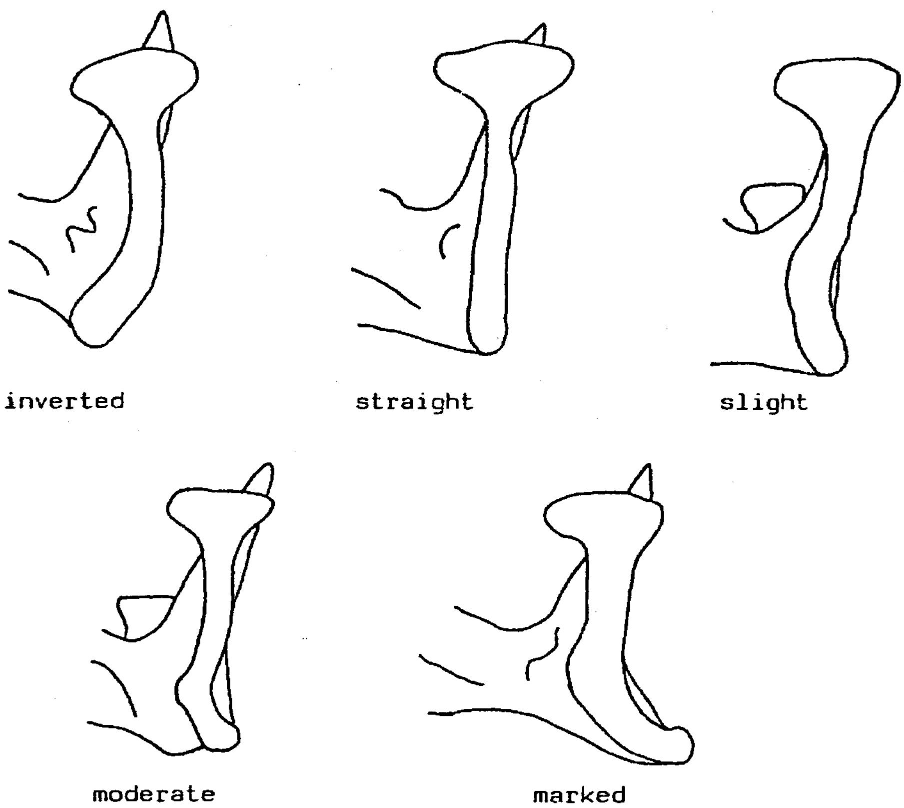

Figure 4.04: Sex estimation using the gonial area (unpublished Morris drawings, 1984)

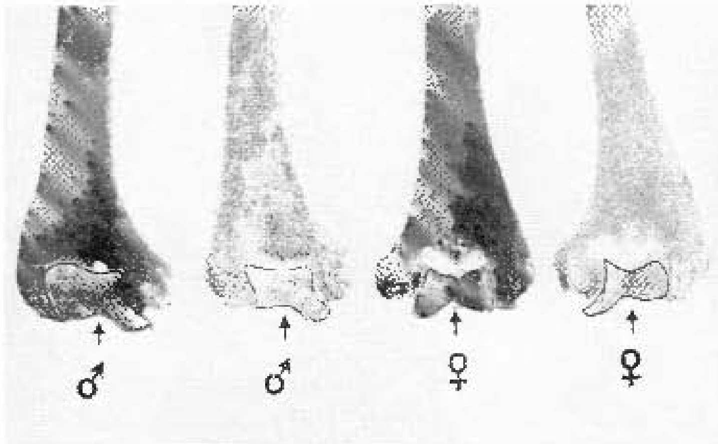

Figure 4.05: Estimating sex using the trochlear outline (Rogers, 1999)

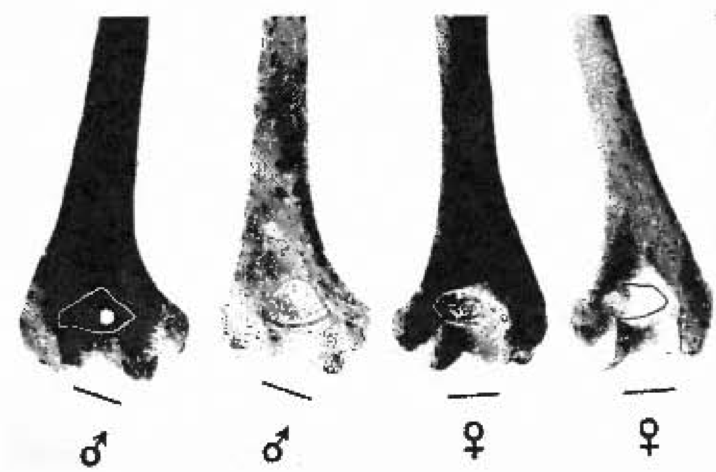

Figure 4.06: Estimating sex using trochlear symmetry and olecranon fossa shape (Rogers, 1999)

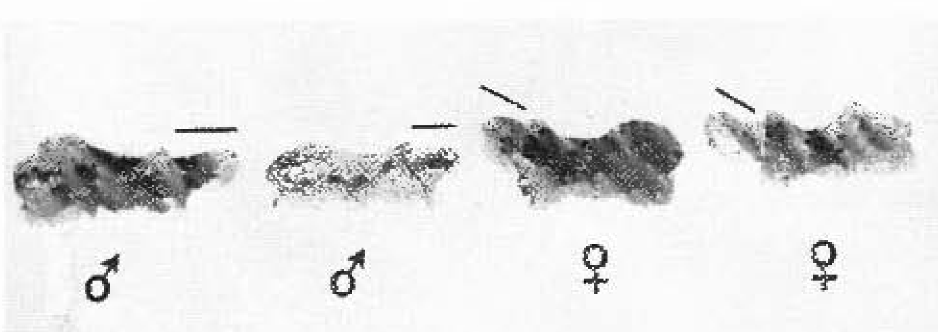

Figure 4.07: Estimating sex using the medial epicondyle (Rogers, 1999)

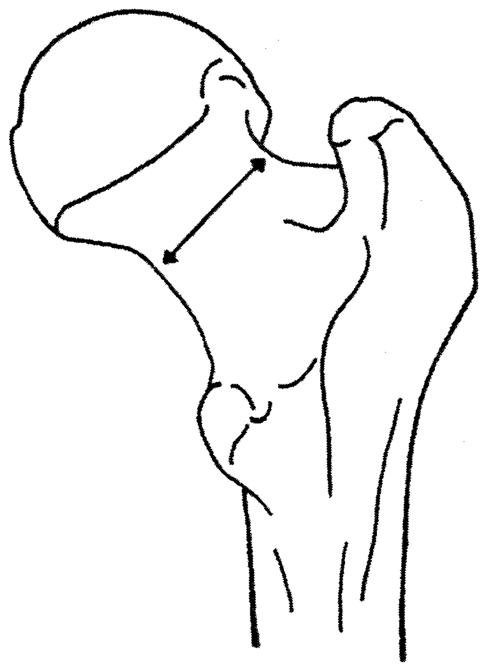

Figure 4.08: Estimation of sex using the supero-inferior femoral neck diameter measurement (SID) (Seiderman et al., 1998).

$$Sex = 05.10 * SID - 15.356$$

Where Sex < 0 indicates a female and Sex > 0 indicates a male. This equation is supposed to be 90% accurate (Seiderman et al., 1998).

The prediction is that this method should be at least 87% to 92% accurate in determining sex as the technique relies on the differences in size of the femoral neck and should complement existing procedures.

While the overlap in skeletal size of males and females is still a big problem for reliably estimating sex from skeletal material, the accuracy of sex estimation depends on the range of complimentary methods used.

The femoral head method is not employed with this sample as according to Asala (2001, 2002), the determination of sex from the head of the femur is race specific and numerical values have yet to be determined. The study sample used here is of unknown origin and thus it is difficult to assign race.

4.3 Estimation of Age at Death

Estimating age at death is essential for physical, biological and forensic anthropology studies especially for demographic studies. Estimation of age at death in the study populations was estimated by evaluating the macroscopic and microscopic biological changes in the skeleton using the bones (Figure 4.09) and teeth for each individual (Figure 4.10). The macroscopic methods has not only the advantage of being the easiest, they are also the least destructive. The microscopic method, although destructive, in that a piece of bone is cut off and processed, has the advantage of being more accurate.

4.3.1. Age categories defined

As these skeletons are of unknown individuals buried in and around Cape Town during the 18th and 19th centuries, exact ages of death are hard to estimate for the individuals. Broader age ranges were assigned allowing for comparison between groups of people i.e. males and females of similar or differing age categories. These broader age ranges also have the advantage of having "built-in" error terms. Thus a possible 25 years + / - 5 years becomes the 20 to 30 year old category, this being a much better estimate of the age as exact ages were impossible to establish with these

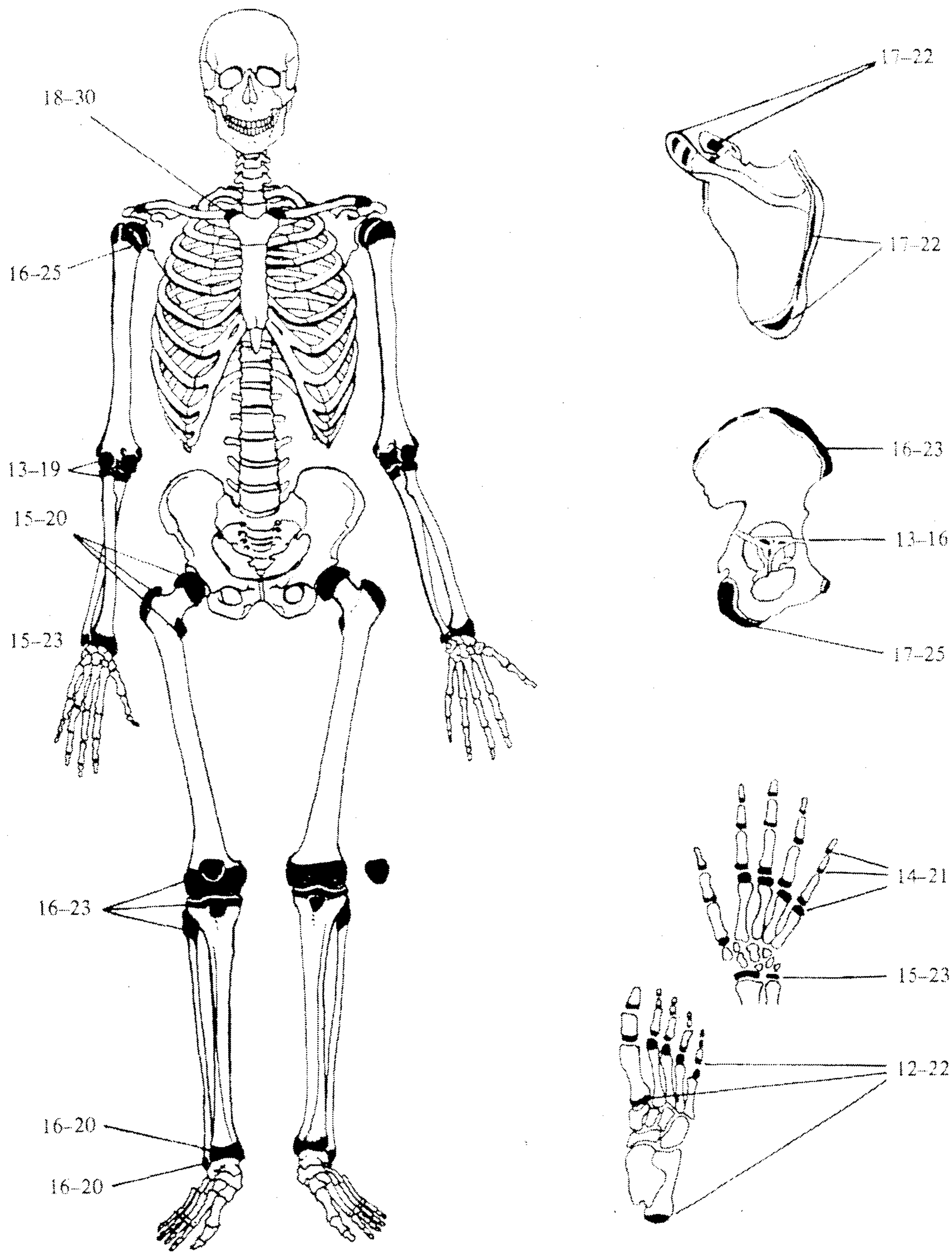

Figure 4.09: Union of epiphyses for age-at-death estimation in sub-adults. All numbers represent years, the difference between each pair showing the time span within which the particular epiphyses unite (Brothwell, 1972: 60)

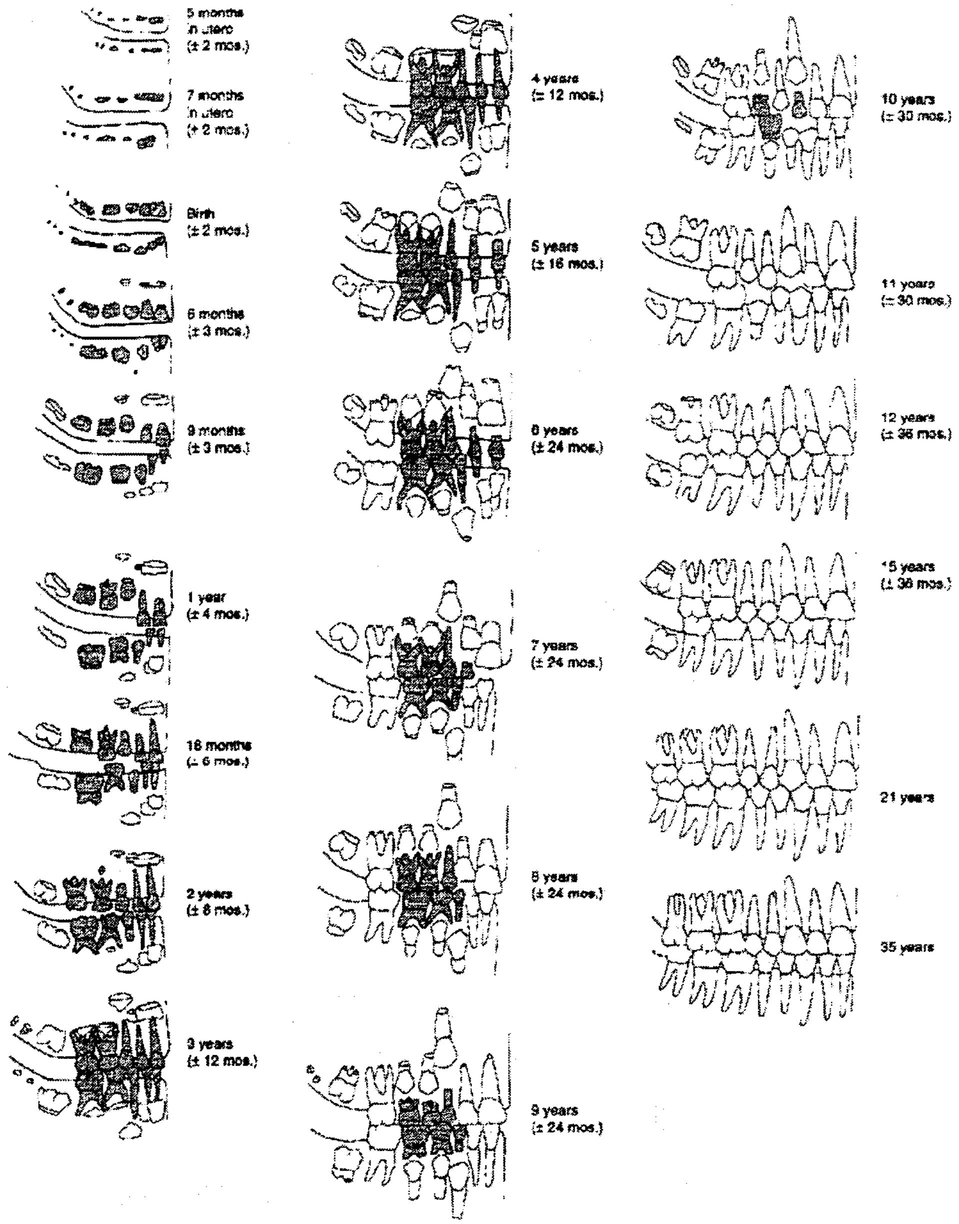

Figure 4.10: Estimation of age – tooth formation and eruption among Native Americans (Buikstra & Ubelaker, 1994: 51)

groups of unknown individuals. For comparative purposes, this project used five age categories as presented by Peckmann (2002) who utilised those presented by Morris (1984). For the infants, juveniles and subadults, 5 to 10-year intervals were used to characterise and emphasise the rapid age changes in the skeleton during the growth phase in life. Adult age is taken from 20.1 years of age. This age allows for the average age of complete fusion of long bones to be taken into account (Figure 4.11) (Buikstra & Ubelaker, 1994).

The categories are:

- Infant – birth to 5 years old
- Juvenile – 5.1 to 15 years old
- Sub-adult – 15.1 to 20 years old
- Young adult – 20.1 to 40 years old
- Old adult – 40.1+ years old

4.3.2. Macroscopic method

The estimation of age at death involves observing macroscopic morphological features in the skeletal remains. Thus, what is known about chronological changes in the skeleton is used. These changes do not occur at the same rates in different bones and structures. During infancy, most changes involve the ossification and growth of bones and the eruption and growth of deciduous teeth. During childhood and through adolescence, bone growth, dental eruption and calcification of permanent dentition continue. In addition, the epiphyses on the post-cranial skeleton develop and unite. Between 18 and 20 years of age, most growth is complete, almost all the teeth have erupted and are fully calcified and most of the epiphyses are united. After 20 years of age, landmarks are provided by the progressive union of the cranial sutures (Figure 4.12), changes in the symphyseal face of the pubis and changes in the microscopic structure of bones and teeth (Ubelaker, 1978, Gillet, 1991, Buikstra & Ubelaker, 1994).

The criteria used for ageing subadults included:

- Dental development (tooth calcification and eruption)
- The length of long bones
- The union of epiphyses.

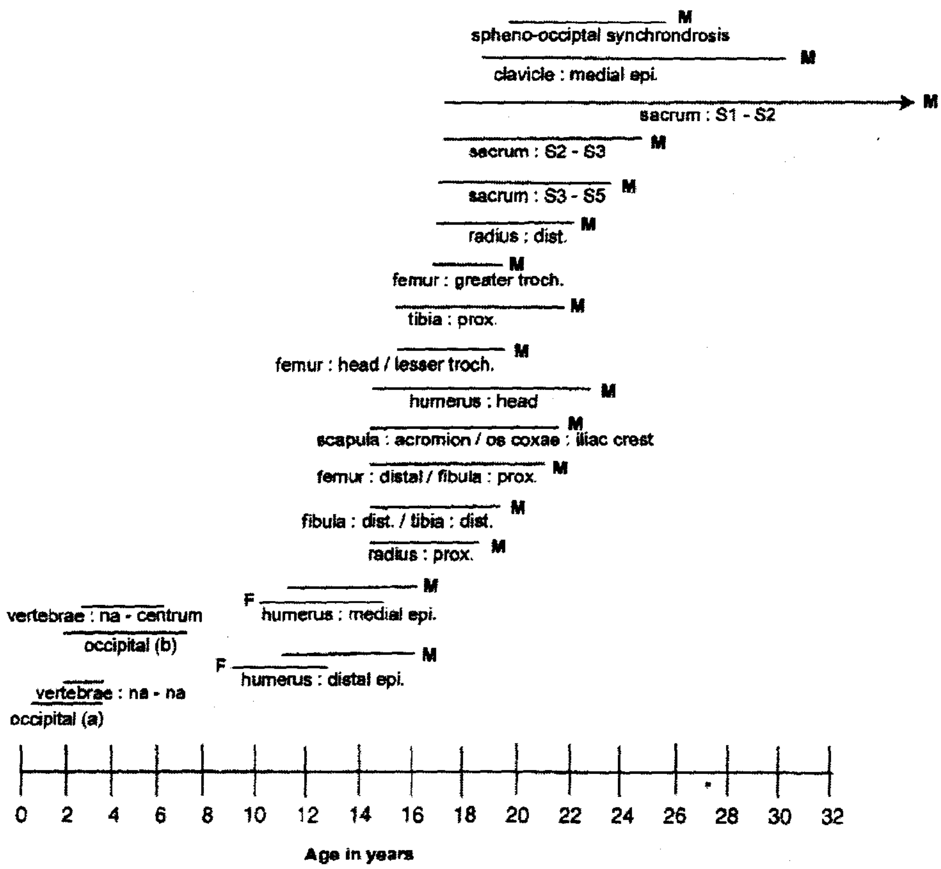

Figure 4.11: Estimation of age from epiphyseal union; M – males, F – females (Buikstra & Ubelaker, 1994: 43)

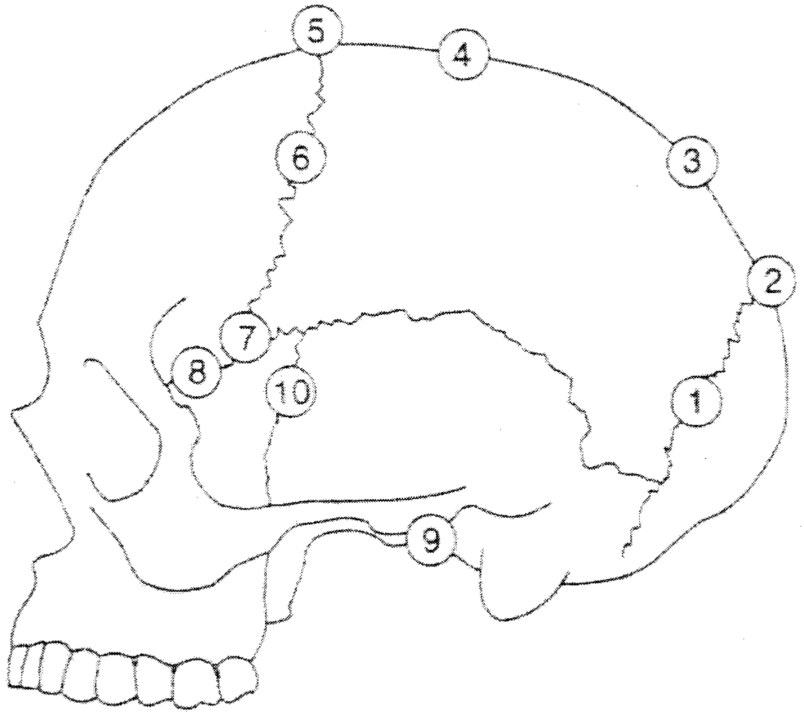

Figure 4.12: Estimation of age from cranial suture closure (Buikstra & Ubelaker, 1994:71)

The criteria used for ageing adults included:

- Chronological changes at the pubic symphysis
- Cranial suture closure
- Degenerative changes (such as vertebral osteophytosis)
- Morphological changes at the auricular surface of the ilium
- Resorption of cancellous bone
- Microscopic cortical remodelling

Where teeth were available to age individuals, dental calcification and eruption were used (Figure 4.10). However the accuracy of the age estimate at death is compromised by post-mortem damage.

Cranial suture closure (Figure.12) was only used in cases where large enough areas of cranial bone with several sutures were available. Suture closure was quite difficult to quantify in some cases as some sutures were only partially closed. The results were treated with caution.

When using the pelvis for ageing, the Suchey-Brooks (1990) and Sinha & Gupta (1995) pubic symphysis scoring system was used for males and females. This method was supplemented by the use of the revised Meindl & Lovejoy (1989) auricular surface age determination technique by Buckberry & Chamberlain (2002), Mulhern & Jones (2005) as well as Igarashi, et al. (2005) (Figures 4.13, 4.14 & 4.15). The revised method proved more accurate as the original method established by Meindl & Lovejoy (1989) overestimated the age in younger individuals and underestimated the ages of older individuals (Igarashi, et al., 2005). Age changes in the auricular surface are reasonably well defined to provide relatively accurate estimates of ages at death. The survival rate of this area of the pelvis is also higher than the pubic symphysis in archaeological populations (Lovejoy, et al., 1985).

The following categories of relief and texture features for age at death estimation were used from Igarashi, et al. (2005).

Relief

Wide groove	Surface with wide transverse grooves having wide flat bottoms.
Striation	Surface with narrow transverse fine grooves that do not have flat bottoms and have V-shaped sections.
Roughness	Uneven surface without regular structures such as striations or wide grooves.
Flatness	Smooth surface without protrusions or depressions.

Texture

Smoothness	Smooth and even surface.
Fine granularity	Surface with depressions so shallow that no clear shadow is seen on surface under light from any direction.
Coarse granularity	Surface with depressions deep enough so that clear shadows on surface can be seen. A surface with typical coarse granularity resembles surface of *crepe de chine*.
Sparse porosity	Surfaces with pores that reach down to spongy bone and have a total area smaller than that of the remaining surface of compact bone.
Dense porosity	Surface with many pores, total area of which is larger than that of remaining surface of compact bone.

Hypertrophied bony structure

Dull rim	Hypertrophied margin developed in broad rim.
Lipping	Hypertrophied margin similar to lip.
Tuberosity	Nodes or spine often found just outside upper rear and lower front margins of auricular surface.
Bony ridge	Osteophytes in para-auricular region connecting sacrum and ilium, often found on upper part of sacroiliac joint.

However good this method by Igarashi, et al. (2005) is, the rate of change at the auricular surface is so variable among individuals that it was not used as a single method for age estimation.

In general the standards set out by Stout et al. (1994) for estimating age from the sternal end of the fourth rib could not be employed as the ribs were either too fragmented, not well preserved or the sternal ends not recovered during the excavation process.

4.3.3. Histological method

Besides the above-mentioned macroscopic techniques, microscopic techniques were also employed to confirm the age at death. This technique was only applied to the Marina Residence sample, as age data on the Cobern Street sample was already available. One of these is quantitative bone histology (histomorphometry) (secondary osteons – type I – density increase with age) using complete transverse cross sections at mid shaft of the adult femur. This is possible because bone is continually remodelled from birth to death.

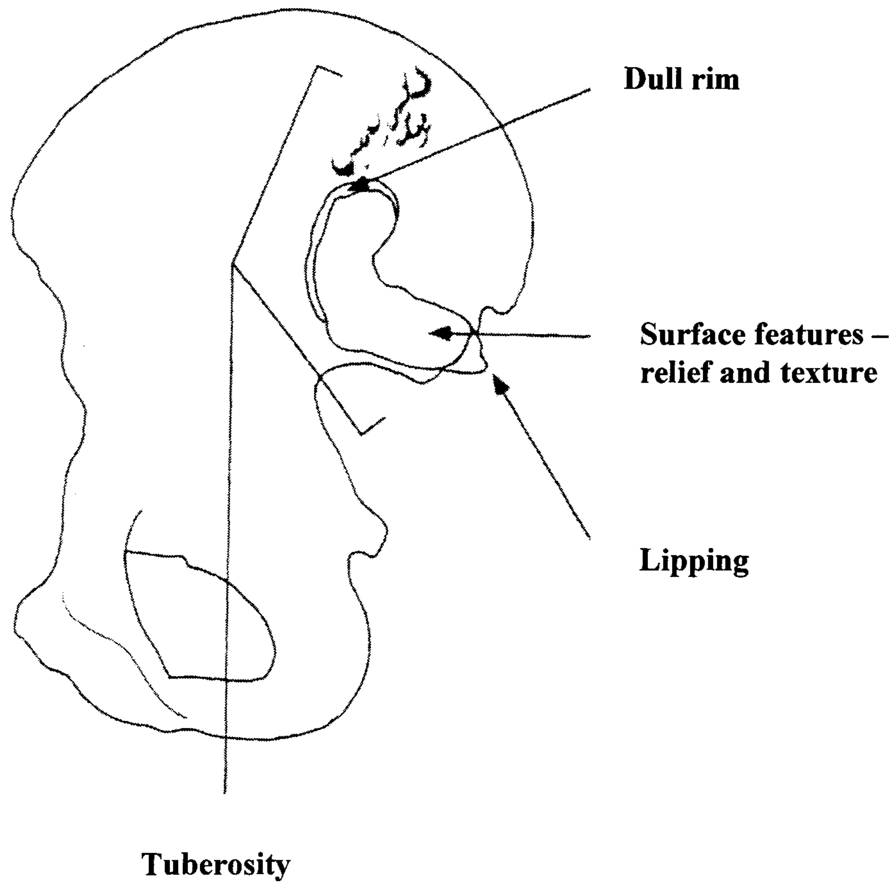

Figure 4.13: Estimation of age by examining features on or around the auricular surface (Igarashi et al., 2005)

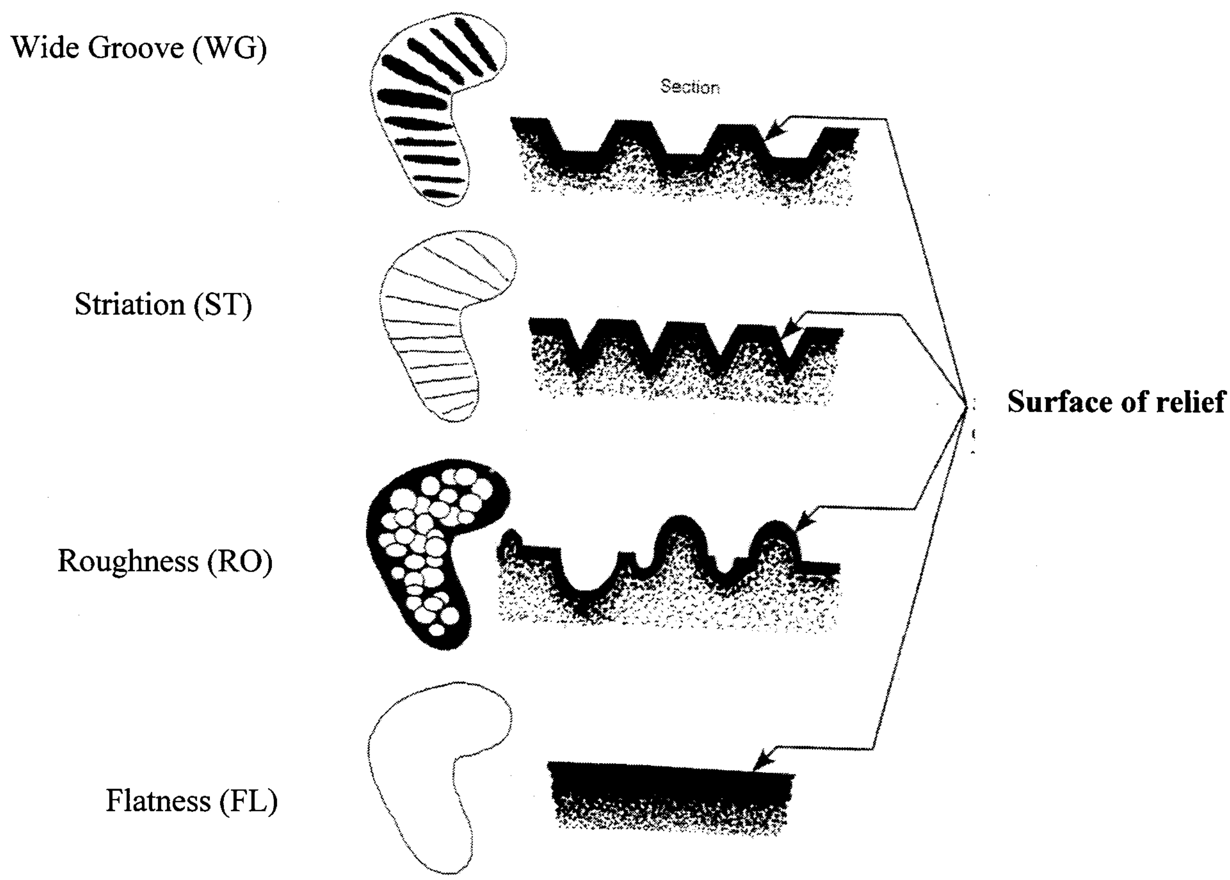

Figure 4.14: Patterns of relief on the auricular surface (Igarashi et al., 2005)

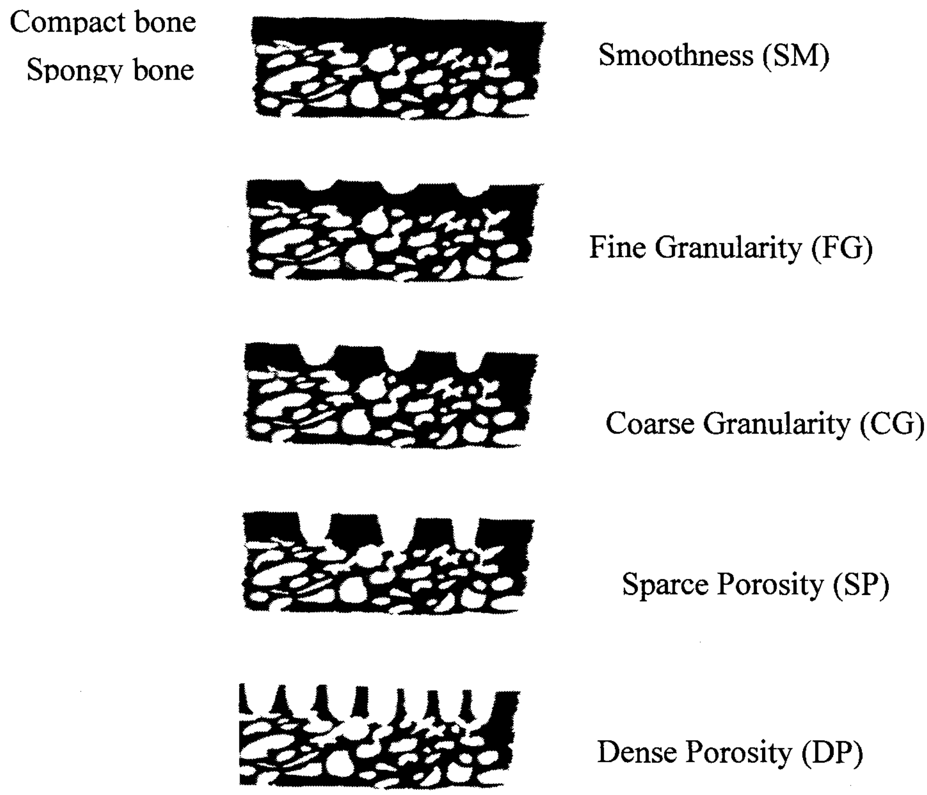

Figure 4.15: Patterns of textures observed in relief (Igarashi et al., 2005)

In 1958 Frost developed an easy manual method on the preparation of undecalcified bone. This method was refined by Kerley (1965) and further refined by Maat et al., (2001) on Dutch samples. The Maat et al., (2001) technique uses a thin transverse section of the anterior shaft of the femur to determine age. These bone sections can then be viewed under a polarised light source to ascertain the amount of modelled and non-remodelled bone. As bone remodels throughout one's lifetime, depending on *your activity levels, changes in the bone are noted (Ruff, et al., 2006).* Modelled versus non-remodelled bone is then calculated microscopically to determine age.

Light microscopy is an investigative tool within easy reach of most people at academic institutions today. A modification of the method set out by Maat, et al. (2002) in their "Barge's Anthropologica" series based on the Frost (1958) method, has yielded very favourable results in estimating age at death for historical bone sections (Maat et al., 2006, Stout, 1998, Ortner, 1975 and Kerley, 1965).

The normal technique is as follows (Maat et al., 2002):

1. A sheet of waterproof sand / abrasive paper is cut in half and placed on a slab of glass that has been thinly and evenly greased with Vaseline® with the abrasive side up.
2. With a hacksaw or an electric band saw cut off a 2 – 3 mm thick slice of bone from the femur anteriorly in the mid-plane to obtain a thin section of bone.
3. Moisten the central area of the abrasive paper with a few drops of tap water and grind down both sides of the thick slice by hand with a rotating motion until both sides are smooth and flat.
4. Continue wet grinding until the desired transparency is attained. This can be checked using a dissecting microscope.
5. Clean the section by submersing it in distilled water with a few drops of detergent in it using a small soft brush. Repeat the cleaning using fresh distilled water. Allow the section to dry in a Petri dish.
6. Clean a glass microscope slide with alcohol and place a few drops of mounting medium on its centre. Place the dried section in the mounting medium and immediately cover with a xylene dipped glass coverslip. The mounting medium will spread itself under the coverslip. Keep the slide in a horizontal position until dry.

For fragile specimens:

Follow the same technique as for normal bone except:

- At point 2: Take a thicker slice of bone (4 – 5 mm).
- At point 4: Clean the section with distilled water, allow to dry and apply a few drops of cyanoacrylate glue –superglue – to the bone as well as a few drops in the centre of an alcohol cleaned new glass slide. Place the specimen on the glue. Weigh the specimen down to allow the glue to harden for at least 2 hours.
- At point 6: Clean the slide with some alcohol. Place a few drops of mounting medium on the glued specimen and immediately cover with a xylene-coated coverslip. Keep the slide horizontal until dry.

The archaeological samples used in this study could not be prepared in the above manner without some modification as neither the normal nor the fragile procedures yielded the desired results, as the section could not be sanded down to a transparent enough slide to do a viable count. Personal communications with Professor George Maat (one of the authors of the technique) and Mrs Barbara Mohr a technical officer at UCT suggested the following:

1. After cutting a thicker section of bone: The bone is rehydrated for approximately 10 minutes in 100% absolute alcohol.
2. Thereafter it is soaked in Propylene dioxide for 5 minutes
3. Soaked in propylene oxide and resin mixture (1:1) without accelerator for 60minutes
4. Resin minus accelerator overnight at 40°C
5. Resin plus accelerator for 1 hour at room temperature
6. Embed the section of bone in epon® using a thermo-setting disposable break away plastic container.
7. The container is then placed on a vibrating device that eliminates any air bubbles around the section thereafter it is placed in an oven at 60°C for at least 24 hours.
8. The excess epon® is cut away using an electric band saw and the embedded specimen was processed.

Because the epon proved to be particularly tough to "sand down" by hand effectively, the Geology Department at The University of Cape Town was approached to find out whether they could cut thin slices of the embedded bone. They processed the embedded sections as follows:

- They sanded down the section on a Logitech® sanding machine until the bone was exposed.
- The sanded down section was mounted onto an alcohol cleaned glass slide.
- The mounted section was secured in an Accutome® machine and a 3mm section sliced off.

These sections were returned and processed (sanded) by hand until the desired thickness was attained for viewing under a light microscope with a Polaroid filter.

These microscopic techniques complement and enhance the traditional macroscopic techniques. The macroscopic and microscopic techniques used together may give one a greater confidence that the age of the individual in question will lay in the predicted projected age ranges and also narrows down those with a rather broad age range.

4.4 Radiography

4.4.1. Harris lines

Harris lines are transverse lines of radio-density usually observed at the ends of long bones. They have been demonstrated to be the result of slowing or total arrest of growth of a long bone associated with metabolic insults, such as disease and malnutrition (Larsen, 1997, Ribot & Roberts, 1996, Aufderheide & Rodriguez-Martin, 1998, Pointek et al., 2001). The lines form during the recovery phase following growth arrest, in which mineralisation of bone at the growth plate continues in the absence of epiphyseal cartilage deposition (Larsen, 1997). Harris lines have also been related to hypervitaminosis D, lead poisoning and phosphorus poisoning (Garn, et al., 1968). Although, their exact aetiology is not known, these lines provide some insight into the stress history of a population or individual under study.

The LODOX (Low Dose X-ray) machine, used to x-ray the long bones for the examination of Harris lines, uses technology that combines low dose radiation with computer generated x-rays. The x-rays are then stored in a digital database. Lines measuring at least one third of the diameter of the shaft were counted. The locations of the lines were measured from the diaphysis, in order to identify the time of the insult.

Harris lines were recorded using LODOX radiographs in both the distal and proximal ends of four long bones (tibia, femur, radius and ulna). Both the left and right sides were x-rayed, when available. Although the tibia is most commonly affected by Harris lines (Aufderheide & Rodriguez-Martin, 1998), the other three bones were also used, especially when the tibia was absent. Byers (1991) technique was used to estimate the age of the individual at the time of Harris line formation. This technique presents formulae for calculating the percent of mature bone length at the time of the radiopaque formation for the tibia, femur, radius and humerus. The total length from the proximal to the distal end of the bone, parallel to the long axis of the bone and the distance from the transverse line to the closest end also parallel to the long axis are the only two measurements needed for the formulae (Byers, 1991). The distance between the lines were measured using callipers and all measurements were recorded in millimetres. A percentage is obtained that corresponds to an age of line development that is read off from tables in the Byers (1991) article. Although the Byers (1991) measurements were derived from modern living populations, they are also applicable to historical material. Even though the lines are only formed during childhood and adolescence, some researchers still find their presence in adults a vauable tool when interpreting health and stress in historic populations (Grolleau-Raoux, 1997, Ameen et al., 2005)

The frequencies of Harris lines were classified into three groups:

- 0 = none
- 1 = one Harris line
- 2 = more than one Harris line

4.5 Estimation of muscularity

Enthesopathies can be seen as rough patches and bone projections at the insertion of tendons and ligaments. They develop as a result of prolonged and excessive muscular activity due to increased mechanical loading. Their location and size on the skeleton give an indication of habitual activities involving specific muscles or groups of muscles (Larsen, 1997).

In 1994, Robb developed a set of standards – in essence, a coding system - by which muscle attachments could be graded on archaeological material. These grades infer levels of muscular activity. He recorded 42 muscle attachment sites for the left and right sides of both upper and lower limbs, each having 6 grades from 0 to 5.

This study only uses 11 sites of muscle attachment, two from the tibia – patella ligament and soleus (both situated at the proximal end) and nine from the humerus – subscapularis, supraspinatus, infraspinatus, pectoralis major, latissimus dorsi, anterior deltoid tuberosity, lateral deltoid tuberosity, common extensors and common flexors (five located on the humeral head, two on the shaft and two distally). The patella ligament insertion (from the quadriceps muscle) is on the tibial tuberosity while the posterior shaft of the tibia house the soleus muscle insertion. The enthesis for subscapularis is located on the lesser tuberosity of the humerus. The supraspinatus and infraspinatus enthesis are on the greater tuberosity of the humerus. The enthesis for pectoralis major is found on the lateral lip of the bicipital groove with the enthesis for latissimus dorsi on the floor of the same groove. The enthesis for the anterior deltoid tuberosity is found anteriorly on the shaft and that for the lateral deltoid tuberosity, on the lateral edge of the shaft. The common extensors entheseal marking is found on the lateral epicondyle and that for the common flexors on the medial epicondyle (Guyton, 1985).

These muscle sites were specifically chosen so that a comparison can be made between this study and that done by Peckmann (2002) and Ledger, et al. (2000) who also concentrated on the humerus and tibia for their studies. Only the right side measurements were used as per Robb's (1994) analyses. The same models as used and developed by Peckmann (2002) was utilised for this study.

The analysis of enthesopathies provides an understanding of the impact of certain types of activities on the body. Enthopathies are seen here as markings of physical activities and not as diffuse idiopathic skeletal hyperostosis (DISH). Only adult individuals were observed for markers of occupational stress. This is because age is a confounding factor in the development of most or all of these skeletal markers.

The grades that were used were adjusted to make it more applicable to the study group and are as follows:

- 0 = no marking
- 1 = poorly defined facet lacking one or more margins, smooth surface
- 2 = facet is defined clearly on all sides, smooth surface
- 3 = facet is well defined on all sides, surface is finely textured or rugose
- 4 = rim shows osteophytes, surface shows destruction with extensive pitting.

It has been noted by Sanders (2001) that these scores are not always reliable. Sanders suggested that Robb scores should be used in conjunction with beam analysis in order to gain a better perspective of how specific activities affect bone remodelling. Thus overall lifestyle activity (instead of specific activity) may have to be established. Beam analysis will not be used for this project, but data are available for the Cobern Street material (Ledger et al., 2000).

4.6 Lifestyle stress indicators

4.6.1 Osteological

The study of the skeleton for disease nearly always gives a static picture of that individual only at the time of death (Allison, et al., 1974). Very obvious skeletal changes are often induced by infection. Although not all illnesses leave skeletal signatures, the study of abnormal bone can provide important information concerning an individual's health status (Buikstra & Ubelaker, 1994). Thus, by understanding the presence and patterns of diseases in ancient human skeletons, there is a significant contribution to our understanding of modern human diseases (Grauer & Roberts, 1996).

Recognition of the extent of the disease will also provide insights into the community in which they lived. Some signs of these diseases affect all age groups e.g. cribra orbitalia and porotic hyperostosis while others were more commonly found in older individuals e.g. osteoarthritis (Katzenberg & Saunders, 2000). The entire skeleton present was visually examined for signs of abnormality. Observations were recorded pertaining to health and lifestyle.

4.6.1.1. Cribra orbitalia and Porotic hyperostosis

Cribra orbitalia and porotic hyperostosis are lesions identified by a spongy, porous appearance. Cribra orbitalia appears on the roofs of the eye orbits and porotic hyperostosis occurs primarily on the frontal and parietal bones and to a lesser extent on the occipital bone of the cranium. Diploic thickening and thinning of the outer surface of bone usually accompany them (Stuart-Macadam, 1985, 1987a, 1987b, 1989, 1992a, 1992b, Sullivan 2005). Both cribra orbitalia and porotic hyperostosis are usually associated with iron deficiency anaemia, whereby pressure is exerted on the tables of the compact bone by the expanding marrow (Stuart-Macadam, 1987, Sullivan, 2005). Where iron deficiency is not implicated, the porosites are seen as biological stress indicators for conditions such as rickets, inflammation or post-mortem erosion (Wapler, et al., 2004). All individuals with intact orbits and or cranial vaults were examined for the presence and severity of cribra orbitalia and porotic hyperostosis.

Scoring system for the presence and severity of cribra orbitalia (Peckmann, 2002):

- 0 = none
- 1 = light: scattered fine foramina
- 2 = medium: large and small isolated foramina that have linked to form a trabecular structure
- 3 = Severe: outgrowth in trabecular structure from the normal contour of the outer bone table.

Status at time of death (this may be difficult to interpret as a number of pathological conditions can affect bone modelling and remodelling):

- Remodelled (healed at time of death, bone is smooth to the touch but pitting is still visible)
- Unremodelled (active at time of death, bone is rough to the touch).

4.6.1.2. Periostitis

Skeletal lesions, initially involving the periosteum, and characterised as osseous plaques with demarcated margins or irregular elevations of bone surfaces, are often observed on archaeological skeletal remains. The lesions represent a non-specific, basic inflammatory response that may result from bacterial infection or injury, sufficient to stimulate an osteoblastic activity on the periosteum (Larsen, 1997). Unremodelled and unhealed lesions are loosely organised woven bone on a skeletal element; whereas the skeletal tissue of healed and remodelled lesions is incorporated into the normal cortical bone, leaving the surface somewhat inflated (Larsen, 1997, Katzenberg & Saunders, 2000).

Observations were noted according to site and whether the spread was localised or widespread and whether the status at time of death was healed or unhealed. The lesions were scored in the following manner:

- 0 = none
- 1 = slight to moderate (pits and striations on bone surfaces with slight elevation of the bone surface)
- 2 = severe (sheaths of new bone with proliferation of endosteal and periosteal surfaces)

4.6.1.3. Degenerative joint disease

Osteoarthritis is a non-infective form of arthritis. It is one of the more common pathological conditions which are produced by the gradual alteration of the articular cartilage and the articular surfaces of the bone as a consequence of long-term mechanical stress, repeated irritation of the cartilage or disruption of circulation of the blood to the area (Ubelaker, 1978, Rothschild & Woods, 1991, Gonzalez-Reimers et al., 2004). It is most commonly found along the margins of the vertebral centra as a build up of osteophytes (spur formation or lipping). Both amphiarthrodial and diarthrodial joints are examined. Amphiarthrodial joints are found at the intervertebral discs and pubic symphysis and they ensure stabilisation at the joint through fibro-cartilaginous connections. Diarthrodial joints are synovial joints allowing flexibility and movement.

Degenerative joint disease was observed on the following post-cranial joints:

1. Vertebral column (amphiarthrodial joints found at intervertebral discs)
2. Shoulder (glenoid fossa, humeral head, distal clavicle)
3. Elbow (distal humerus, proximal ulna and radius)
4. Hip joint (head of femur)
5. Knee joint (distal femur and proximal tibia)

These observations were done visually. Visual diagnostic criterion that were used, include:

- 0 = none
- 1 = slight lipping
- 2 = marked lipping
- 3 = eburnation

4.6.2. Dental

The dentition is of importance in archaeological studies as often teeth are better preserved than other parts of skeletal material. The nutritional quality and various food types influence the patterns of dental wear and disease. Thus, studies of the dentition contribute to dietary reconstructions (Buikstra & Ubelaker, 1994, Hillson 1996, Aubry et al., 2003). Only adult dentition will be observed for analyses.

The use of dental morphology along with tooth wear, oral pathology and enamel hypoplasia allows one to reconstruct the lifestyle of the individuals being studied. The dentition begins its formation very early in gestation and has not completed its development until the third decade of life. Enamel does not remodel after formation, thus a permanent recorded of dental defects are present (Milner & Larsen, 1991, Buikstra & Ubelaker, 1994). The insults that the body and dentition receive may be recorded in the teeth while bone has the opportunity to remodel during the life of the individual thus removing the earlier changes (Mayhall, 2000). Dental caries and tooth wear (attrition and abrasion) were noted.

Non-metric observations for disease processes were done on the teeth, both maxillary and mandibular. These include:

1. *Dental caries*: decay of the teeth that appear as dark eroded regions on the enamel (Buikstra & Ubelaker, 1994).
2. *Antemortem tooth loss*: resorption of alveolar bone that results from antemortem loss of a tooth (Burns, 1999).

3. *Abscess*: a resorption of the maxillary or mandibular bone, signifying inflammation of the pulp chamber (Burns, 1999).

4.6.2.1. Condition of teeth

Any analysis of teeth requires the knowledge of the presence and condition of teeth. Both the mandibular and maxillary teeth were examined and recorded.

Condition of teeth was recorded as follows:

- 1 = absent (tooth missing, socket unbroken)
- 2 = present
- 3 = unerupted
- 4 = erupting
- 5 = socket resorbed (ante-mortem tooth loss)
- 6 = socket broken (tooth missing)

$$\text{Antemortem loss (\%)} = \frac{\text{Antemortem tooth loss} \times 100}{\text{Number of teeth erupted}}$$

$$\text{Postmortem loss (\%)} = \frac{\text{Postmortem tooth loss} \times 100}{\text{No. erupted} - \text{No missing positions} - \text{Antemortem loss}}$$

No. erupted = the assessed number of erupted teeth on the basis of available space for socket positions in jaws

No. missing positions = number of missing socket positions and related teeth (Maat et al., 2002).

4.5.2.2. Dental wear

Within any given age group, more extreme attrition is associated with the consumption of coarser foods. Dental wear also reduces the sites for caries to develop (Buikstra & Ubelaker, 1994). Both the mandibular and maxillary teeth were examined and recorded.

Wear was recorded as follows (Table 4.01):

- 0 = unworn
- 1 = minimal
- 2 – 2.5 = slight / moderate

3. *Abscess*: a resorption of the maxillary or mandibular bone, signifying inflammation of the pulp chamber (Burns, 1999).

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Wear was recorded as follows (Table 4.01):

- 0 = unworn
- 1 = minimal
- 2 – 2.5 = slight / moderate

- 3 = heavy
- 4 = extreme

4.6.2.3. Dental caries

Caries is the most common of all the observed dental pathologies. It appears as dark, eroded regions in the tooth enamel (Buikstra & Ubelaker, 1994) caused by the destruction of enamel, dentine and cement as a result of bacteria producing acid in dental plague (Hillson, 1996). This eventually leads to cavity formation. Tooth surfaces vary in their predisposition to caries. Multifaceted occlusal surfaces are most likely to be affected by caries than the smooth sides of the crown (Schneider, 1986, Cruwys & Foley, 1986, Buikstra & Ubelaker, 1994). Caries has a characteristic pattern. Molars are most commonly affected, followed by the premolars and the anterior teeth. An increased caries frequency has been associated with an increase of consumed food rich in sugar or carbohydrates. Coarser diets assist natural cleaning and as a consequence lower the caries rates (Buikstra & Ubelaker, 1994). Multiple caries lesions on one tooth counted as one observation.

Caries present was recorded as follows:

- 1 = none
- 2 = interproximal
- 3 = buccal
- 4 = lingual
- 5 = occlusal

$$\text{Caries frequency (\%)} = \frac{\text{No. carious teeth x 100}}{\text{No. inspected}}$$

No. caries teeth = number of teeth with caries (NOT the total number of lesions)

No. inspected = number of teeth inspected (Lukacs, 1995, Maat et al., 2002)

$$\text{Caries teeth per mouth (\%)} = \frac{\text{No. carious lesions x 100}}{\text{Total number of individuals affected by caries}}$$

$$\text{Caries intensity (\%)} = \frac{\text{No. of carious lesions x 100}}{\text{Number of teeth in sample}}$$

Diseased Missing Index (DMI) % =

$$\frac{\text{Total number of carious teeth and number of restored sockets}}{\text{Total number of teeth and resorbed sockets}} \times 100$$

Stages	Incisors and Canines	Premolars	Molars
0 unworn	No wear	No wear	No wear
1 minimal wear	Enamel only	Enamel only	Enamel only
2 slight wear	Dentine exposed as a thin line or in a mesio-distal ellipse	Cusps worn and one or two dentine patches are visible	All cusps have some exposure of dentine
2.5 moderate wear	Dentine patch is wide	Dentine exposure have coalesced	At least two dentine patches have coalesced but entire occlusal enamel is not yet removed
3 heavy wear	Large dentine exposure with only enamel rim remaining, surface may be flat, cupped or rounded	Enamel rim with one large dentine exposure	One large dentine exposure with enamel rim, but crown wear may be enough to remove rim from one side
4 extreme wear	Tooth crown lost, pulp cavity exposed and roots may be functioning in occlusal surface	Tooth crown lost, pulp cavity exposed and roots may be functioning in occlusal surface	Tooth crown lost, pulp cavity exposed and roots may be functioning in occlusal surface

Table 4.01: Numerical classification and description of tooth wear categories (developed from Morris, 1984, Table 4.2)

The dental characteristics of the study sample are not studied in depth in this thesis as a concurrent Master's thesis by another student (Mr T. Manyaapelo, in prep.) on the dental description is being completed.

4.7 Trauma

Trauma may be defined in many ways but conventionally it is understood to be an injury to living tissue caused by some mechanism extrinsic to the body (Aufderheide & Rodriguez-Martin, 1998). The anatomical and social implications and importance arise when this trauma then becomes readily visible on the human skeletal material (Lovell, 1997).

Bone remodelling in the form of callus formation will show at sites of traumatic lesions, especially where bones had been broken and united again (Sauer, 1998). Signs of trauma were recognised by the changes in the contour of the affected bones (Aufderheide & Rodriguez-Martin, 1998). All skeletal material was examined for any visible manifestations of physical trauma. The sites and severity of trauma was recorded.

4.8 Skeletal measurements

Metric analysis involved using the standard measurements for recording the size of various attributes of the human skeleton as set out by Buikstra & Ubelaker (1994).

4.8.1. Cranial and mandibular measurements

All cranial measurements (Figures 4.16, 4.17 & 4.18) were done with a spreading or sliding callipers.

Cranial measurements (definitions taken from Buikstra and Ubelaker, 1994)

1. Cranial length (g – op): The distance between glabella (g) and opisthocranion (op) in the midsagittal plane, measured in a straight line.
2. Cranial breadth (eu – eu): The maximum width of the skull perpendicular to the midsagittal plane.
3. Basion-bregma height (ba – b): The direct distance from the lowest point on the anterior margin of the foramen magnum (ba) to bregma (b).

4. Bizygomatic breadth (zy – zy): The direct distance between the most lateral points on the zygomatic arches (zy)
5. Bimaxillary breadth: The direct distance between the most inferior point of the suture between the zygomatic arch and the maxilla.
6. Upper facial height (n – pr): The direct distance from nasion (n) to prosthion (pr).
7. Basi-prosthion length (ba – pr): The distance from basion (ba) to prosthion (pr).
8. Nasal aperture breadth (al – al): The maximum breadth of the nasal aperture (al).
9. Nasal aperture height (n – ns): The direct distance from nasion (n) to the midpoint of a line connecting the lowest points of the inferior margin of the nasal notches (ns).
10. Orbital breadth (d- ec): The laterally sloping distance from dacryon (d) to ectochonion (ec).
11. Orbital height: The direct distance between the superior and inferior orbital margins.
12. Maxillo-alveolar breadth (ecm – ecm): The maximum breadth across the alveolar borders of the maxilla measured on the lateral surfaces at the location of the second maxillary molars (ecm).
13. Bi-mastoid breadth: The direct distance between the right and left mastoids.
14. Bi-temporal breadth: The maximum width between the temporal bones perpendicular to the midsagittal plane.

Mandibular measurements (Figures 4.19a & 4.19b) (definitions taken from Buikstra and Ubelaker, 1994)

1. Maximum breadth outside condyles (cdl –cdl): The direct distance between the most lateral points on the two condyles (cdl).
2. Bigonial breadth (go –go): The direct distance between the right and left gonion (go).
3. Mental foramen breadth: The direct distance between the right and left mental foramen.
4. Symphyseal height (id – gn): The direct distance from infradentale (id) to gnathion (gn).

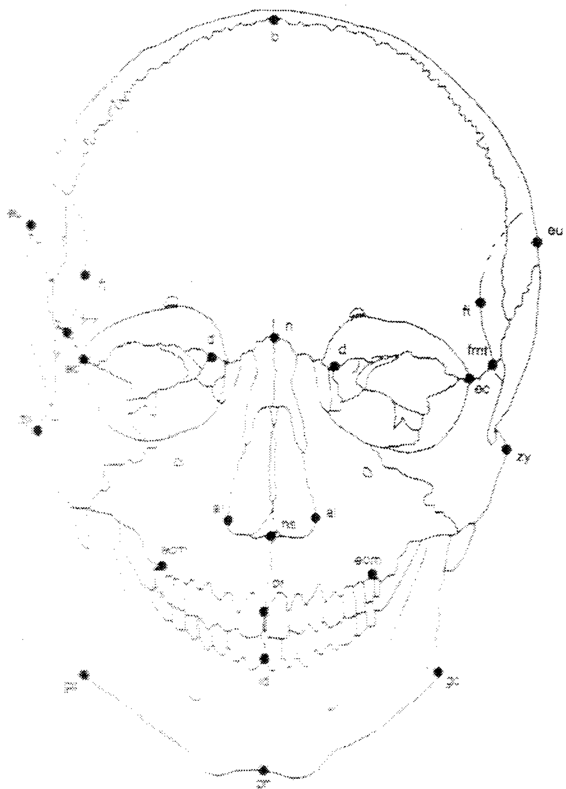


Figure 4.16: Landmarks on the skull used for cranial measurements (Buikstra & Ubelaker 1994: 71)

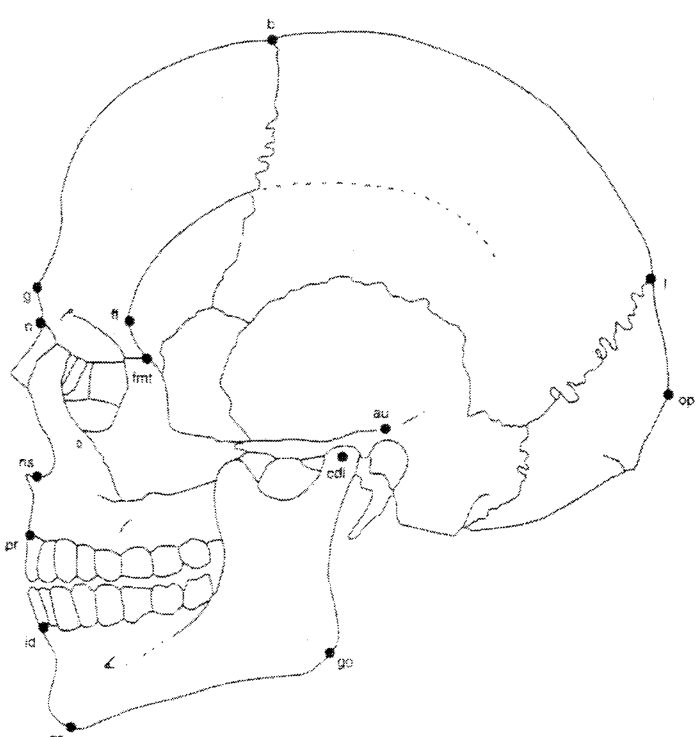


Figure 4.17: Landmarks on the skull used for cranial measurements (Buikstra & Ubelaker 1994: 72)

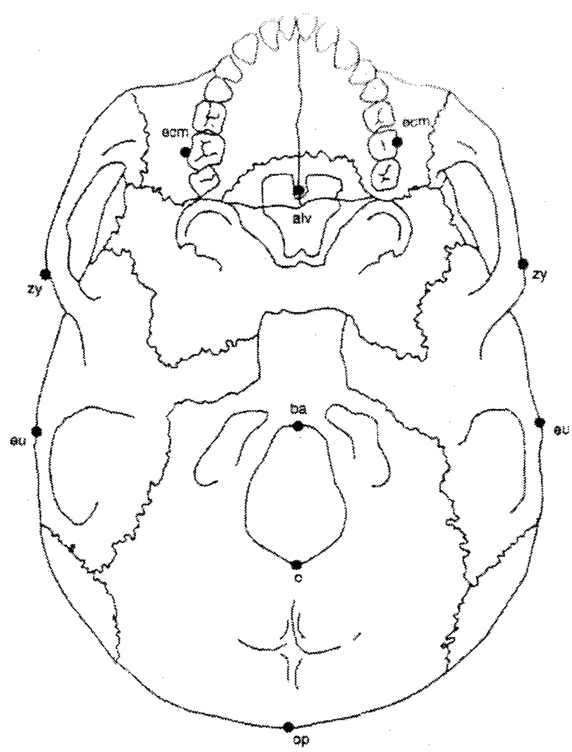


Figure 4.18: Landmarks on the base of the skull used for cranial measurements (Buikstra & Ubelaker 1994: 73)

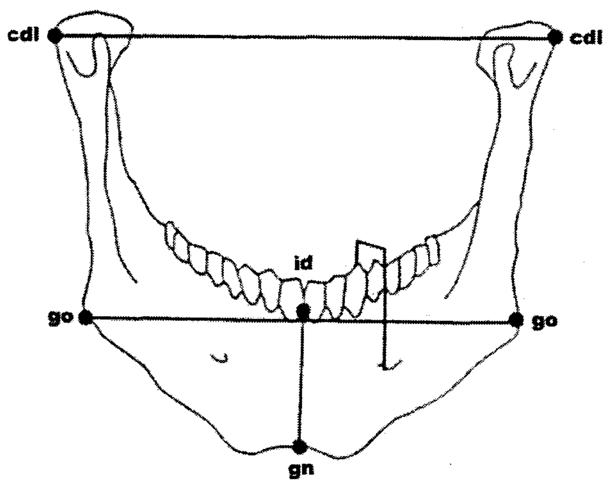


Figure 4.19a: Landmarks on the mandible used for measurements (Buikstra & Ubelaker, 1994: 78)

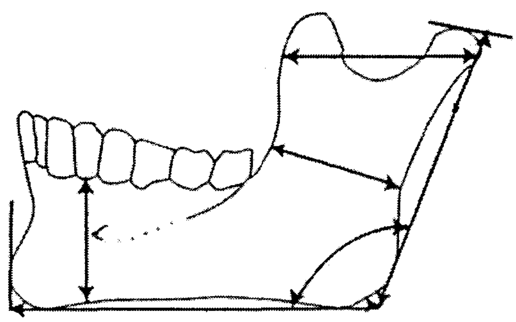


Figure 4.19b: Landmarks on the mandible used for measurements (Buikstra & Ubelaker, 1994: 78)

5. Mandibular angle: The angle formed by the inferior border of the corpus and the posterior border of the ramus – measured with a mandibular board.

4.8.2. Post-cranial measurements

Measurements of bones were taken whenever possible. The lengths of long bones were recorded together with diameters and / or circumferences. All bones were measured to the nearest millimetre. Long bones were measured with an osteometric board. Diameters were measured with sliding callipers and the circumferences with a measuring tape. Both the left and right sides were measured and recorded

The following were recorded following the definitions set out in Buikstra & Ubelaker (1994):

Clavicle (Figure 4.20)

- Maximum length: The maximum distance between the most extreme ends of the clavicle.
- Antero-posterior diameter: The distance from the anterior to the posterior surface at midshaft.
- Supero-inferior diameter: The distance from the superior to the inferior surface at midshaft.

Humerus (Figure 4.21)

- Maximum length: The direct distance from the most superior point on the head of the humerus to the most inferior point on the trochlear with the humeral shaft parallel to the long axis of the osteometric board.
- Epicondylar breadth: The distance of the most laterally protruding point on the epicondyle from the corresponding point on the medial epicondyle.
- Vertical diameter of head: The direct distance between the most superior and inferior points on the border of the articular surface.
- Maximum diameter midshaft: The maximum diameter at midshaft.
- Minimum diameter midshaft: The minimum diameter at midshaft.

Radius (Figure 4.22)

- Maximum length: The distance from the most proximally positioned point on the radial head to the tip of the styloid process without regard for the long axis of the bone.
- Antero-posterior diameter: The distance between the anterior and posterior surfaced at midshaft.
- Medio-lateral diameter: The distance between the medial and lateral surfaces at midshaft.

Ulna (Figure 4.23)

- Maximum length: The distance from the most superior point on the Olecranon to the most inferior point on the styloid process.
- Antero-posterior diameter: The maximum diameter of the diaphysis where the crest exhibits the greatest development in the antero-posterior plane.
- Medio-lateral diameter: The distance between medial and lateral surfaces at the level of the greatest crest development.
- Physiological length: The distance between the most distal point on the coronoid process and the most distal point on the inferior surface of the distal head of the ulna.
- Minimum circumference: The least circumference near the distal end of the bone.

Sacrum

- Anterior length: The distance from a point on the promontory positioned in the midsagittal plane to a point on the anterior border of the tip of the sacrum.

Os Coxae (Figure 4.24)

- Height: The distance from the most superior point on the iliac crest to the most inferior point on the ischial tuberosity.
- Iliac breadth: The distance from the anterior-superior iliac spine to the posterior-superior iliac spine.
- Pubis length: The distance from the point in the acetabulum where the three elements of the os coxae meet to the upper end of the pubic symphysis.

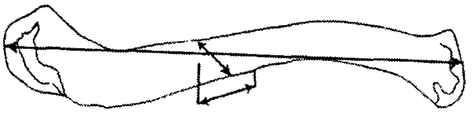


Figure 4.20: Clavicle measurements, superior view (Buikstra & Ubelaker, 1994: 79)

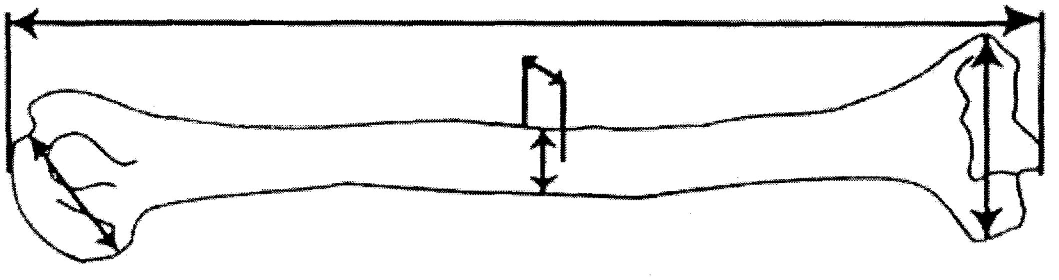


Figure 4.21: Measurements of the humerus (Buikstra & Ubelaker, 1994: 80)

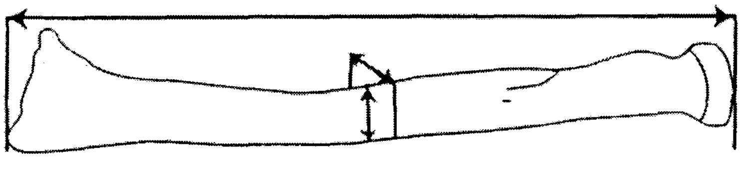


Figure 4.22: Measurements of the radius (Buikstra & Ubelaker, 1994: 80)

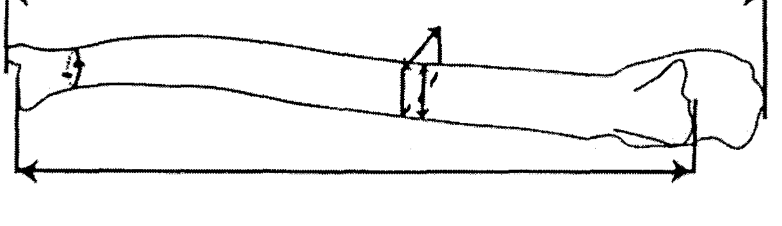


Figure 4.23: Measurements of the ulna (Buikstra & Ubelaker, 1994: 81)

- Ischium length: The distance from the point in the acetabulum where the three elements of the os coxae meet to the deepest point on the ischial tuberosity

Femur (Figure 4.25)

- Maximum length: The distance from the most superior point on the head of the femur to the most inferior point on the distal condyles.
- Bicondylar length: The distance from the most superior point on the head to a plane drawn along the inferior surfaces of the distal condyles.
- Epicondylar breadth: The distance between the two most laterally projecting points on the epicondyles.
- Maximum diameter of head: The maximum diameter of the femur head.
- Supero-inferior diameter: The distance across the narrowest part of the femoral neck (Seiderman, et al., 1998) (Figure 4.8).
- Antero-posterior subtrochanteric diameter: The distance between the anterior and posterior surfaces at the proximal end of the diaphysis.
- Medio-lateral subtrochanteric diameter: The distance between the medial and lateral surfaces of the proximal end of the diaphysis at the point of its greatest lateral expansion below the base of the lesser trochanter.
- Antero-posterior midshaft diameter: The distance between the anterior and posterior surfaces measured at the midpoint of the diaphysis, at the highest elevation of the linear aspera.
- Medio-lateral midshaft diameter: The distance between the medial and lateral surfaces at midshaft, measured perpendicular to the anterior-posterior diameter.
- Midshaft circumference: The circumference measured at the level of the midshaft diameter.

Tibia (Figure 4.26)

- Length: The distance from the superior articular surface of the lateral condyle to the tip of the medial malleolus.

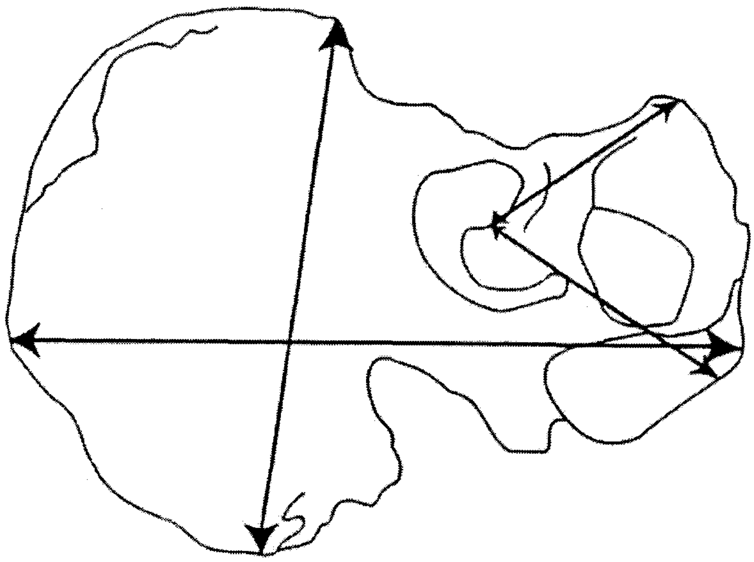


Figure 4.24: Measurements of the os coxae (Buikstra & Ubelaker, 1994: 82)

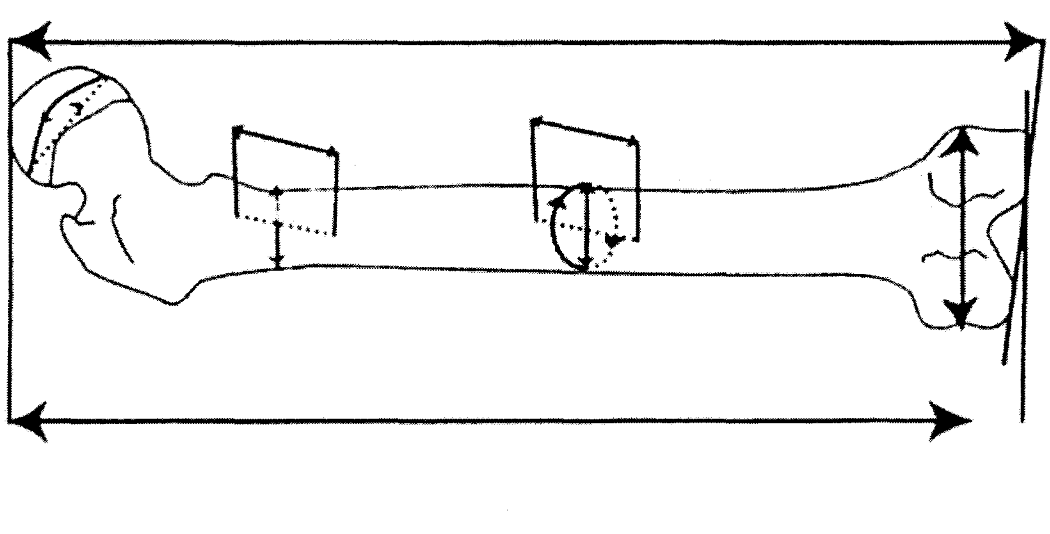


Figure 4.25: Measurements of the femur, posterior view (Buikstra & Ubelaker, 1994: 83)

- Maximum proximal epiphyseal breadth: The maximum distance between the two most laterally projecting points on the medial and lateral condyles of the proximal articular epiphysis.
- Maximum distal epiphyseal breadth: The maximum distance between the two most laterally projecting points on the medial malleolus and the lateral surface of the distal articular epiphysis.
- Medio-lateral diameter at nutrient foramen: The straight-line distance of the medial margin from the interosseous crest at the level of the nutrient foramen.
- Antero-posterior diameter at nutrient foramen: The straight-line distance of the anterior and posterior margins at the level of the nutrient foramen.
- Circumference at nutrient foramen: The circumference measured at the level of the nutrient foramen.

Fibula (Figure 4.27)

- Maximum length: The maximum distance between the most superior point on the fibula head and the most inferior point on the lateral malleolus.
- Maximum diameter at midshaft: The maximum diameter at midshaft.

Calcaneus (Figure 4.28)

- Maximum length: The distance between the most posteriorly projecting point on the tuberosity and the anterior point on the superior margin of the articular facet for the cuboid measured in the sagittal plane.
- Middle breadth: The distance between the most laterally projecting point on the dorsal articular facet and the most medial point on the sustentaculum tali.

4.8.2.1. Stature estimates

The maximum lengths of all intact adult femora were measured using an osteometric board and recorded in centimetres to one decimal point. These long bones measurements were used to reflect post-mortem adult stature. Feldesman and Fountain (1996) also put forward a 'generic' regression formula for estimating stature:

Generic = 31.263362 + 3.019390 * femur.

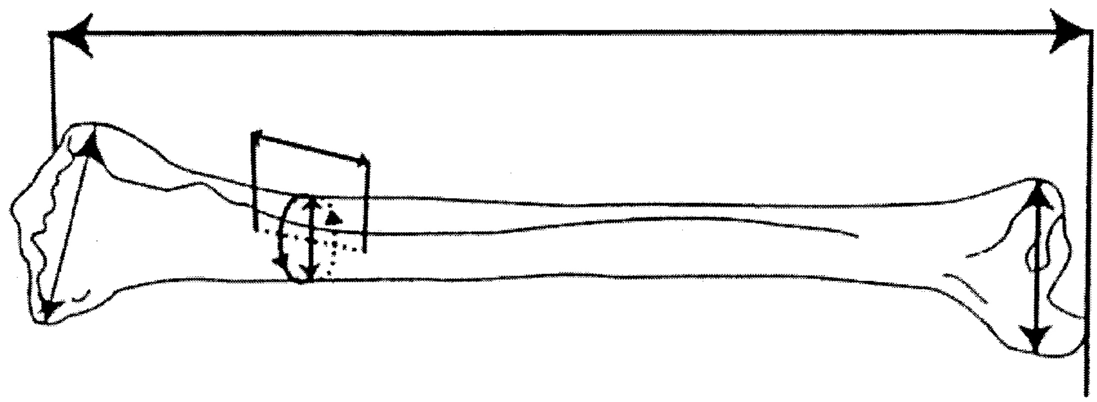


Figure 4.26: Measurements of the tibia, anterior view (Buikstra & Ubelaker, 1994: 83)

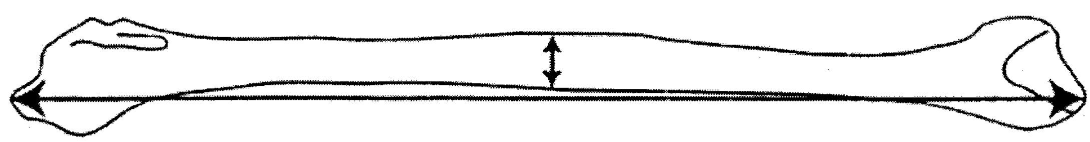


Figure 4.27: Measurements of the fibula, lateral view (Buikstra & Ubelaker, 1994: 84)

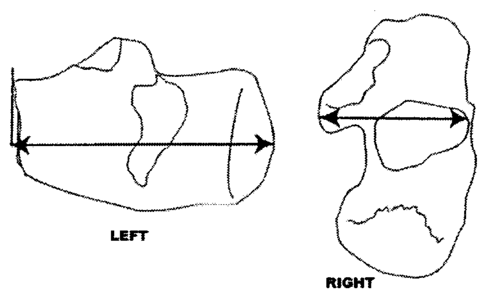


Figure 4.28: Measurements of the calcaneus (Buikstra & Ubelaker, 1994: 84)

This formula is used to determine post-mortem stature. It is applicable not only across various groups of people but is relevant to both males and females.

The regression equations set forth by Lundy (1983), Feldesman et al. (1990) and some by Feldesman and Fountain (1996) are inappropriate as many of the elements required are either missing in these fragmentary skeletal remains or the biological race of the subjects must be known. While many anthropologists use the generic ratio (3.745) by Lundy & Feldesman (1989) on the basis of its simplicity and its solid performance, according to Feldesman & Fountain (1996) the generic regression of femur length on stature yields even more accurate results than the generic ratio.

4.9 Standardization of measurements

Although some of the Cobern Street sample had already been studied, the bones were re-measured by the assessor so that any errors occurring would be consistent throughout all the study samples. To prove the measurements accurate and no intra-observer error occurred, the concordance correlation coefficient was calculated using a few specimens from Marina Residence and Cobern Street. The measurements were shown to be reproducible. A fuller discussion of this coefficient is available in Lin (1989). The concordance correlation coefficients were determined for the long bone lengths, diameters and circumferences for a set of five repeated measurements using SPSS 11.5. The mean coefficients for these sets of results all fell within the 95% confidence interval thus indicating that the physical measurements taken were accurate and consistent from one specimen to the next.

4.10 Statistical methods

The small sample sizes in this project suggest a degree of caution be practiced when examining the data.

Both parametric and nonparametric methods are employed. Parametric tests are calculated on numerical data, means or variances that follow a normal distribution pattern. The most common statistical parametric test is the ANOVA (analysis of variance), which is used to test the hypothesis that the means from two or more samples are equal. When a difference between groups is determined, the Bonferroni test (used for a small number of pairs of means) or the Tukey (used for a large number of pairs) is used. A post hoc pair-wise comparison is used to establish which pairs differ. Nonparametric methods are used when the results are measured on an ordinal scale (data that uses a ranking system). The nonparametric method used for ranking data is the Mann-Whitney U statistical test that is used to compare the medians of two independent samples.

The Chi squared test which is a measure of the level of agreement between a set of observed and expected values, is employed with qualitative data to test the significance of frequency patterns or proportion differences between and within groups. Chi squared values are significant at $p < 0.05$.

T-tests were used to compare the means. T-test values are significant at $p < 0.05$.

Testing is done on Excel (Microsoft Office 2000), Statistica and SPSS11.5 for Windows. The results are presented as a probability value. If $p < 0.05$ then the difference between the means is significant and a significant difference exists between the samples. A low p-value indicates a rejection of the null hypothesis of equivalency.

Chapter 5

RESULTS

5.1 Condition of skeletal remains

Tables 5.01 and 5.02 illustrate the condition of the skeletal remains at both sites viz. Marina Residence and Cobern Street, analysed for this project. The majority of the remains at both sites were incomplete for both the cranial and post-cranial samples. The skeletal material for the infants, juveniles and sub-adults were for the most very fragmentary with only a few fragments of bone surviving; often not enough to take any measurements from. The post-cranials from the secondary burial of the Marina Residence site were too fragmentary to study with some of the cranial material in a slightly better condition. The preservation state of the skeletal material is not studied for this project as it forms another project by a 2007 honours student, Ms Dembetembe (in preparation).

Site	Complete n	Nearly complete n	Incomplete n	Total n
Marina Residence	10	24	20	54
Cobern Street	24	25	37	86

Table 5.01: Cranial condition of skeletal samples

Site	Complete n	Nearly complete n	Incomplete n	Total n
Marina Residence	8	10	45	63
Cobern Street	10	23	86	119

Table 5.02: Post-cranial condition of skeletal samples

5.2 Demography

5.2.1 Sex and Age Distribution – Standard Method

The distribution of males and females varies between the Marina Residence and Cobern Street sites (Table 5.03). It should be noted that the Later Stone Age individuals are not included in the analysis as this study concentrates only on the pre-historical skeletal material. There are twice as many males at Marina Residence as

					MALES			FEMALES				
Site	Burial Type	Infant	Juvenile	SA	YA	OA	A	YA	OA	A	Unknown	Totals
Marina Residence	**Burial**	1	1	4	14	18	5	6	8	0	1	57
	Scatter	0	0	0	2	5	0	1	1	1	0	10
	Secondary burial	0	0	0	3	5	0	1	1	1	0	11
	Subtotal	**1**	**1**	**4**	**19**	**28**	**5**	**8**	**10**	**2**	**1**	**78**
Cobern Street	**Burial**	9	10	4	14	10	2	11	6	0	5	71
	Scatter	3	8	2	5	2	4	2	5	2	15	48
	Subtotal	**12**	**18**	**6**	**19**	**12**	**6**	**13**	**11**	**2**	**20**	**119**
	Grand Total	**13**	**19**	**10**	**38**	**40**	**11**	**21**	**21**	**4**	**21**	**197**

Infants = Birth – 5 years
Juveniles = 5.1 – 15 years
SA = subadults, 15.1 – 20 years
YA = younger adults, 20.1 – 40 years
OA = older adults, 40.1 + years
Unknown = osteologically adults but unable to estimate sex

Table 5.03: Sex and age distribution for the Marina Residence and Cobern Street sites

there are females. The male to female ratio for the Marina Residence sample (2.6:1) (Table 5.04) is higher than that for Cobern Street (1.4:1) (Table 5.05). There are a small percentage of adult individuals for whom the estimation of sex could not be determined. In the Marina Residence sample 11.1% were classified as adults of indeterminate sex while at Cobern Street only 6.5% were classified as adults of indeterminate sex. There were totally unknown samples found at both sites that could be classified into any category (juvenile, sub-adult or adult), as the skeletal remains were too few and very fragmentary. The Marina Residence site yielded 1.2% unknown samples and Cobern street 16.3%. Thus there were a total of 12.3% and 22.8% individuals of indeterminate sex at Marina Residence and Cobern Street respectively.

Site	Male : Female ratio
Marina Residence	2.6 : 1
Cobern Street	1.4 : 1

Table 5.04: Male to female ration for each site

Site	*Young : Adult ratio
Marina Residence	0.09 : 1
Cobern Street	0.43 : 1

*Young = includes infants, juveniles and sub-adults

Table 5.05: Young to adult ratio for each site

The Chi square test shows a significant difference in the composition of males and females between the two study sites ($p = 0.02$). There is also a significant difference between the composition of males and females at Marina Residence, ($p < 0.01$).

The ages between and within the samples also vary (Table 5.03). There are more younger adult males (23.5%) and older males (34.6%) at Marina Residence as expected with a 2.6:1 ratio of males to females. There are more younger adult males (16.3%) and juveniles (15.4%) at Cobern Street. Overall there are 10 times more infants and juveniles at Cobern Street site (25.2%) than at the Marina Residence site

(2.5%). This is significant ($p = 0.01$). The child/adult ratio, where child include infants, juvenile and sub-adults and adult includes younger adults and older adults is a useful guide to age differences in the samples ($p = 0.01$) for Marina Residence and not significant for Cobern Street) (Table 5.05).

The Chi square test for significance shows a significant difference in the frequency of age categories when comparing the two sites ($p < 0.001$). When the test is applied to the child/adult ratio, there is a significant ratio between the two sites ($p < 0.001$).

5.2.2. Sex Distribution – Femoral Neck Method

A further attempt at estimating sex in individuals with no distal humeri intact and incomplete and very fragmentary remains is made. The femoral neck method developed by Seiderman, et al. (1998) uses the anatomical landmarks of the proximal end of the femoral neck. The theory is that this region has a higher rate of intact preservation than the femoral head, making it ideal for use in estimating sex in adults A few equations were developed but the equation for people of unknown ancestry (the case for both Marina Residence and Cobern Street) is used:

$$\text{Sex} = 05.10 * \text{SID} - 15.356$$

SID = Supero-inferior diameter of the femoral neck

For the Marina Residence site (Table 5.06), only 50% of younger adult females could be positively identified as female compared to 83.3% of older adult females. Younger adult males were 81% positively identified as male compared to 83.3 percent in older adult males.

The Cobern Street site yielded different results (Table 5.06). Females in both categories were positively identified as female (100%) whereas only 50% of younger adult males and 60% of older adult males could be positively sexed by this method.

This method proved more accurate in the older adults than the younger adults. This was significant at both sites ($p < 0.01$).

	Marina Residence	Cobern Street	p-values
YA Females	50.0	100.0	< 0.001
OA Females	83.3	100.0	0.009
Ave. Females	**66.7**	**100.0**	< 0.001
YA Males	81.0	55.0	0.008
OA Males	83.3	60.0	< 0.001
Ave. Males	**82.2**	**57.5**	0.006
Overall Average	**74.0**	**78.8**	

YA = younger adults
OA = older adults

Table 5.06: Sex distribution using the femoral neck method (SID)

5.2.3 Sex Distribution – Distal Humeri Method

There are a few discrepancies for biological sex in some of the samples especially where there are incomplete skeletal specimens. A method developed by Rogers (1999) is used to assist in sex estimation. It assumes that human beings today show discernible sexual dimorphism. Thus, small differences in morphology and robusticity make it possible to determine sex. This method uses only the distal humerus to determine sex. All specimens with at least one intact distal humerus are used.

Using the Rogers (1999) method on the Marina Residence site, of the 34 individuals having intact humeri, 23 presented as male, 10 as females and one was unable to be sexed as it produced half male and half female characteristics and proved to be an individual under the age of 18 years old (Tables 5.07 and 5.08). Two individuals visually sexed by the standard methods as male presented as female and one female presented as male. Two unsexed sub-adults could positively be identified as male and the unidentified adult could also be identified as male. This shows a 73.5% confirmation of existing adult sex estimation and a 26.5% difference from existing sex estimation. This is significant, $p < 0.001$.

At the Cobern Street site, of the 37 individuals with intact humeri tested, 21 presented as male and 16 as female (Tables 5.09 and 5.10). The unknown individual presented as male and two males visually sexed by standard methods presented as

Sex	Standard Visual Method	Distal Humeri Method
Male	21	23
Female	9	10
Unknown	4	1
Total	**34**	**34**

Table 5.07: Sex distribution using the distal humeri method for Marina Residence

Marina Residence	Standard Visual Method	Distal Humeri Method
MR 4	F	M
MR 7	SA	?
MR 22	M	F
MR 30	F	M
MR 32	M	F
MR 39	SA	M
MR 50	SA	M
MR 53	A	M
MR 56	M	F

Table 5.08: Marina Residence individuals with differing results in the distal humeri method and standard visual method

Sex	Standard Visual Method	Distal Humeri Method
Male	18	21
Female	18	16
Unknown	1	0
Total	**37**	**37**

Table 5.09: Sex distribution using the distal humeri method for Cobern Street

CS	Standard Visual Method	Distal Humeri Method
UCT 520.1	?	M
UCT 522	F	M
UCT 555	F	M

Table 5.10: Cobern Street individuals with differing results in the distal humeri method and standard visual method

M = male
F = female
A = adult of indeterminate sex
SA = sub-adult

MR = Marina Residence
UCT = Cobern Street

females. Thus, there was a 91.9% confirmation of existing adult sex estimations and an 8.1% difference from the existing sexes. This is not significant, $p = 0.5$.

Because of the relatively better results obtained from the distal humeri method, those individuals who had a 'change of sex' with this method, will henceforth be analysed with regard to the sex established with this method i.e. MR 4 will now be considered male and not female (Tables 5.08 and 5.10).

5.2.4 Age Distribution – Histological Method

There are discrepancies for estimated age in some of the samples especially where there are fragmentary skeletal specimens. A method introduced by Kerley (1965) and refined by Maat et al. (2002) on Dutch samples is used to assist in the estimation of age. This method uses thin transverse sections of the anterior shaft of the femur to determine age. Only skeletal material from the Marina Residence site was used. The percentage non-remodeled bone in the subperiosteal area was determined from a projection on a calibrated framework.

Three scores were taken within a 50 degree frame on the slide and averaged. This averaged result is then projected onto a standard scatter plot devised by Maat et al. (2002) and the individual age determined. This averaged age is within + / - 2 years of the actual age of the individual. Table 5.11 shows the femora sampled and the result from the histological method employed to estimate age. An r-correlation was done to establish the relationship between the averaged standard visual method for estimating age and the histological method for estimating age. It is significant, $p < 0.001$, r coefficient = 0.96 (Figure 5.01).

5.2.5. Mortality Profiles

Although mortality profiles only illustrate those who have died in a population, they are still useful tools for interpreting what life was like while those individuals lived. Wood et al. (1992) corroborates this by stating that skeletal samples are only representative of those who die at that age.

The mortality profiles are constructed based on the individual's age-at-death, thus the unknown individuals are not included. From her personal communication with Bourne in 2001, Peckmann (2002) states that the ideally normal mortality rates for historic populations have a larger number of infants and juveniles dying, a smaller

Burial #	Estimated Age	Histological Age
MR 4	50	58
MR 5	32.5	28
MR 15 (1)	25	26
MR 15 (2)	42.5	44
MR 15 (3)	50	59
MR 15 (4)	25	25
MR 15 (5)	60	57
MR 15 (7)	42.5	43
MR 15 (8)	25	26
MR 21	65	63
MR 23	42.5	46
MR 24	22.5	21
MR 27	42.5	45
MR 28	35	38
MR 29	50	50
MR 32	55	60
MR 33	32.5	28
MR 34	25	28
MR 37	25	26
MR 37/38		41
MR 38	42.5	48
MR 42	42.5	43
MR 44	55	53
MR 46	30	35
MR 48	32.5	39
MR 48A	32.5	42
MR 50	18	19
MR 52	40	41
MR 53	65	70
MR 54	50	54
MR 61	50	59
MR SF46		60

MR = Marina Residence
SF = shaft fill

Table 5.11: Histological age determined for Marina Residence

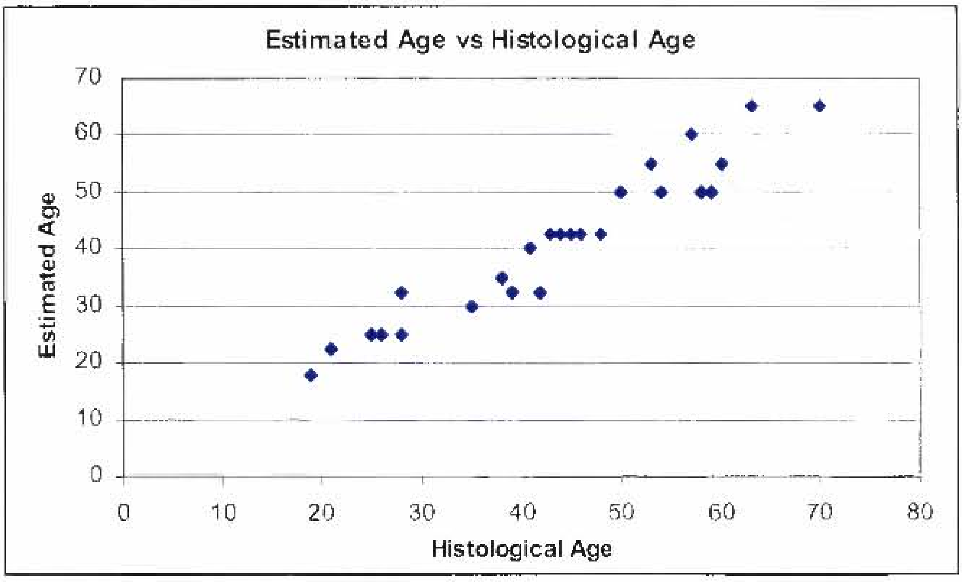


Figure 5.01: Comparison of estimated age and histological age for Marina Residence

number of sub-adults and a larger number of deaths in the younger and older adult categories. Only the Cobern Street sample would fit this profile (Figure 5.02); with infants (n = 12), juveniles (n = 19), sub-adults (n = 6), younger adults (n = 33) and older adults (n = 25). At Cobern Street site there are also more younger adult males (n = 20) than younger adult females (n = 13) and similar numbers of older adult males (n = 12) and older adult females (n = 13). There are six adult males and two adult females that could not be specifically aged as well as 20 individuals who could not be specifically aged or sexed due to the very fragmentary nature of their skeletal remains.

The Marina Residence site (Figure 5.03) does not fit the normal mortality profile for historic populations according to Bourne, as there are such a small number of infants (n = 1), and juveniles (n = 1) present, with a few sub-adults (n = 4), twice as many younger adult males (n = 19) than younger adult females (n = 8) and almost triple the number of older adult males (n = 28) than older adult females (n = 10). Seven adult males and two adult females could not be specifically aged as well as one individual that could not be aged or sexed due to the very fragmentary nature of their skeletal remains.

Figure 5.04 shows a visual comparison between Marina Residence and Cobern Street for age-at-death profiles. Overall there is no significance. However, when taken by age category, the first two categories have significant differences, $p = 0.01$ for the 0 to 10 years group and the 11 to 20 years group, $p = 0.02$.

5.3 Growth

5.3.1. Harris lines

The occurrence of transverse lines of radio-density at the ends of long bones or Harris lines are recorded and analysed in the long bones of the Marina Residence and Cobern Street samples (Tables 5.12 and 5.13). According to Aufderheide & Rodriguez-Martin (1998) and Garn et al. (1968), these lines are related to periods of stress sufficient enough to arrest long bone growth. The formation of these lines is the result of either the pause in bone growth due to dietary deficiency or disease and the recovery from this insult causes a thin layer of bone to thicken and form a transverse line detectable on a radiograph (Steinbock, 1976, Humphrey, 1998).

Even though tables 5.12 and 5.13 only represent 17 and 16 individuals each from Marina Residence and Cobern Street, respectively, each site had 19 individuals

Figure 5.02: Cobern Street age-at-death profile for all ages

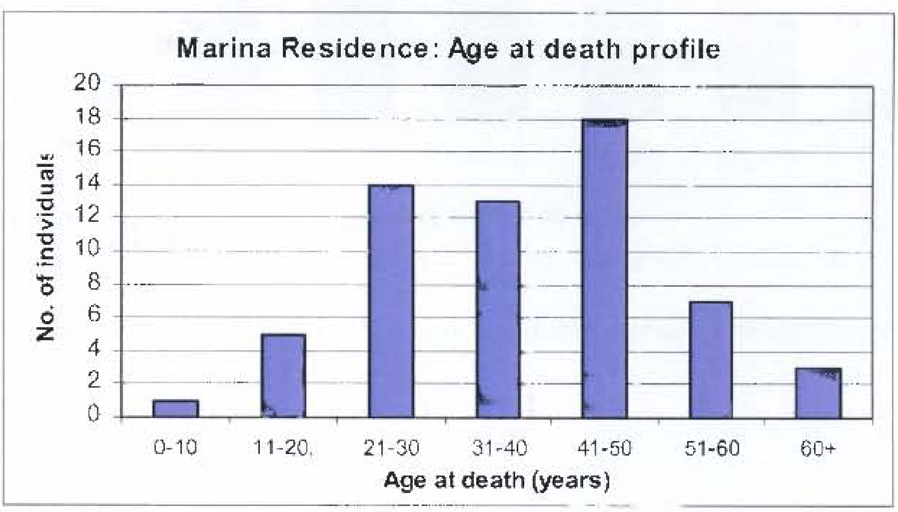


Figure 5.03: Marina Residence age-at-death profile for all ages

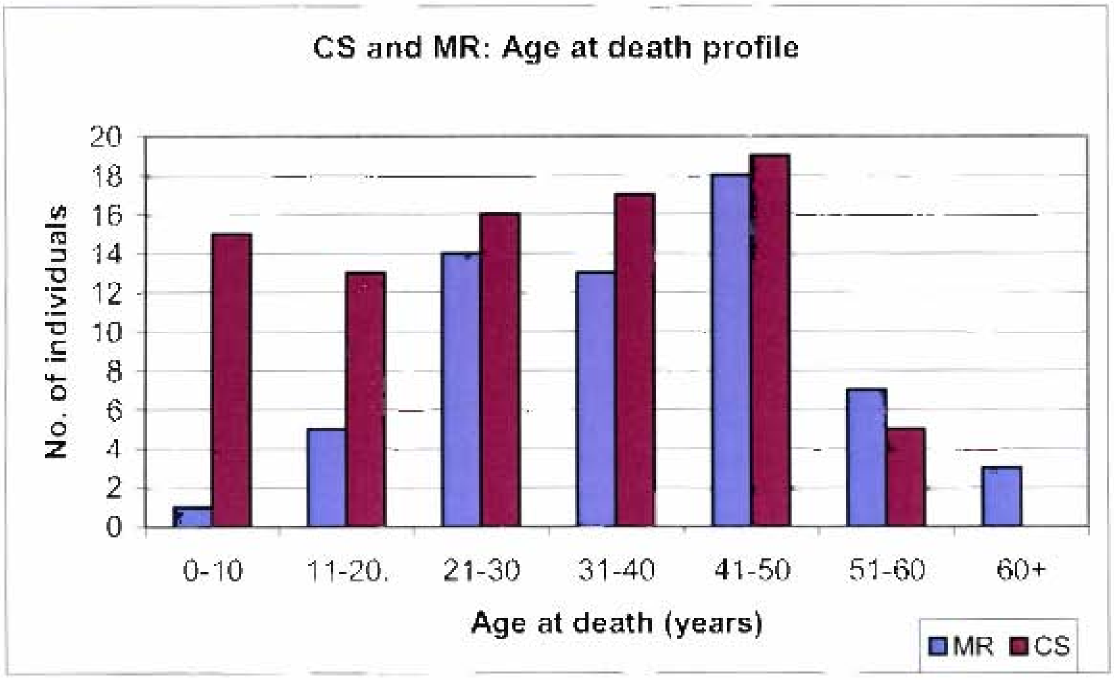


Figure 5.04: Cobern Street and Marina Residence age-at-death profile comparison

Burial #	Sex	Age-at-death (years)	Number of lines	Age of line formation (years)
MR 5	M	25-40	1	8-9
MR 24	F	20-25	3	8-9
				8-9
				10-11
MR 25	M	25-30	1	14-15
MR 27	M	35-50	4	12-13
				13-14
				13-14
				13-14
MR 29	M	40-60	5	8-9
				9-10
				10-11
				12-13
				14-15
MR 33	M	25-40	5	7-8
				8-9
				11-12
				12-13
				12-13
MR 37	M	20-30	3	8-9
				10-11
				12-13
MR 43B	M	40-60	2	1-2
				5-6
MR 44	F	50-60	3	< 1
				< 1
				1-2
MR 48A/48A/50A (1)	M		3	7-8
MR 48A/48A/50A (1)				11-12
MR 48A/48A/50A (1)				12-14
MR 48A/48A/50A (2)	M		5	5-6
MR 48A/48A/50A (2)				6-7
MR 48A/48A/50A (2)				7-8
MR 48A/48A/50A (2)				8-9
MR 48A/48A/50A (2)				10-11
MR 52	M	35-45	2	12-13
				13-14
MR 53	A	60+	2	14-15
				16-17
MR 54	M	50+		2-3
				4-5
MR 61	F	40-60	1	2-3
MR SF53	M		2	6-7
				8-9
MR SF62	M		1	13-14

Table 5.12: Individuals exhibiting Harris lines at Marina Residence

Burial #	Sex	Age-at-death (years)	Number of lines	Age of line formation (years)
UCT 458	F	17-18	1	1
UCT 459	M	20-30	1	1-2
UCT 461	F	20-30	2	4-5
				5-6
UCT 504	M	25	3	13-14
				13-14
				15-16
UCT 508	F	40-50	2	10-11
				11-12
UCT 510	M	25-30	3	1-2
				14-15
				14-15
UCT 514	F	25-35	1	2-3
UCT 519	M	50+	9	10-11
				11-12
				12-13
				12-13
				13-14
				13-14
				14-15
				14-15
				14-15
UCT 522	F	50	4	7-8
				8-9
				11-12
				11-12
UCT 547	M	40	2	9-10
				11-12
UCT 551	M	35-40	4	1-2
				12-13
				12-13
				13-14
UCT 552	M	30-35	2	11-12
				12-13
UCT 555	F	20-30	3	8-9
				10-11
				11-12
UCT 557	M	40+	2	12-13
				14-15
UCT 559	M	40+	6	5-6
				5-6
				7-8
				9-10
				10-11
				12-13
UCT 563	F	22-25	3	7-8
				8-9
				10-11

Table 5.13: Individuals exhibiting Harris lines at Cobern Street

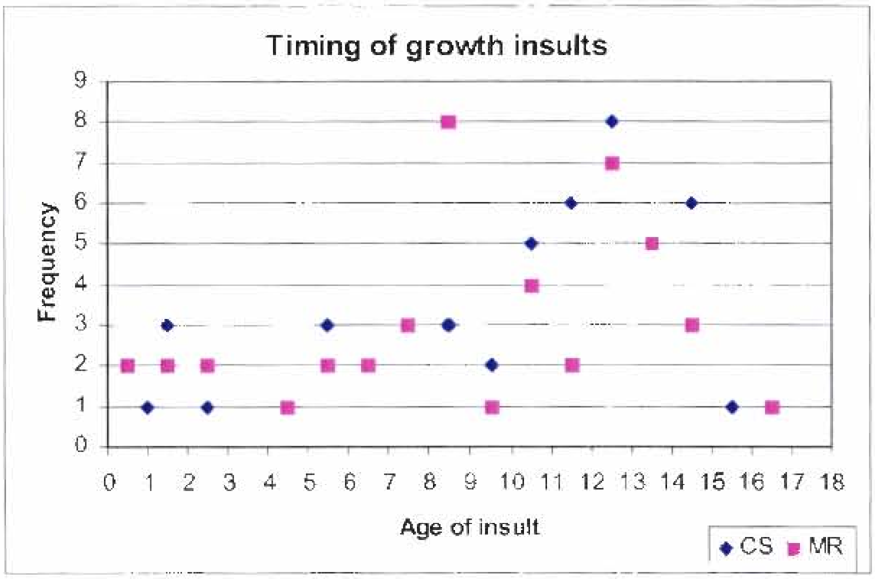
exhibiting Harris lines. The other individuals from each site had incomplete fragmentary skeletal material that could not be measured. These individuals are taken into account in the analyses. Thus even though the two sites have the same number of individuals with Harris lines, Marina Residence has a slightly higher percentage (33.2%) than Cobern Street (30.3%) because of the study sample size differences. The Cobern Street sample has a slightly lesser number of lines per person (2.8 lines/person) than Marina Residence (3.1 lines/ person). At both site there were more males (n = 15 for Marina Residence and n = 10 for Cobern Street) than females (n = 3 for Marina Residence and n = 9 for Cobern Street) expressing Harris lines (Table 5.14). This is significant (p =0.02). Figure 5.05 show the highest frequency of lines in the Marina Residence sample is 8 and 14 years. The frequency of lines peaks in the Cobern Street sample peaks between 10 and 15 years. This is not significant, p = 0.28.

5.4 Musculoskeletal Stress Markers

Eight entheseal sites on the humeri and two entheseal sites on the proximal tibia are analysed, using Robb's scores (Robb, 1994) for their response to biomechanical stress. The categories of age and sex are analysed independently to highlight differences that may occur between males and females and at the different age classes (Tables 5.15 and 5.16). Only individuals of known ages are used. The Mann-Whitney U test is used, as it is a nonparametric test that compares ranked data of two independent samples. The upper and lower limbs are analysed separately to determine if there is a difference in muscle grade expression between males and females between and within both sites.

Tables 5.15 and 5.16 also show the entheseal scores when the upper limb muscles are analysed as a single unit. Mean entheseal scores are calculated by pooling all scores – weighted averages are not calculated. The older adult females have higher muscle grades than the younger females. A similar trend is found in the males. The large standard deviation in the Cobern Street YA females (SD = 1.52) is due to the wider range of scores: the entheses vary from grade 0 to grade 4.

Tables 5.15 and 5.16 show the entheseal scores when the lower limb muscles are analysed as a single unit. The mean entheseal scores are calculated by pooling all scores – weighted averages are not calculated. The younger adult females have higher



CS = Cobern Street
MR = Marina Residence

Figure 5.05: Comparison of the timing of growth insults at the two study sites

	Marina Residence				Cobern Street		
	Females	Males	Unknown	Total	Females	Males	Total
No. with Harris lines	3	15	1	19	9	10	19
No. of Harris lines	7	50	2	59	19	35	54
% Harris lines	15.8	78.9	5.3	100	47.4	52.6	100
No. Harris lines per individual	2.3	3.3	2	3.1	2.1	3.5	2.8

Table 5.14: Summary of Harris line formation

Upper Limb	Female		Male	
	YA	OA	YA	OA
Subscapularis	1.5	3.5	3.0	3.4
Supraspinatus / Infraspinatus	2.0	3.3	2.7	3.3
Pectoralis major	1.3	3.0	2.5	3.3
Latissimus dorsi	1.3	3.0	2.4	2.9
Deltoid tuberosity anterior	2.0	2.5	2.5	3.0
Deltoid tuberosity lateral	1.8	2.3	2.2	2.8
Common extensors	2.3	2.5	2.8	3.0
Common flexors	3.3	3.0	2.4	2.8
MEAN	**1.9**	**2.9**	**2.6**	**3.1**
Lower Limb				
Patellar ligament	4.0	3.5	3.1	3.5
Soleus	4.0	3.2	3.5	3.6
MEAN	**4.0**	**3.3**	**3.3**	**3.6**

YA = younger adult
OA = older adult

Table 5.15: Muscle marking scores for Marina Residence

Upper Limb	Female		Male	
	YA	OA	YA	OA
Subscapularis	2.2	3.3	2.5	3.1
Supraspinatus / Infraspinatus	2.7	3.5	2.5	2.9
Pectoralis major	2.4	3.3	3.0	3.3
Latissimus dorsi	2.8	3.3	3.0	3.3
Deltoid tuberosity anterior	2.6	3.0	2.7	3.0
Deltoid tuberosity lateral	2.7	2.8	2.5	2.9
Common extensors	2.9	2.8	2.5	3.4
Common flexors	2.8	2.8	2.8	3.3
MEAN	**2.6**	**3.1**	**2.7**	**3.1**
Lower Limb				
Patellar ligament	2.8	3.2	2.3	3.4
Soleus	2.8	3.2	2.6	3.4
MEAN	**2.8**	**3.2**	**2.5**	**3.4**

YA = younger adult
OA = older adult

Table 5.16: Muscle marking scores for Cobern Street

muscle grades than the older adult females at Marina Residence. The opposite is true at Cobern Street. The older adult males have higher muscle grades than the younger adult males at both sites. The large standard deviation in the Marina Residence YA and OA females (SD = 1.85) is due to the wider range of scores: the entheses vary from grade 0 to grade 4.

The p-values for the upper limb entheseal sites are shown in tables 5.17 and 5.18. The Mann-Whitney U test shows no significant difference within each age category, between sex and muscle grade when both study sites are combined (Table 5.17). This could be due to the small sample sizes. Despite this, age and sex are important factors when analyzing entheseal attachments and thus the study samples are divided not only into females and males but into younger and older adults too. The Mann-Whitney U test is used to examine the differences between the two sites.

When the upper limb entheses of younger adults are examined, there are no significant differences between the entheseal scores for the males. There appears to be for the younger adult females however, the small sample size of the Marina Residence group prevents statistical analysis. The older adult males and females show no significant differences in their entheseal scores for the upper limb.

The p-values for the lower limb entheseal sites are shown in tables 5.17 and 5.18. The Mann-Whitney U test shows no significant difference within each age category, between sex and muscle grade when both study sites are combined. Once again, despite this, age and sex are important factors when analyzing entheseal attachments and thus the study samples are divided not only into females and males but into younger and older adults too.

When the lower limb entheses of younger adults are examined, there is a significant difference only between the Marina Residence and Cobern Street younger adult males, $p = 0.02$. None of the other categories show significant differences.

When comparing the upper limb entheseal scores to the lower limb entheseal scores, there is a significant difference for the Marina Residence site, $p < 0.01$.

	Both sites combined
UPPER LIMB	
Younger Adult	
females vs males	0.05
Older Adult	
females vs males	0.09
LOWER LIMB	
Younger Adult	
females vs males	0.09
Older Adult	
females vs males	0.06

Table 5.17: Entheses scores – P-values

	MR - CS
Upper Limb	
YA	
males vs males	0.92
YA	
females vs females	~
OA	
males vs males	0.45
OA	
females vs females	0.59
Lower Limb	
YA	
males vs males	0.02*
YA	
females vs females	~
OA	
males vs males	0.26
OA	
females vs females	0.42

YA = younger adult OA = older adult

Table 5.18: Entheses p-values

5.5 Lifestyle and disease stress indicators

5.5.1. Dental Features

5.5.1.1. Dental Attrition

The occurrence of occlusal attrition is examined in adults only. The unsexed individuals are not included in this analysis since age and sex are important variables. The number of individuals (n) is calculated based on the proportion of maxilla and / or mandible present. Individuals represented by only one half of a maxilla or mandible is counted as one quarter of one individual.

In the younger adult category (Table 5.19), the Marina Residence attrition scores for both anterior (1.2) and posterior teeth (2.0) are consistently lower than those of Cobern Street (1.8 and 2.2 respectively) i.e. there is more wear of the teeth at Cobern Street. At Marina Residence, the attrition scores are similar for the anterior (1.2 and 1.9) and the posterior teeth (1.3 and 2.0) in both the females and the males i.e. the wear patterns are similar for both the anterior and the posterior teeth. However, at Cobern Street, the anterior attrition score (2.0 and 2.4) is higher than the posterior attrition score (1.6 and 2.1) i.e. the anterior teeth show a greater degree of wear than the posterior teeth. The attrition scores are lower for the females at both sites i.e. the females' teeth are less worn. The Mann-Whitney U test is employed to compare the two groups to determine if significant differences occur in occlusal wear between individuals of the two sites.

In the younger adult category, there is a significant difference between the Cobern Street and the Marina Residence females, $p < 0.01$. The same applies for the older adult males at both sites. There are no significant differences between the two sites for the younger adult males and the older adult females.

When looking at the anterior and the posterior teeth, in the older adult category (Tables 5.20 and 5.21), attrition scores appear similar for both study sites for males and females. T-tests showed no significant differences in dental attrition between the Cobern Street and Marina Residence older adult males and females, $p = 0.06$ and $p = 0.05$ respectively. There are significant differences for the younger adults at the Marina Residence site, $p < 0.01$. There is no significant difference for the younger adults at the Cobern Street site.

	Marina Residence			Cobern Street		
	Female	Male	Total	Female	Male	Total
n*	4.25	12	16.25	12.75	12.75	25.5
I1	1.3	1.8	1.6	2.0	2.4	2.2
I2	1.1	1.9	1.5	2.0	2.5	2.3
C	1.1	2.0	1.6	2.0	2.2	2.1
PM1	1.8	2.0	1.9	1.8	2.2	2.0
PM2	1.8	1.9	1.9	1.7	2.2	2.0
M1	1.4	2.5	2.0	2.1	2.3	2.2
M2	1.3	2.1	1.7	1.7	2.3	2.0
M3	0.3	1.7	1.0	0.7	1.4	1.1
Anterior Attrition Score	1.2	1.9	1.5	2.0	2.4	2.2
Posterior Attrition Score	1.3	2.0	1.7	1.6	2.1	1.8
Mean Attrition Score	1.2	2.0	1.6	1.8	2.2	2.0

n* = individuals represented by only one half of a maxilla or mandible are counted as one quarter of one individual

Table 5.19: Average stage of occlusal attrition in younger adult dentition

	Marina Residence			Cobern Street		
	Female	Male	Total	Female	Male	Total
n	4	8.75	12.75	5.5	8.5	14
I1	2.4	2.2	2.3	2.3	2.9	2.6
I2	2.5	2.1	2.3	2.2	2.8	2.5
C	2.0	2.3	2.2	2.3	2.7	2.5
PM1	2.2	2.3	2.3	2.0	2.4	2.2
PM2	2.2	2.4	2.3	2.5	2.6	2.6
M1	2.6	2.8	2.7	2.3	2.7	2.5
M2	1.8	2.2	2.0	2.6	2.5	2.6
M3	1.3	2.1	1.7	2.3	2.6	2.5
Anterior Attrition Score	2.3	2.2	2.3	2.3	2.8	2.5
Posterior Attrition Score	2.0	2.4	2.2	2.3	2.6	2.5
Mean Attrition Score	2.2	2.3	2.2	2.3	2.7	2.5

n* = individuals represented by only one half of a maxilla or mandible are counted as one quarter of one individual

Table 5.20: Average stage of occlusal attrition in older adult dentition

	Marina Residence	Cobern Street
Younger Adult		
anterior vs. posterior wear	0.01*	0.05
ave. wear: females vs. males	<0.01*	0.1
Older Adult		
anterior vs. posterior wear	0.4	0.3
ave. wear: females vs. males	0.1	0.1

* significant

Table 5.21 Dental attrition – Probability of age and /or sex affecting dental

Mean attrition score are the highest for the males in both the younger adult and the older adult age categories at both sites with Cobern Street having the overall higher male scores (2.2 and 2.7).

5.5.1.2. Caries Rates

A carious lesion was only recorded when a clear cavity was present. 'False' lesions can appear due to post-mortem depositional damage to the teeth possibly mimicking carious development (Figure 5.06). Tables 5.22 to 5.24 illustrate the caries rate in the Marina Residence and Tables 5.25 to 5.27 in the Cobern Street sites. The number of individuals (n) is calculated based on the proportion of maxilla and / or mandible present. Individuals represented by only one half of a maxilla or mandible is counted as one quarter of one individual.

The number of carious teeth is more than ten percent in all categories except in the Cobern Street younger adult females that is the lowest at 7.1% with the Cobern Street older adult females being the highest at 25%. The average number of carious teeth per mouth is high between 1.9 and 4.7 teeth per mouth with the Marina Residence younger adult males at 4.3 per mouth and the Cobern Street older adult females at 4.7 per mouth being the highest. When the sites are compared, there is a significant difference in the presence of caries between the two sites only for the younger adult males, $p = 0.04$.

When the ages are pooled, the two sites are similar in number of carious teeth per mouth for females, 2.5 and 2.7 for Marina Residence and Cobern Street respectively and males, 3.7 and 3.8 for Marina Residence and Cobern Street respectively.

Tables 5.28 and 5.29 gives a summary of the caries rate per tooth type at Marina Residence and Cobern Street. The males in all age categories have higher caries rates per tooth than the females except for the Cobern Street older adult where the females have a slightly higher rate than the males. At Marina Residence the second molars are the most affected by caries except in the younger adult male category where the third molar was most often affected. The same trend could be seen at Cobern Street.

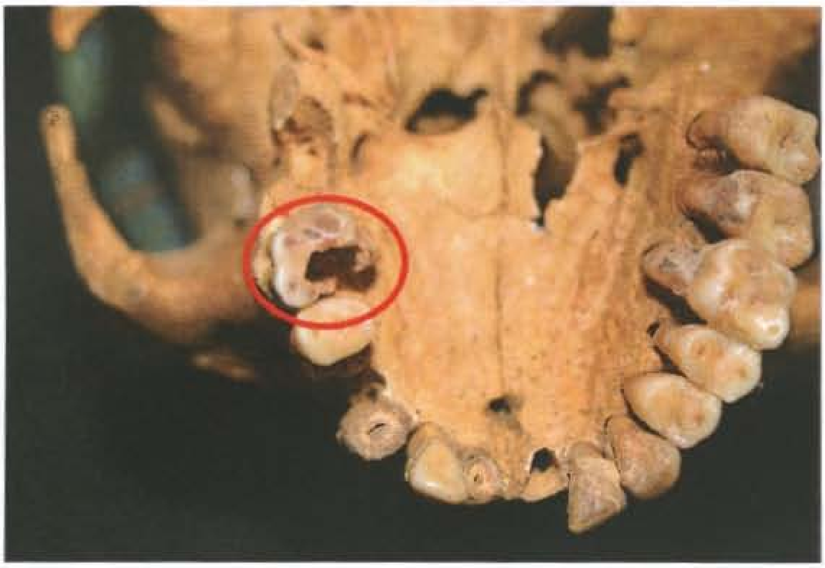


Figure 5.06: UCT 557 - Caries

Younger Adults (20.1 - 40 years)

*n**	Female		Male		Total	
	4.25		*12*		*16.25*	
	No.	%	No.	%	No.	%
No. of carious teeth	10	12.8	52	16.3	62	15.6
No. of individuals with caries	3	70.6	11	91.7	14	86.2
Ave. no. of carious teeth per mouth	2.4	~	4.3	~	3.8	~
Total no of teeth	78	~	320	~	398	~

Older Adults (40.1+ years)

n*	Female		Male		Total	
	4		8.75		12.75	
	No.	%	No.	%	No.	%
No. of carious teeth	11	10.1	25	11.9	36	11.3
No. of individuals with caries	1	25.0	8	91.4	9	70.6
Ave. no. of carious teeth per mouth	2.8	~	2.9	~	2.8	~
Total no of teeth	109	~	210	~	319	~

All ages of Adults

n*	Female		Male		Total	
	8.25		20.75		29	
	No.	%	No.	%	No.	%
No. of carious teeth	21	11.2	77	14.5	98	13.7
No. of individuals with caries	4	48.5	19	91.6	23	79.3
Ave. no. of carious teeth per mouth	2.5	~	3.7	~	3.4	~
Total no. of teeth	187	~	530	~	717	~

YA = younger adults
OA = older adults
n* = individuals represented by only one half of a maxilla or mandible are counted as one quarter of one individual

Tables 5.22– 5.24: Marina Residence – Summary of caries rates

Younger Adults (20.1 - 40 years)

n*	Female 12.75		Male 12.75		Total 25.5	
	No.	%	No.	%	No.	%
No. of carious teeth	24	7.1	46	13.7	70	10.4
No. of individuals with caries	9	70.6	12	94.1	21	82.4
Ave. no. of carious teeth per mouth	1.9	~	3.6	~	2.7	~
Total no of teeth	339	~	337	~	676	~

Older Adults (40.1+ years)

n*	Female 5.5		Male 8.5		Total 14	
	No.	%	No.	%	No.	%
No. of carious teeth	26	25.0	34	16.2	60	19.1
No. of individuals with caries	4	72.7	6	70.6	10	71.4
Ave. no. of carious teeth per mouth	4.7	~	4	~	4.3	~
Total no of teeth	104	~	210	~	314	~

All ages of Adults

n*	Female 18.25		Male 21.25		Total 39.5	
	No.	%	No.	%	No.	%
No. of carious teeth	50	11.3	80	14.6	130	13.1
No. of individuals with caries	13	71.2	18	84.7	31	78.5
Ave. no. of carious teeth per mouth	2.7	~	3.8	~	3.3	~
Total no. of teeth	443	~	547	~	990	~

YA = younger adults
OA = older adults
n* = individuals represented by only one half of a maxilla or mandible are counted as one quarter of one individual

Tables 5.25 – 5.27: Cobern Street – Summary of caries rates

Tooth type	Marina Residence					
	Younger Adults			Older Adults		
	Female	Male	Sexes Pooled	Female	Male	Sexes Pooled
I1	9.1	7.7	8.4	6.7	16.7	11.7
I2	15.4	10.5	13.0	14.3	3.5	8.9
C	9.1	10.9	10.0	7.1	9.4	8.3
PM1	7.7	11.1	9.4	13.3	9.7	11.5
PM2	7.7	15.6	11.6	0	7.1	3.6
M1	20.0	17.1	18.5	7.7	9.5	8.6
M2	40.0	20.0	30.0	16.7	23.8	20.2
M3	0	36.4	18.2	16.7	20.8	18.8
Average	12.8	16.3	14.5	10.1	11.9	11.0

Table 5.28: Summary of caries rates percentage per tooth type for Marina Residence

Tooth type	Cobern Street					
	Younger Adults			Older Adults		
	Female	Male	Sexes Pooled	Female	Male	Sexes Pooled
I1	2.7	0	1.4	0	18.2	91
I2	2.4	8.3	5.4	0	16.0	8.0
C	0	7.1	3.6	0	13.8	6.9
PM1	0	18.8	9.4	4.3	3.5	3.9
PM2	0	27.3	13.6	2.2	3.9	3.0
M1	14.0	50.0	32.0	25.6	18.5	22.1
M2	22.7	42.7	32.8	42.2	38.5	40.3
M3	16.7	62.6	397	31.7	19.2	25.5
Average	7.1	25.0	16.0	13.7	11.4	12.5

Table 5.29: Summary of caries rates percentage per tooth type for Cobern Street

When compared, the total uncorrected caries rate, the caries correction factor (Lukacs, 1995) and the proportional caries correction factor (Erdal& Duyar, 1999) do not show any significant difference data (Table 5.30). However, when the data is separated into anterior and posterior aspects, the uncorrected caries rate and the proportional caries correction factor (Erdal& Duyar, 1999) do show significant differences ($p < 0.02$) for both the anterior and the posterior teeth in the Marina Residence sample. In the Cobern Street sample, the uncorrected caries rate and the proportional caries correction factor (Erdal& Duyar, 1999) show a significant difference ($p < 0.02$) for only the posterior teeth.

The frequency of anterior versus posterior caries is also investigated. The Chi squared test is applied to the two sites to test for significant difference in frequency of caries between anterior and posterior teeth; the younger and older adult females and males are separated. There is a significant difference only for the younger adult males, $p = 0.01$.

5.5.1.3. Antemortem Tooth Loss

The incidence of antemortem tooth loss (AMTL) is analysed using both study groups (Tables 5.31 to 5.36). Only the younger and older adult individuals of known sex and age are used. The number of individuals (n) is calculated based on the proportion of maxilla and / or mandible present. Individuals represented by only one half of a maxilla or mandible is counted as one quarter of one individual.

The Cobern Street older adult females had the most number of teeth lost antemortem, 17.5% and the Cobern Street younger adult males the least at 3.2%. The Marina Residence younger adult females had the most number of individuals with AMTL at 70.6%. There were significant differences between the younger adult males and young adult females, $p = 0.04$ and 0.03 respectively.

The pattern of AMTL for Marina Residence (Table 5.37), in the younger adult category, the females lost the second (28.6%) and third molars (28.6%) most frequently, and the first (14.9%) and second (13.3%) molars in the males. In the older adults, the most frequent AMTL for the females are the second incisor (20.0%), the second (27.3%) and third (25.0%) molars and for males are all the molars (32.3%, 34.5% and 22.6% respectively).

	UNCORRECTED			CORRECTED	
	Number of teeth with caries	Number of observed teeth	Caries Rate (%)	Caries correction factor (%)*	Proportional correction (%)^
Marina Residence					
Anterior teeth	27	271	10.0	9.4	3.5
Posterior teeth	71	446	15.9	14.0	8.8
Total	98	717	13.7	12.3	12.3
Cobern Street					
Anterior teeth	16	350	4.6	4.3	1.6
Posterior teeth	114	640	17.8	15.7	9.8
Total	130	990	13.1	11.8	11.4

* Lukacs, 1995
^ Erdal & Duyar, 1999

Table 5.30: Observed and corrected caries rates – Ages and sex combined

Younger Adults (20.1 - 40 years)

n*	Female		Male		Total	
	4.25		12		16.25	
	No.	%	No.	%	No.	%
No. of teeth lost ante-mortem	10	7.1	34	8.9	44	8.4
No. of individuals with AMTL	3	70.6	7	58.3	10	61.5
Ave. no. of AMTL per mouth	0.02	~	2.8	~	2.7	~
Total no. of tooth places observed	140	~	384	~	524	~

Older Adults (40.1+ years)

n*	Female		Male		Total	
	3		8.75		11.75	
	No.	%	No.	%	No.	%
No. of teeth lost ante-mortem	13	13.5	35	12.5	48	12.8
No. of individuals with AMTL	2	66.7	6	68.6	8	68.1
Ave. no. of AMTL per mouth	4.3	~	4	~	4.1	~
Total no. of tooth places observed	96	~	280	~	376	~

Adults all ages

n*	Female		Male		Total	
	7.25		20.75		28	
	No.	%	No.	%	No.	%
No. of teeth lost ante-mortem	23	9.8	79	11.9	92	10.2
No. of individuals with AMTL	5	69.0	13	62.7	18	64.3
Ave. no. of AMTL per mouth	3.2	~	3.8	~	3.3	~
Total no. of tooth places observed	236	~	664	~	900	~

YA = younger adults
OA = older adults
n* = individuals represented by only one half of a maxilla or mandible are counted as one quarter of one individual

Tables 5.31 – 5.33: Marina Residence – Summary of antemortem tooth loss

Younger Adults (20.1 - 40 years)

n*	**Female** 8.75		**Male** 14.5		**Total** 23.25	
	No.	%	No.	%	No.	%
No. of teeth lost ante-mortem	19	6.8	15	3.2	34	4.6
No. of individuals with AMTL	6	68.6	7	48.3	13	55.9
Ave. no. of AMTL per mouth	2.2	~	1.0	~	1.5	~
Total no. of tooth places observed	280	~	464	~	744	~

Older Adults (40.1+ years)

n*	**Female** 7.5		**Male** 8.5		**Total** 16	
	No.	%	No.	%	No.	%
No. of teeth lost ante-mortem	42	17.5	32	11.8	74	14.5
No. of individuals with AMTL	5	66.7	5	58.8	10	62.5
Ave. no. of AMTL per mouth	5.6	~	3.8	~	4.6	~
Total no. of tooth places observed	240	~	272	~	512	~

Adults all ages

n*	**Female** 16.25		**Male** 23		**Total** 39.25	
	No.	%	No.	%	No.	%
No. of teeth lost ante-mortem	61	11.7	47	6.4	108	8.6
No. of individuals with AMTL	11	67.7	12	52.2	23	58.6
Ave. no. of AMTL per mouth	3.8	~	2.0	~	2.8	~
Total no. of tooth places observed	520	~	736	~	1256	~

YA = younger adults
OA = older adults
n* = individuals represented by only one half of a maxilla or mandible are counted as one quarter of one individual

Tables 5.34 – 5.36: Cobern Street – Summary of antemortem tooth loss

Tooth type	Marina Residence					
	Younger Adults			Older Adults		
	Female	Male	Sexes Pooled	Female	Male	Sexes Pooled
I1	14.3	12.8	13.6	9.1	0	4.6
I2	7.1	7.0	7.1	20.0	6.7	13.3
C	0	2.0	1.0	0	0	0
PM1	13.3	6.3	9.8	0	5.9	2.9
PM2	0	8.0	4.0	18.2	12.1	15.2
M1	9.1	14.9	12.0	18.2	32.3	25.2
M2	28.6	13.3	21.0	27.3	34.5	30.9
M3	28.6	10.6	19.6	25.0	22.6	23.8
Average	12.8	10.6	11.7	16.9	16.7	16.8

Table 5.37: Summary of antemortem tooth loss percentage per tooth type for Marina Residence

Tooth type	Cobern Street					
	Younger Adults			Older Adults		
	Female	Male	Sexes Pooled	Female	Male	Sexes Pooled
I1	5.7	0	2.9	19.2	8.8	14.0
I2	0	0	0	15.4	6.1	10.7
C	0	0	0	14.8	9.1	12.0
PM1	0	0	0	14.3	6.1	10.2
PM2	0	0	0	14.8	20.5	17.7
M1	11.8	3.6	7.7	33.3	17.7	25.5
M2	20.7	5.4	13.0	18.6	21.2	19.9
M3	20.7	17.9	19.3	25.9	13.3	19.6
Average	7.00	3.4	5.2	19.5	12.9	16.2

Table 5.38: Summary of antemortem tooth loss percentage per tooth type for Cobern Street

At the Cobern Street site (Table 5.38), in the younger adult category, the females lost the second (20.6%) and third (20.3%) molars most frequently, and the second molar (17.9%) in the males. In the older adults, the most frequent AMTL for the females are the first incisor (19.2%), the first (33.3%) and third (25.9%) molars and for males are the second premolar (20.5%) and the first (17.7%) and second (21.2%) molars.

On average, the greatest AMTL occurs with the Cobern Street younger adult males (19.5%) and the Marina Residence older adult females and males (16.9% and 16.7% respectively).

When combining caries and AMTL, the diseased missing index (DMI) can be calculated, as missing teeth cannot show caries (Table 5.39). This index gives a clearer indication of dental health.

	Marina Residence	**Cobern Street**
YA Females	7.1	8.6
YA Males	13.5	9.9
OA Females	11.5	10.8
OA Males	8.9	12.5
Average DMI	**10.3**	**10.5**

YA = younger adult
OA = older adult
DMI = diseased missing index

Table 5.39: Comparison of the diseased missing index

The Cobern Street younger adult females and older adult males have higher DMI scores than Marina Residence. The Marina Residence younger adult males and their older adult females have higher DMI scores than their Cobern Street counterparts. However, when considering the average DMI, the scores are basically the same.

5.5.1.4. Dental Abscesses

The number of individuals with dental abscesses (Figure 5.07) is frequent at both study sites, 23.5% for Marina Residence and 33.3% for Cobern Street (Table 5.40). This is significant between individuals with abscesses and those without, p = 0.04 and 0.02 respectively for Marina Residence and Cobern Street. Cobern Street, with a third of individuals affected, has the higher frequency of the two sites (Table 5.42). More females show signs of being affected than do males at Cobern Street (Table 5.42) whereas more males than females show signs of infection at Marina Residence (Table 5.41). Both the younger adult and the older adult age categories showed similar rates of abscessing.

5.5.1.5. Dental Modification

The number of individuals with dental modification is generally less for Marina residence (13.8%) and more for Cobern Street (32.9%) (Table 5.43). Cobern Street has the higher frequency of the two sites. More males show signs of dental modification by filing the teeth than do females in both groups. Both the younger adult and the older adult age categories showed similar rates of dental modification. It is interesting to note that there were two types of dental modification at Cobern Street (Figure 5.08 and 5.09), that involving the lateral borders of the incisors and that involving only the buccal surface of the anterior teeth. Statistical analyses are not feasible due to the small number of individuals affected with dental modification at Marina Residence. There was a significant difference between those with modifications and those without dental modification at Cobern Street, $p = 0.03$.

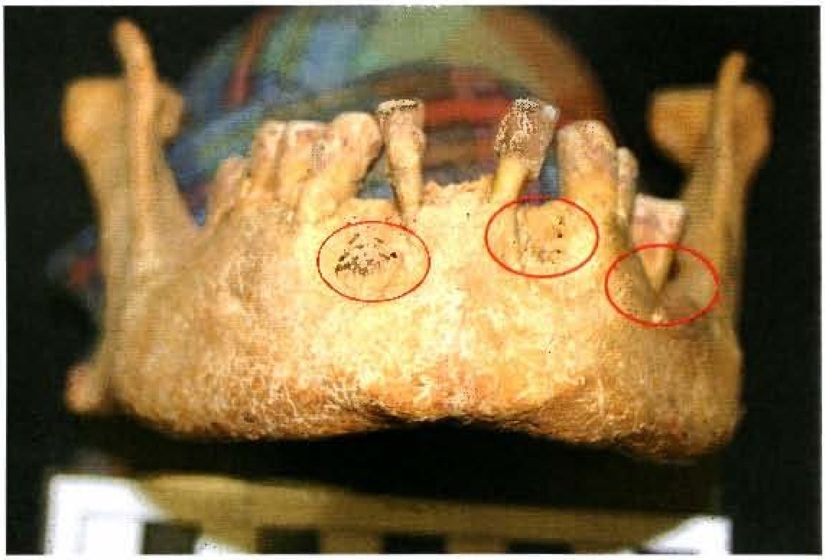


Figure 5.07: UCT 526 – Abscesses at the canine and molar positions

Site	Sex	Age	Position of abscess
Marina Residence			
MR 4	F	40-60	Right mandibular PM2
MR 8	F	45.55	Left maxillary M2
MR 10	F	20-30	Left mandibular M2
MR 13	M	25-40	Right maxillary M1
MR 26	M	40-50	Right mandibular M1 + M3; left maxillary M1 + M3
MR 51	M	30-40	Left mandibular M2 + M3
MR SF 33	M	?	Right maxillary M1 + M3, left M2
Cobern Street			
UCT 490	F	40-50	Right mandibular M1
UCT 491	F	25-30	Right maxillary M2 + M3
UCT 502	F	45-55	Left maxillary PM1 + M1, right PM2
UCT 508	F	40-50	Left mandibular M1
UCT 510	M	25-30	Right mandibular M1 - M3
UCT 511	F	16	Left mandibular M3
UCT 521	M	40-50	Right mandibular PM2
UCT 526	M	50-60	Left mandibular canine + M1 + M3, right canine
UCT 542	F	40-50	Right mandibular PM1 + PM2
UCT 543	M	> 50	Right mandibular PM1 + PM2
UCT 549	M	35-40	Right maxillary M2, left M2 + M3
UCT 550	F	25-35	Right mandibular M1 - M3
UCT 556	F	35-40	Left maxillary M1
UCT 557	M	> 40	Left maxillary M2 + M3
UCT 559	F	20-25	Right maxillary M1

F = female
M = male
MR = Marina Residence
UCT = Cobern Street

Table 5.40: Individuals with dental abscesses

n*	Female 8.25	Male 20.75	Total 29
No. of abscesses	3	10	13
No. of individuals with abscesses	3	4	7
Ave. no. of abscesses per mouth	0.4	0.5	0.5

n* = individuals represented by only one half of a maxilla or mandible are counted as one quarter of one individual

Table 5.41: Summary of dental abscesses at Marina Residence

n*	Female 18.25	Male 21.25	Total 39.5
No. of abscesses	15	15	30
No. of individuals with abscesses	9	6	15
Ave. no. of abscesses per mouth	0.8	0.7	0.8

n* = individuals represented by only one half of a maxilla or mandible are counted as one quarter of one individual

Table 5.42: Summary of dental abscesses at Cobern Street

Site	Sex	Age	Position of dental modification
Marina Residence			
MR 32	M	50-60	Medial and / or lateral incisor border
MR 33	M	25-40	Medial and / or lateral incisor border
MR 48	M	35-45	Medial and / or lateral incisor border
MR48B/49B/50B		?	Medial and / or lateral incisor border
Cobern Street			
UCT 511	F	16	Medial and / or lateral incisor border
UCT 535	J	12	Medial and / or lateral incisor border
UCT 547	M	40	Medial and / or lateral incisor border
UCT 548	M	35-50	Medial and / or lateral incisor border
UCT 558	F	30	Medial and / or lateral incisor border
UCT 510	M	25-30	Medial and / or lateral incisor border
UCT 550	F	25-35	Medial and / or lateral incisor border
UCT 526	M	50-60	Maxillary incisor buccal surface only
UCT 562	M	35-40	Maxillary incisor buccal surface only
UCT 563	F	22-25	Maxillary incisor buccal surface only
UCT 500	M	25-30	Maxillary incisor buccal surface only
UCT 544	F	35-50	Maxillary incisor lingual surface only
UCT 543	M	>50	Maxillary incisor lingual surface only

YA = younger adult
OA = older adult
J = juvenile
F = female
M = male
MR = Marina Residence
UCT = Cobern Street

Table 5.43: Individuals with dental modification

Figure 5.08: UCT 557 - Dental modification

Figure 5.09: UCT 500 - Dental modification on buccal surface only

5.5.1.6. Pipe Smoker's Wear

The number of individuals with pipe smoker's wear (Figure 5.10) is small for both study sites, with Marina Residence at 17.7% and Cobern Street at 15.6% (Table 5.44). Marina Residence has the higher frequency of the two sites. More males show signs of this pattern of dental wear from clutching clay-stemmed pipes between their teeth than do females in both groups. The age category with the greatest number of pipe smoker's wear is the older adults. Statistical analyses are not feasible due to the small number of individuals affected with pipe smoker's wear.

5.5.1.7. Dental anomalies

Table 5.45 show two individuals from Marina Residence had supernumery teeth (5.9%) (Figure 5.11). One individual also from Marina Residence had shovel shaped incisors (2.94%). One individual from Cobern Street had tooth crowding of the mandibular incisors (2.2%) (Figure 5.12). Statistical analyses are not feasible due to the small number of individuals affected.

5.5.2. Skeletal Features

5.5.2.1. Cribra orbitalia

Cribra orbitalia is a lesion located on the orbital roof (Figure 5.13). It is characterized by the pitting of the compact bone on the orbital roof. This was not an easily observable lesion in the Marina Residence and Cobern Street site (Table 5.46) due to the fragmentary nature of many of the skulls. Only five individuals, one child, one sub-adult female, two younger adult males and one older adult female, were observed with cribra orbitalia, two from Marina Residence (6.9%) and two from Cobern Street (7.1%). Statistical analyses are not feasible due to the small number of individuals affected with this pathology.

5.5.2.2. Porotic hyperostosis

Porotic hyperostosis is characterized by the pitting of the compact bone of the skull (Figure 5.14). It is frequently linked with an increase in thickness of the adjacent diploic bone. The lesions are most generally found on the parietal and frontal bones and less frequently on the occipital bone. Only three individuals, one sub-adult female and two younger adult males, were observed porotic hyperostosis (Table 5.47).

Figure 5.10: MR 33 - Pipe smoker's wear

Site	Sex	Age
Marina Residence		
MR 25	M	25-30
MR 26	M	40-50
MR 33	M	25-40
MR 38	F	35-50
MR 43B	M	40-60
MR 61	F	40-60
Cobern Street		
UCT 460	M	20
UCT 498	F	35-40
UCT 501	M	30-40
UCT 508	F	40-50
UCT 518	M	35-40
UCT 547	M	40
UCT 552	M	30-35

F = female M = male
MR = Marina Residence
UCT – Cobern Street

Table 5.44: Individuals with pipe smoker's wear

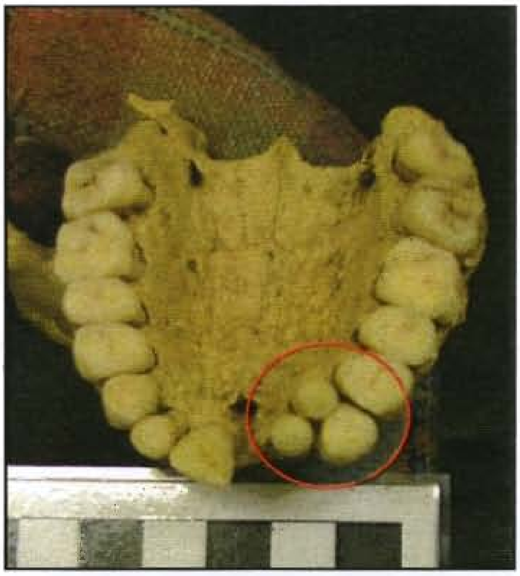


Figure 5.11: MR 56 - Supernumery teeth

Site	Sex	Age	Class	Dental anomaly
Marina Residence				
MR 34	M	20-30	YA	Shovel shaped incisors
MR 56	M	25-40	YA	Supernumery teeth
MR 58	F	30-40	YA	Supernumery teeth
Cobern Street				
UCT 500	M	25-30	OA	Tooth crowding

YA = younger adult
OA = older adult
F = female
M = male
MR = Marina Residence
UCT = Cobern Street

Table 5.45: Individuals with other dental anomalies

Figure 5.12: UCT 500 - Tooth crowding

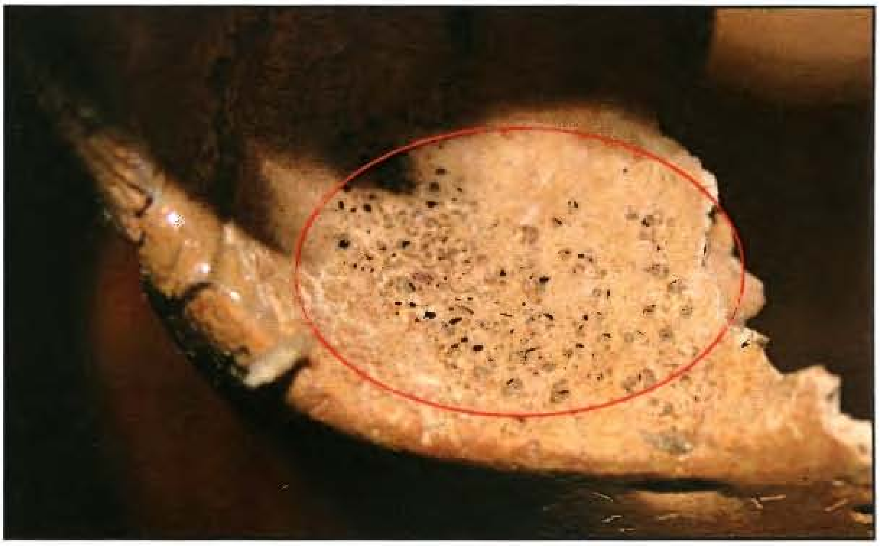


Figure 5.13: UCT 511 - Cribra orbitalia - active

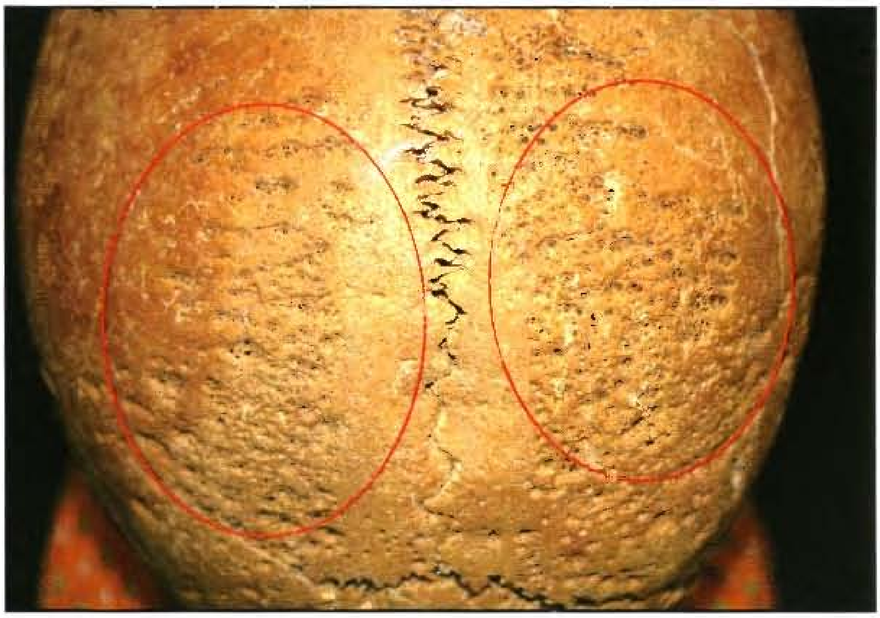


Figure 5.14: UCT 511 - Porotic hyperostosis - active

Site	Sex	Age	Cribra orbitalia
Marina Residence			
MR 46	M	25-35	Cribra orbitalia - inactive
MR 43A	F	30-50	Cribra orbitalia right orbit - inactive
Cobern Street			
UCT 511	F	16	Cribra orbitalia - active
UCT 549	M	35-40	Cribra orbitalia - inactive
UCT 561	I	1	Cribra orbitalia - inactive

I = infant
F = female
M = male

MR = Marina Residence
UCT = Cobern Street

Table 5.46: Occurrence and state of Cribra orbitalia

Site	Sex	Age	Class	Porotic hyperostosis
Marina Residence				
MR 5	M	25-40	YA	Inactive - right parietal only
Cobern Street				
UCT 511	F	16	SA	Active – frontal, parietals & occipital
UCT 549	M	35-40	YA	Inactive – frontal and parietals

YA = younger adult
SA = sub-adult
F = female
M = male

MR = Marina Residence
UCT = Cobern Street

Table 5.47: Occurrence and state of Porotic hyperostosis

One individual was from Marina Residence (3.7%) while the other two were from Cobern Street (4.9%). At Cobern Street, both the individuals suffering from cribra orbitalia also had porotic hyperostosis. Statistical analyses are not feasible due to the small number of individuals affected with this pathological process.

5.5.2.3. Other skeletal pathological processes

Some individuals at both study sites presented with skeletal manifestations of not only infections but other pathological processes too (Tables 5.48 to 5.52). Some of the infections were healed while others were unhealed at the time of death. Periostitis is the inflammation of the periosteum. It can occur in three ways:

1. By extension of the adjacent soft tissue infection to the bone
2. As a manifestation of a generalised disease
3. By the involvement of the surface of the bone from osteitis or osteomyelitis

It is important to note that Periostitis is not always the result of infection. It can be produced from trauma and hemorrhage (Aufderheide & Rodriquez-Martin, 1998).

Four individuals, three from Marina Residence (5.6%) and one from Cobern Street (1.7%), presented with severe periostitis on their tibiae or femora (Table 5.48) (Figure 5.15). One of the individuals from Marina Residence had a partially preserved accompanying skull showing 'caries sicca' lesions (Figure 5.16). These are possible cases of venereal syphilis. The differntial diagnoses for syphilis included (1) the most common lesions are on the parietal and frontal bones of the skull, (2) face can show destructive lsions, (3) most commonly bones affected are tibia, frontal and parietal, sternum, clavicle, vertebrae, femur, humerus, ulna and radius in decreasing order of frequency, (4) lesions are bilateral, (5) periostitis is severe and (6) outer surface of bone is rough and hypervascular (Aufderheide & Rodriquez-Martin, 1998).

Scoliosis is the lateral curvature of the spine with rotation of the vertebral and spinous processes towards the concavity of the curvature (Figure 5.17). The disc spaces are also shortened. The differential diagnosis used for scoliosis included, (1) lateral wedging of the vertebral body at the apex of the curve, (2) asymmetry of the vertebral processes, (3) deviation from the medial plane of the vertebral body and spinous processes and (4) the thoracic vertebrae transverse processes are deflrected backward in the convexity and forward in the concavity (Aufderheide & Rodriquez-

Martin, 1998). Three individuals, two from Cobern Street (3.7%) (Table 5.49) and one from Marina Residence (1.9%) presented with scoliosis.

Tuberculosis (TB) is an acute or chronic infection of soft or skeletal tissues by *Mycobacterium tuberculosis*. It is acquired by inhaling bacilli-laden moisture droplets coughed into the air by a lung-infected human. Thus the disease commonly begins as a respiratory infection. Some bacteria escape to surrounding tissue following bacterial multiplication. More than 40% of skeletal TB lesions involve the spine (Aufderheide & Rodriquez-Martin, 1998) (Figure 5.18). The differential diagnosis for TB included, (1) infection of trabecular bone of the vertebral column, (2) anterior vertebral body erosion, (3) intervertebral disc herniation in adjacent affected vertebrae, (4) abscesses in adjacent vertebral bodies and (5) the adjacent ribs showing similar lesions (Aufderheide & Rodriquez-Martin, 1998). One individual from Cobern Street (1.8%) presented with this anomaly (Table 5.48).

Septic arthritis can be defined as an infection in the synovium by a pathogenic infectious agent that can lead to joint destruction. The enzymes of the infectious agent as well as the white blood cells disrupt the synovium and cartilage, reaching the underlying bone and initiating osteomyelitis and destroying the joint. Ankylosing may be a product of the healing process. Septic arthritis can be differentiated from degenerative joint disease by monoarticular involvement with demonstrable abscesses and fistula as well as the ankylosis (Aufderheide & Rodriquez-Martin, 1998). One (1.8%) younger adult male at Cobern Street (Figure 5.19) represented with septic arthritis with ankylosis (Table 5.48).

Rheumatoid arthritis is a chronic, systemic, inflammatory disease of the synovial joints and connective tissue. Its cause is unknown. Only about two percent of the population is affected of which the overwhelming majority is female (Rogers & Dieppe, 1990, Aufderheide & Rodriquez-Martin, 1998, Sambrook, 2000). One (1.8%) older adult female from Marina Residence (Figure 5.20) presented with possible rheumatoid arthritis in the fusion of a medial and distal phalange (Table 5.49). This could also be septic arthritis or spondyloarthropy.

Site	Sex	Age	Pathological processes
Marina Residence			
MR 22	M	20-40	Infection on the left femur at midshaft - local and healed
MR 6	F	20-35	Infection on humeus and radius - widespread and healed
MR 61	F	40-60	Infection on the left clavicle - widespread and unhealed
MR 4	F	40-60	Infection on femur along linea aspera, widespread and unhealed
MR 55	A	?	Periostitis on tibiae, widespread and unhealed - possible syphilis
MR SF56	M	25-40	Periostitis on femur - possible syphilis
			Depressions on skull are "Caries sicca" - syphilic lesions
MR 62	M	50+	Periostitis on tibiae, widespread and unhealed - possible syphilis
Cobern Street			
UCT 541	M	35-50	Infection on left radius
UCT 501	M	30-40	Periostitis of the right tibia
UCT 549	M	35-40	Periostitis on the tibia
UCT 556	F	35-40	Periostitis on the tibia
UCT 521	M	40-50	Periostitis on the tibiae - possible syphilis
UCT 516	F	17-19	Periostitis on the ulna
UCT 552	M	30-35	Tuberculosis of the spine affecting T6 - T12 and ribs
UCT 501	M	30-40	Fused femur, patella and tibia - Septic arthritis with ankylosis

F = female
M = male
A = osteological adult but unable to be sexed
MR = Marina Residence
UCT = Cobern Street

Table 5.48: Occurrence of infections

Figure 5.15: MR 55 - Periostitis – probable syphilis

Figure 5.16: MR SF56 – Caries sicca lesions on top of skull

Figure 5.17: MR 44 – Scoliosis also confirmed from the bone

Figure 6.18: UCT 552 – Tuberculosis

Site	Sex	Age	Other pathological processes
Marina Residence			
MR 4	F	40-60	Cranial bone thickened – Paget's disease
			Phalanges have arthritic lipping and some are fused together – possible rheumatoid arthritis
MR 41	A	40+	Osteophytic growth on foot bones
MR 43B	M	40-60	Lumbar vertebrae has slight eburnation at articular surfaces
MR 44	F	50-60	Scoliosis
Cobern Street			
UCT 502	F	45-55	Calcification on L4 - upper surface
UCT 544	F	35-50	Heel spurs on left calcaneus
UCT 460	M	20	Left medial cunieform split
UCT 504	M	25	Osteophytes at costo-transverse joints
UCT 556	F	35-40	Osteophytes on soleal line
UCT 500	M	35-45	Pitted roof of acetabulum
UCT 498	F	35-40	Scoliosis
UCT 539	M	40-50	Scoliosis - lumbar spine, lipping an S1
UCT 554	M	35	Split sternum

F = female
M = male
MR = Marina Residence
UCT = Cobern Street

Table 5.49: Other skeletal pathologies found at Marina Residence and Cobern Street

Paget's disease can result from a bone lesion of unknown etiology. It is characterised by a profound increase in both bone resorption and new bone formation. Differential diagnoses include (1) trabeculae thickened by new bone formation in the skull, (2) rapid bone formation of the inner and outer tables as well as the diploë within, (3) new bone is granular in appearance, (4) cancellous bone on the vertebral bodies are denser and more granular in appearance often resulting in vertebral fusion and (5) cortex of the long bones are thicker (Aufderheide & Rodriquez-Martin, 1998). One (1.5%) older adult female from Marina Residence (Figure 5.21) presented with Paget's disease (Table 5.49).

5.5.2.4. Skeletal anomalies

L5 sacralization occurs when the 5th lumbar vertebra is incorporated into the sacrum and the lumbar spine loses a segment (Figure 5.22). The morphological aspect of the sacrum is normal but shows an extra sacral foramen (Aufderheide & Rodriquez-Martin, 1998). One individual from Cobern Street (1.8%) presented with this anomaly (Table 5.50).

Another of the anomalies were flared metaphyses of the distal humeri and septal apertures. A flared metaphysis is the unusual widening of the distal portion of the humerus. A septal aperture is a perforation between the olecranon fossa and coronoid fossa of the distal humerus (Figure 5.23).

Two (5.9%) individuals from Marina Residence and fourteen (37.8%) (Table 5.51) individuals from Cobern Street presented with flared metaphyses of the distal humeri. There was a significant difference between those with flared metaphyses of the distal humeri and those without at Cobern Street, $p = 0.02$.

Six (17.7%) individuals from Marina Residence and five (13.5%) individuals from Cobern Street presented with septal apertures.

The premature fusion of the sagittal suture (Figure 5.24), limits the development of the skull in the transverse direction. Scaphocephaly normally involves only the sagittal suture and has no complications (Aufderheide & Rodriquez-Martin, 1998). One individual from Marina Residence presented with this anomaly (Table 5.51).

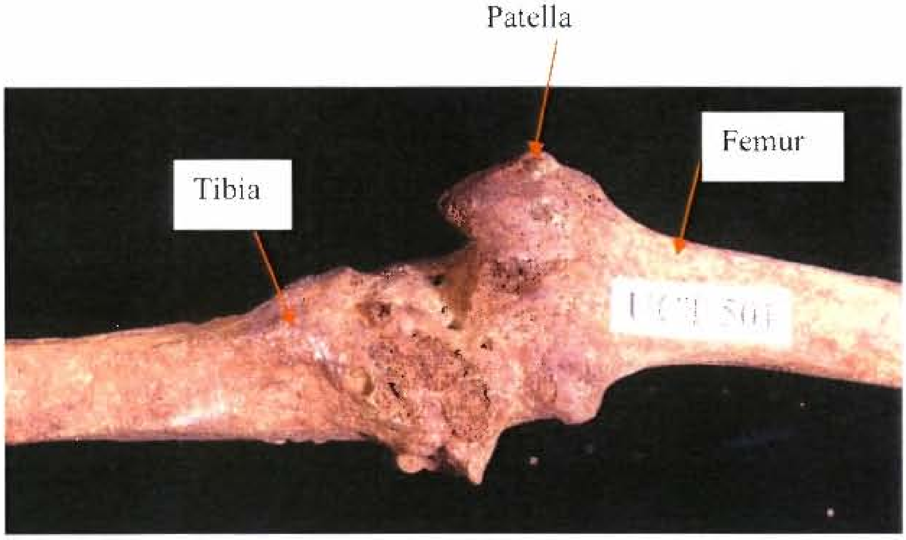


Figure 5.19: UCT 501 - Septic arthritis at the knee

Figure 5.20: MR 4 – Possible rheumatoid arthritis or septic arthritis or spondyloarthropy in the phalanges

Figure 5.21: MR 4 – Paget's disease

Cobern Street	Sex	Age	Other anomalies
UCT 460	M	20	Flared distal humeri
UCT 501	M	30-40	Flared distal humeri
UCT 504	M	25	Flared distal humeri
UCT 508	F	40-50	Flared distal humeri
UCT 510	M	25-30	Flared distal humeri
UCT 522	F	50	Flared distal humeri
UCT 546	F	> 40	Flared distal humeri
UCT 549	M	35-40	Flared distal humeri
UCT 551	M	35-40	Flared distal humeri
UCT 555	F	20-30	Flared distal humeri
UCT 556	F	35-40	Flared distal humeri
UCT 557	M	> 40	Flared distal humeri
UCT 558	F	30	Flared distal humeri
UCT 572.2	M	U	Flared distal humeri
UCT 460	M	20	Trochlear aperture
UCT 499	F	< 40	Trochlear aperture
UCT 500	M	35-45	Trochlear aperture
UCT 510	M	25-30	Trochlear aperture
UCT 514	F	25-35	Trochlear aperture
UCT 460	M	20	Left split medial cuneiform
UCT 526	M	50-60	L5 sacralization

F = female   M = male
UCT = Cobern Street

Table 5.50: Individuals from Cobern Street presenting with flared distal humeri and septal apertures

Figure 5.22: UCT 526 – L5 sacralization

Marina Residence	Sex	Age	Other anomalies
MR 3	M	30-40	Flared distal humeri
MR 6	F	20-35	Flared distal humeri
MR 6	F	20-35	Trochlear aperture
MR 7	SA	~16	Trochlear aperture
MR 8	F	45-55	Trochlear aperture
MR 29	M	40-60	Trochlear aperture
MR 31	M	20-30	Trochlear aperture
MR 61	F	40-60	Trochlear aperture
MR 48	M	35-45	Early sagittal suture closure - Scaphocephaly

F = female
M = male
SA = sub-adult
YA = younger adults
OA = older adults
MR = Marina Residence

Table 5.51: Individuals from Marina Residence presenting with flared distal humeri and septal apertures

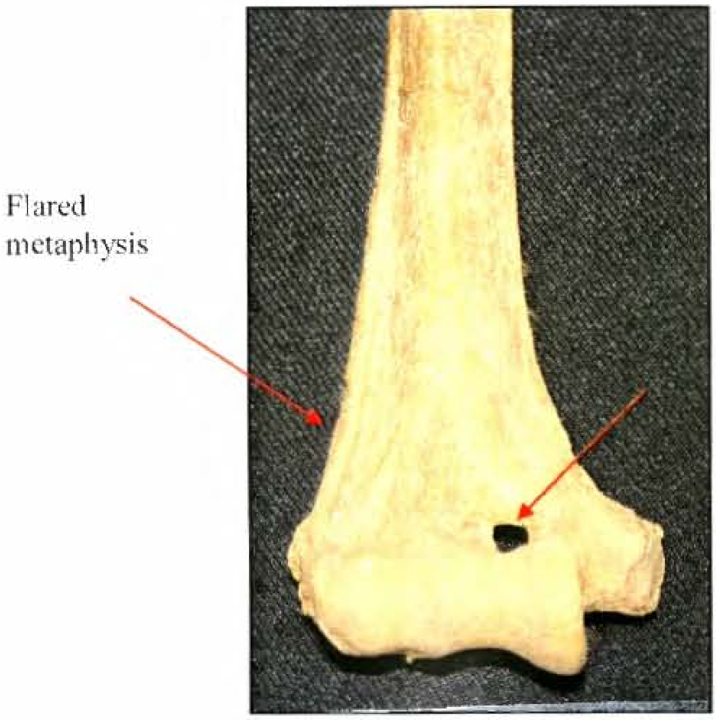


Figure 5.23: MR 6 - Flared distal humerus with septal aperture

Figure 5.24: MR 48 – Early sagittal suture closure

5.5.3. Degenerative Joint Disease

Degenerative joint disease can produce osteoarthritis in both synovial and non-synovial joints. Because of the relatively small numbers of individuals affected with osteoarthritis in each category, the results of the statistical analysis should be treated with caution (Table 5.52, Figure 5.25. In the upper body, only the shoulder and elbow joints are investigated (Tables 5.53 to 5.56). In the lower body only the hip and knee joints are investigated.

At the Marina Residence site, the older adults (65.2%) display a greater frequency of osteoarthritis than the younger adults (34.8%) (Table 5.52). While at the Cobern Street site the opposite is true, 59.5% for younger adults and 40.5% for older adults (Table 5.52) i.e. the younger adults show a greater frequency of osteoarthritis than do the older adults. This is significant for Cobern Street, $p < 0.01$.

In the younger adults category at Marina Residence, more males (41.2%) than females (16.7%) have osteoarthritis. The opposite is true for the older adults, 83.3% for females and 58.8% for males. At Cobern Street, more females (64.3%) than males (54.5%) have osteoarthritis in the younger adult category while the opposite is true for the older adults, 35.7% in females and 43.5% in males.

For the Marina Residence and Cobern Street females and Cobern Street males, the synovial joint most often affected by osteoarthritis was the elbow, whereas in the Marina Residence males it was the hip (Tables 5.53 to 5.56).

Non-synovial osteoarthritis is common in the vertebral column. Intervertebral disc degeneration often results in bone remodeling producing osteophytes on the vertebral bodies. The involved locations are those that are the most frequently flexed: C5-C6, T8-T9 and L4-L5 (Aufderheide & Rodriguez-Martin, 1998).

At both sites, the males had a higher incidence of vertebral osteophytes than the females for all adults (Table 5.57). At the Marina Residence site, all younger adult males and younger adult females had vertebral osteophytes. However this data should be treated with extreme caution, as the total sample size was only three!

	Younger Adults			Older Adults		
	n	No. of specimens with arthritis	%	n	No. of specimens with arthritis	%
Marina Residence			YA			OA
Female	6	1	16.7	6	5	83.3
Male	17	7	41.2	17	10	58.8
TOTAL	23	8	34.8	23	15	65.2
Cobern Street			YA			OA
Female	14	9	64.3	14	5	35.7
Male	23	13	56.5	23	10	43.5
TOTAL	37	22	59.5	37	15	40.5

YA = younger adults
OA = older adults

Table 5.52: Incidence of synovial joint arthritis in younger adults and older adults

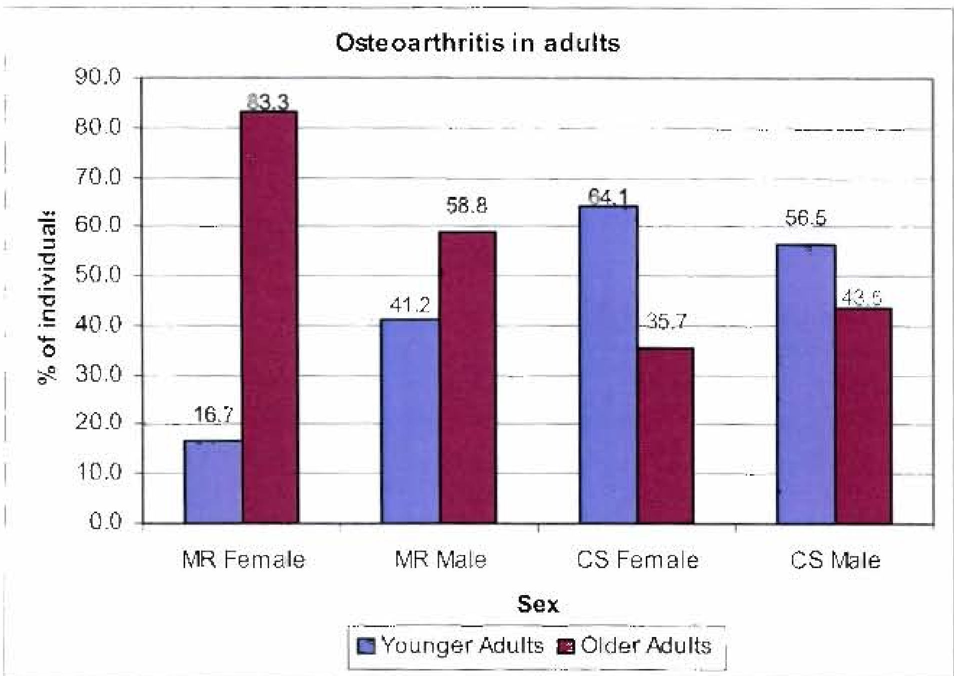


Figure 5.25: Graphic depiction of incidence of synovial joint arthritis in younger adults and older adults

FEMALES	Marina Residence		
Synovial joint	n*	No. of specimens with arthritis	%
UPPER BODY			
Shoulder	12	5	41.7
Elbow	10	5	50.0
Total	22	10	45.4
LOWER BODY			
Hip	8	3	37.5
Knee	3	1	33.3
Total	11	4	36.4
TOTAL	33	14	42.4

n* = total number of synovial joints (includes sub-adults)

Table 5.53: Anatomical location of synovial joint arthritis in the Marina Residence females

FEMALES	Cobern Street		
Synovial joint	n*	No. of specimens with arthritis	%
UPPER BODY			
Shoulder	21	3	14.3
Elbow	22	8	36.4
Total	43	11	25.6
LOWER BODY			
Hip	17	1	5.9
Knee	27	9	33.3
Total	44	10	22.7
TOTAL	87	21	24.1

n* = total number of synovial joints (includes sub-adults)

Table 5.54: Anatomical location of synovial joint arthritis in the Cobern Street females

MALES	Marina Residence		
Synovial joint	n*	No. of specimens with arthritis	%
UPPER BODY			
Shoulder	36	9	25.0
Elbow	36	4	11.1
Total	72	13	18.1
LOWER BODY			
Hip	29	9	31.0
Knee	34	3	8.8
Total	63	12	19.0
TOTAL	135	25	18.5

n* = total number of synovial joints (includes sub-adults)

Table 5.55: Anatomical location of synovial joint arthritis in the Marina Residence males

MALES	Cobern Street		
Synovial joint	n*	No. of specimens with arthritis	%
UPPER BODY			
Shoulder	26	7	26.9
Elbow	23	17	73.9
Total	49	24	49.0
LOWER BODY			
Hip	27	5	18.5
Knee	26	12	46.2
Total	53	17	32.1
TOTAL	102	41	40.2

n* = total number of synovial joints (includes sub-adults)

Table 5.56: Anatomical location of synovial joint arthritis in the Cobern Street males

	n*	No. specimens with osteophytes	%
Marina Residence			
Female	4	3	75.0
Male	8	7	87.5
Total	12	10	83.3
Cobern Street			
Female	7	5	71.4
Male	11	9	81.8
Total	18	14	77.8

n* = total number of complete or nearly complete vertebral columns (15+ vertebrae)

Table 5.57: Incidence of vertebral osteophytes in all adult males and all adult females

	n*	No. specimens with osteophytes	%
Marina Residence			
Female	1	1	100.0
Male	2	2	100.0
Total	3	3	100.0
Cobern Street			
Female	4	2	50.0
Male	7	5	71.4
Total	11	7	63.6

n* = total number of complete or nearly complete vertebral columns (15+ vertebrae)

Table 5.58: Incidence of vertebral osteophytes in younger adult males and younger adult females

	n*	No. specimens with osteophytes	%
Marina Residence			
Female	3	2	66.7
Male	6	5	83.3
Total	9	7	77.8
Cobern Street			
Female	3	3	100.0
Male	4	4	100.0
Total	7	7	100.0

n* = total number of complete or nearly complete vertebral columns (15+ vertebrae)

Table 5.59: Incidence of vertebral osteophytes in older adult males and older adult females

At the Cobern Street site, the incidence of vertebral osteophytes was higher in the younger adult males than younger adult females (Table 5.58). At Marina Residence, the incidence of vertebral osteophytes was higher in the older adult males than older adult females (Table 5.59). At Cobern Street, all older adult males and older adult females had vertebral osteophytes. Once again caution should be exercised, as the sample size is small.

5.5.4. Trauma

The occurrence of trauma in the Marina Residence and Cobern Street sites is analysed (Tables 5.60 and 5.61). Although the numbers of individuals in the various trauma types are small, the overall number of individuals presenting with trauma is quite large for the sample sizes at the sites being analysed. At Marina Residence only males presented with trauma while at Cobern Street the ratio was equal between males and females.

Schmorl's nodes are formed by vertical, vertebral disc herniation (Figure 5.26). The disc extends into the trabecular bone of the vertebral body by protruding through the vertebral surface facing the disc (Aufderheide & Rodriquez-Martin, 1998). These formed the most of the traumatic lesions, with two (3.4%) individuals from Marina Residence and six (10%) individuals from Cobern Street having it (Tables 5.60 and 5.61).

According the Buikstra & Ubelaker (1994), fractures are structural failures resulting the breaking of bone or cartilage. Four examples of healed fractures were seen, two from Marina Residence and two from Cobern Street. These were found on the face, arms and legs.

A total of seven (8.9%) individuals from Marina Residence presented with some form of trauma, all of these were male. Eleven (9.3%) individuals from Cobern Street presented with some form of trauma, the numbers were about evenly divided among males and females. Figures 5.27 to 5.33 demonstrate some the results of the trauma experienced at the two sites.

Burial #	Sex	Age	Trauma
MR 3	M	30-40	C7 & T1 fused
			Schmorl's nodes
MR 5	M	25-40	Left tibia and fibula fused together- ankylosis
			Schmorl's nodes on L4
MR 33	M	25-40	Lumbar vertebrae body posteriorly depressed
MR 43B	M	40-60	Healed fracture of the ulna
			Healed fracture of right orbit
MR 46	M	25-35	Autopsy cut on skull
MR 54	M	50+	Tibia and fibula fused together - ankylosis
			Healed fracture of the clavicle
			Healed fractures of both ulnae
			Left femur has ossification on the side - Myositis ossificans traumatica
			Healed fracture of the radius
MR 63 (i)	M	?	Fused vertebrae - ankylosing spondylitis

M= male
MR = Marina Residence

Table 5.60: Incidence of skeletal trauma at Marina Residence

Burial #	Sex	Age	Trauma
UCT 458	F	17-18	Schmorl's nodes on L5
UCT 498	F	35-40	Ankle injury- fused talus and calcaneus (ankylosis) with periostitic activity
			Schmorl's nodes
UCT 499	F	<40	Schmorl's nodes
UCT 508	F	40-50	Fused foot (ankylosis) - fused calcaneus and navicular
UCT 536	M	35-50	Schmorl's nodes on T8, T10 and L2
UCT 539	M	40-50	Healed fracture - radius
UCT 540	F	40-50	Left ulna - distal fracture not united
UCT 542	F	40-50	Right 5th metatarsal healed, avulsion
UCT 549	M	35-40	Schmorl's nodes
UCT 552	M	30-35	Schmorl's nodes

F = female
M= male
UCT = Cobern Street

Table 5.61: Incidence of skeletal trauma at Cobern Street

Figure 5.26: MR 5 – Scmorl's nodes

Figure 5.27: MR 47 - Healed fracture

Figure 5.28: UCT 540 – Unfused fracture of the ulna

Figure 5.29: UCT 543 – Spondylosis of the thoracic vertebrae

Figure 5.30: UCT 508 - Fused foot, calcaneus and navicular

Figure 5.31: MR 54 – Healed fracture of the clavicle

Figure 5.32: MR 54 – Ankylosis and myostitis ossificans of the distal tibia and fibula

Figure 5.33: MR 5 – Ankylosis of the distal tibia and fibula

5.6 Sexual dimorphism, body size and asymmetry

5.6.1. Sexual dimorphism

Understanding the nature of morphological variation between the sexes has practical applications in physical and forensic anthropology (Schulter-Ellis et al., 1983). The traditional standard method for determining sex from human skeletal remains has been using non-metrical data. However the accuracy of these sex estimations varies between different skeletal elements and different human populations.

Cranial and post-cranial measurements were used to establish sexual dimorphism and asymmetry for Marina Residence and Cobern Street. There are differences between male and female bone lengths and can be shown by the formula put forward by Hamilton (1982) for testing sexual dimorphism:

Degree of sexual dimorphism = [(male mean – female mean) / female mean] X 100

This formula assumes that, in general, males are taller than females within most human populations (Hamilton, 1982) and thus sexual dimorphism is weighted on the female mean. The results convey how much taller the males are to their female counterparts. The differences between female and male stature are analysed to test for the degree of sexual dimorphism in the two study groups. Using the stature mean, the highest degree of sexual dimorphism was found within the Marina Residence site (Figure 5.34) with the males being 11.5% taller than their females. A lesser degree of sexual dimorphism was found at the Cobern Street site (Figure 5.34) where males were only 3.7% taller then their females.

Table 5.62 gives a list of post-cranial features and their sexual dimorphic ratios for the two study sites. Some features are more dimorphic than others. The ratios give positive results for the post-cranial features tested, showing that at the two study sites, the males appear to be larger than the females. Tables 5.63 and 5.64 rank the sexual dimorphic ratios from those features that are more sexual dimorphic to those that are not. The tibia shows more sexual dimorphism at Marina Residence followed by the femur. At Cobern Street various long bones showed similar sexual dimorphic features with the femur midshaft circumference being the most dimorphic feature. There is a significant difference between the post-cranial features for the Marina Residence ratios and the Cobern Street ratios, $p = 0.01$.

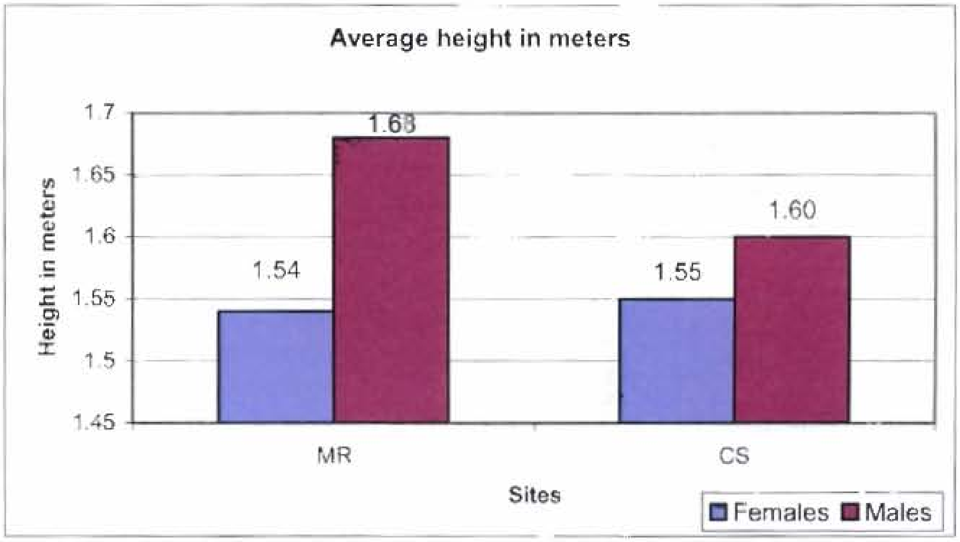


Figure 5.34: Comparison of stature means between Marina Residence and Cobern Street males and females

Post-cranial Feature	Marina Residence ratio	Cobern Street ratio
Upper Limb		
Clavicle max L	3.48	8.60
Humerus max L	8.68	6.17
Humerus epicondylar B	10.38	13.70
Humerus vertical D of head	12.28	10.43
Radius max L	12.47	9.23
Ulna max L	12.39	5.64
Ulna physiological length	9.71	5.13
Ulna min circumference	7.56	11.18
Lower limb		
Sacrum anterior L	1.49	2.47
Femur max L	12.54	1.91
Femur epicondylar B	15.50	8.16
Femur max D head	10.02	8.13
Femur midshaft circumference	10.34	16.83
Tibia L	15.09	4.23
Tibia max prox epiphysis B	27.48	13.83
Tibia circum. nutrient foramen	24.71	5.95
Fibula max L	0.00	3.31
Calcaneus max L	9.38	4.59

L = length
B = breadth
D = diameter

Table 5.62: Post-cranial sexual dimorphism ratios for Marina Residence and Cobern Street

Post-cranial Feature	Marina Residence ratio
Upper Limb	
Radius max L	12.47
Ulna max L	12.39
Humerus vertical D of head	12.28
Humerus epicondylar B	10.38
Ulna physiological length	9.71
Humerus max L	8.68
Ulna min circumference	7.56
Clavicle max L	3.48
Lower limb	
Tibia max prox epiphysis B	27.48
Tibia circum. nutrient foramen	24.71
Femur epicondylar B	15.50
Tibia L	15.09
Femur max L	12.54
Femur midshaft circumference	10.34
Femur max D head	10.02
Calcaneus max L	9.38
Sacrum anterior L	1.49
Fibula max L	0.00

L = length
B = breadth
D = diameter

Tables 5.63: Ranked post-cranial sexual dimorphism ratios for Marina Residence

Post-cranial Feature	Cobern Street ratio
Upper Limb	
Humerus epicondylar B	13.70
Ulna min circumference	11.18
Humerus vertical D of head	10.43
Radius max L	9.23
Clavicle max L	8.60
Humerus max L	6.17
Ulna max L	5.64
Ulna physiological length	5.13
Lower limb	
Femur midshaft circumference	16.83
Tibia max prox epiphysis B	13.83
Femur epicondylar B	8.16
Femur max D head	8.13
Tibia circum. nutrient foramen	5.95
Calcaneus max L	4.59
Tibia L	4.23
Fibula max L	3.31
Sacrum anterior L	2.47
Femur max L	1.91

L = length
B = breadth
D = diameter

Tables 5.64: Ranked post-cranial sexual dimorphism ratios for Cobern Street respectively for Marina Residence males and females; and 7.4 and 9.2 for Cobern Street males and females respectively.

Face & Mandible	MR Ratio	CS Ratio
Max B outside condyles	4.4	2.4
Bigonial B	8.8	12.0
Mental foramen B	2.0	6.8
Symphyseal H	11.2	1.2
Mandibular angle	-0.7	-2.6
Bizygomatic B	5.1	6.2
Upper facial H	1.6	5.2
Orbital B	13.5	1.6
Orbital H	-6.4	-1.8
Nasal H	-1.0	1.1
Nasal B	4.0	5.6
Max alveolar B	2.5	4.1
Prostion-basion L	9.9	5.6
Bimaxillary B	6.7	3.3

L = length
B = breadth
H = height
MR = Marina Residence
CS = Cobern Street

Table 5.65: Cranial sexual dimorphism ratios for Marina Residence and Cobern Street

Face & Mandible	MR Ratio
Orbital B	13.5
Symphyseal H	11.2
Prostion-basion L	9.9
Bigonial B	8.8
Bimaxillary B	6.7
Orbital H	-6.4
Bizygomatic B	5.1
Max B outside condyles	4.4
Nasal B	4.0
Max alveolar B	2.5
Mental foramen B	2.0
Upper facial H	1.6
Nasal H	-1.0
Mandibular angle	-0.7

Face & Mandible	CS Ratio
Bigonial B	12.0
Mental foramen B	6.8
Bizygomatic B	6.2
Nasal B	5.6
Prostion-basion L	5.6
Upper facial H	5.2
Max alveolar B	4.1
Bimaxillary B	3.3
Mandibular angle	-2.6
Max B outside condyles	2.4
Orbital H	-1.8
Orbital B	1.6
Symphyseal H	1.2
Nasal H	1.1

L = length
B = breadth
H = height
MR = Marina Residence
CS = Cobern Street

Tables 5.66 and 5.67: Ranked face and mandible sexual dimorphism ratios for Marina Residence and Cobern Street

Vault	MR Ratio
Bi-mastoid B	8.2
Basibrag H	4.2
Bi-temporal B	-3.1
Max cran B	2.4
Max cran L	0.4

Vault	CS Ratio
Bi-temporal B	6.1
Bi-mastoid B	5.6
Basibrag H	4.6
Max cran B	2.1
Max cran L	1.4

L = length
B = breadth
H = height
MR = Marina Residence
CS = Cobern Street

Tables 5.68 and 5.69: Ranked cranial vault sexual dimorphism ratios for Marina Residence and Cobern Street

	Marina Residence	Cobern Street	Anova p-values*
FEMALES			
FEMUR	-	-	0.31
n	6	11	
mean (mm)	406.8	411.2	
SD	20.2	30.3	
Stature (mm)	1541	1544	
TIBIA	-	-	< 0.001
n	2	14	
mean (mm)	322.5	345.4	
SD	2.1	24.2	
HUMERUS	-	-	0.30
n	7	14	
mean (mm)	296.9	291.3	
SD	15.3	17.8	
RADIUS	-	-	0.77
n	9	14	
mean (mm)	221.4	222	
SD	14.4	16	
MALES			
FEMUR	-	-	<0.001
n	19	19	
mean (mm)	453.5	426.4	
SD	23.9	19.2	
Stature (mm)	1682	1600	
TIBIA	-	-	0.37
n	19	17	
mean (mm)	370.9	363.2	
SD	20.9	19.8	
HUMERUS	-	-	<0.001
n	20	15	
mean (mm)	323.3	300.7	
SD	16	13.2	
RADIUS	-	-	0.14
n	21	18	
mean (mm)	252.8	243.6	
SD	16.6	18	

*ANOVA comparison of both samples combined

Table 5.70: Long bone lengths for individuals 20+ years

Site	Sex	Bonferroni test
Marina Residence vs Cobern Street	Females	0.24
Marina Residence vs Cobern Street	Males	< 0.001
Marina Residence	Females vs Males	< 0.001
Cobern Street	Females vs Males	0.06
Marina Residence vs Cobern Street	Sexes pooled	< 0.001

Table 5.71: Significant differences within and between study groups

Burial #	Sex	Femur Length in cm	Generic regression in cm
MR 21	F	38.4	147.2
MR 24	F	39.5	150.5
MR 38	F	40.0	152.0
MR 44	F	43.7	163.2
MR 58	F	42.6	159.9
MR 61	F	39.9	151.7
MR 23	M	47.0	173.2
MR 25	M	50.8	184.6
MR 27	M	43.2	161.7
MR 28	M	43.4	162.3
MR 29	M	48.6	178.0
MR 31	M	46.1	170.5
MR 33	M	42.7	160.2
MR 37	M	45.4	168.3
MR 46	M	44.7	166.2
MR 48	M	44.0	164.1
MR 5	M	47.0	173.2
MR 50	M	45.7	169.2
MR 52	M	41.7	157.2
MR 52 not art.	M	44.7	166.2
MR 54	M	44.0	164.1
MR 56	M	42.3	159.0
MR 62	M	45.7	169.2
MR SF52	M	45.6	168.9
MR SF56	M	49.0	179.2

M = male
F = female
MR = Marina Residence

Table 5.72: Height determination from femur length at Marina Residence

Burial #	Sex	Femur Length in cm	Generic regression in cm
UCT 502	F	37.2	143.6
UCT 516	F	38.1	146.3
UCT 531	F	38.2	146.6
UCT 458.1	F	39.4	150.2
UCT 556	F	39.4	150.2
UCT 563	F	41.0	155.1
UCT 461	F	41.6	156.9
UCT 499	F	42.6	159.9
UCT 514	F	42.8	160.5
UCT 547	F	46.0	170.2
UCT 555	F	46.0	170.2
UCT 559.2	M	38.2	146.6
UCT 552	M	40.2	152.6
UCT 500	M	40.8	154.5
UCT 551	M	41.0	155.1
UCT 526	M	41.2	155.7
UCT 562	M	41.5	156.6
UCT 509	M	42.0	158.1
UCT 539	M	42.2	158.7
UCT 557	M	42.6	159.9
UCT 460	M	42.8	160.5
UCT 543	M	42.8	160.5
UCT 501	M	43.0	161.1
UCT 554	M	43.2	161.7
UCT 519	M	43.8	163.5
UCT 549	M	44.3	165.0
UCT 536	M	44.6	165.9
UCT 548	M	45.0	167.1
UCT 541	M	45.4	168.3
UCT 510	M	45.6	168.9

M = male
F = female
UCT = Cobern Street

Table 5.73: Height determination from femur length at Cobern Street

The diaphyseal femur lengths of the individuals under the age of 20 years could not be illustrated due to the fragmentary nature of the skeletal remains, which made possible reconstruction of the femur diaphysis unfeasible. This growth curve would hopefully have shown a normal biological development that as the individual age, their femur length would also increase until epiphyseal closure.

5.6.3. Asymmetry

With the same genetic and nutritional input, one assumes that there is symmetry between the left and right sides of the body. However, the tendency for individuals to use the same limb for most manual tasks results in bilateral asymmetry. This asymmetry has come to serve as the basis for deducing hand preference in skeletal remains (Blackburn & Knüsel, 2006). Following the assessment of the post-cranial skeletons from the study sites, the measurements were standardized by means of the 1995 Steele & Mays equation:

$$\text{Asymmetry standardized} = \frac{R - L}{(R + L)/2} * 100$$

R = right side
L = left side

This equation serves to provide a measure of both the direction and the degree of asymmetry expressed in each individual bone.

Table 5.74 show asymmetry in the females and males from the Cobern Street and Marina Residence sites respectively. The positive results show a right-sided dominance over the left side. The negative results show a left-sided dominance over the right side.

The Cobern Street females showed the most asymmetry in the vertical head diameter of the humerus and humerus epicondylar breadth. In contrast the males showed greater asymmetry in the femur midshaft circumference and the femur antero-posterior midshaft diameter.

The Marina Residence females showed the most asymmetry in the antero-posterior clavicular diameter and the femur epicondylar breadth while for the males it was in the humerus maximum diameter at midshaft and the supero-inferior diameter

Feature	Cobern Street Female	Cobern Street Male	Marina Residence Female	Marina Residence Male
Clavicle max L	2.3	1.4	0.2	-2.5
Clavicle A-P D	-2.8	2.4	6.4	3.7
Clavicle S-I D	3.5	-0.9	3.0	-4.3
Humerus max L	2.8	2.6	1.3	4.0
Humerus epicondylar B	5.7	5.1	4.4	-1.1
Humerus vertical D of head	5.1	0.2	-2.4	2.8
Humerus max D midshaft	4.5	3.7	5.6	5.8
Humerus min D midshaft	0.5	1.1	0.3	4.1
Radius max L	-0.4	2.5	1.9	0.5
Radius A-P D	4.4	1.1	0.8	7.5
Radius M-L D	-0.7	0.0	5.1	2.3
Femur max L	1.6	-0.6	-2.7	-0.9
Femur epicondylar B	0.3	-0.2	5.9	-4.9
Femur max D head	2.3	-2.5	1.5	-4.1
Femur A-P subtrochanter D	0.2	2.9	3.6	-0.7
Femur M-L subtrochanter D	1.7	0.7	-1.2	-0.8
Femur A-P midshaft D	1.6	5.9	5.0	0.7
Femur M-L midshaft D	-2.5	-2.9	-2.3	-1.9
Femur midshaft circumference	4.2	6.8	-0.1	-1.2
Femur S-I neck D	2.5	0.4	1.8	-0.7
Tibia L	-0.8	0.0	0.3	0.1
Tibia max prox epiphysis B	0.0	3.1	-4.6	0.0
Tibia max distal epiphysis B	2.0	4.7	7.8	1.1
Tibia M-L D nutrient foramen	-2.6	-4.3	1.0	0.6
Tibia A-P D nutrient foramen	-0.1	-0.7	-0.5	-0.6
Tibia circum. nutrient foramen	2.6	7.0	4.5	-0.5

B = breadth
L = length
D = diameter
A-P = antero-posterior
M-L = medio-lateral
S-I = supero-inferior

Table 5.74: Asymmetry means for the two study sites.

of the clavicle. Thus both sites differed in their most asymmetrical features for both males and females. T-tests showed this is significant, $p = 0.03$.

When looking at the upper limb versus the lower limb (Table 5.75), the right arm was slightly longer than the left arm, pointing to a possible limb preference. This left and right side differences proved significant only in the males, $p = 0.2$ and $p= 0.4$ for Cobern Street and Marina Residence respectively. With regards to the lower limb, the left side was slightly longer than the right except for the Cobern Street females. This was not significant. The intermembral indices also favoured the right side.

When looking at possible levels of robusticity, in most cases, the right side appeared more robust than the left side (Table 5.76).

When comparing the means for the two study sites, the females showed no significant differences, however the male means were significant, $p < 0.001$. When comparing the males versus females (t-tests) within the study sites, both sites were significant, $p < 0.001$.

5.7 Summary of Results

The age and sex distributions at the two study sites were very different from each other. Because of the differential levels of preservation of the skeletal material, some skeletons proved easier to sex and age than others. Using various different methods to age and sex the individuals also provided a greater degree of accuracy when assigning age and sex, especially to those individuals who had too few skeletal remains to be sexes and aged by the standard visual methods. The histological method surrendered surprisingly good results.

The mortality profiles were very different for the two study sites with Cobern Street fitting a normal mortality curve and Marina Residence not.

Although both study samples had the same number of individuals with Harris lines, the timing of the appearance of the lines as well as the line density differed between the two sites.

The musculoskeletal stress markers were different for the older and younger adults, possibly attesting to a difference in the type of activities they were involved in. There were differences between the two study sites.

	Cobern Street				Marina Residence			
	Female		Male		Female		Male	
	Left side	Right side	Left side	Right side	Left side	Right side	Left side	Right side
Humerus + Radius	500.5	507.7	531.4	545.2	511.8	519.7	561.3	575.3
Femur + Tibia	766.2	770.4	784.2	781.8	725.8	716.0	825.3	821.5
Intermembral Index	65.3	65.9	67.8	69.7	70.5	72.6	68.0	70.0

Table 5.75: Limb lengths and intermembral indices for the two study sites

Circumference / Length	Cobern Street				Marina Residence			
	Female		Male		Female		Male	
	Left side	Right side	Left side	Right side	Left side	Right side	Left side	Right side
Femur	16.7	17.1	19.0	20.4	21.0	21.5	20.8	20.7
Tibia	20.8	21.5	20.8	22.3	25.3	26.4	26.3	26.1

Table 5.76: A measure of robusticity for the lower limb

Dental attrition, caries rates and antemortem tooth loss were different within and between sites and also within and between younger and older adults. There were also differences between the anterior and posterior teeth. A marked number of individuals also exhibited dental abscesses, dental modification and pipe smoker's wear at both study sites.

Several skeletal pathologies, anomalies and different types of trauma were found in both study sites.

Osteoarthritis was widespread and not confined to the older adult individuals. The younger adults also exhibited signs that allude to possible heavy labour at a younger age.

Both sites showed some degree of sexual dimorphism and asymmetry. The values were differential at both sites. The Marina Residence males were significantly taller than not only the Cobern Street males but also the females at both sites.

Chapter 6

DISCUSSION

The data presented in the Results chapter allow us to reconstruct life history from mortality patterns, activity patterns, growth and palaeopathology. Mortality will only be discussed in terms of mortality profiles, as the population samples used for this study are not large enough to calculate life expectancy or other palaeodemographic features.

The Cobern Street site has been previously studied in terms of burial patterns (Apollonio, 1998), isotopic analysis and diet (Cox, 1999), biomechanical beam analysis of the long bones (Ledger, et al., 2000) and degenerative joint disease (Joshua, 2004). Various preliminary papers were presented at the 27th Annual conference of the Anatomical Society of South Africa (ASSA) in 1997. What has made this project different is not only the ability to draw all these data together, but to add new knowledge on this cohort of skeletal material and include the Marina Residence material.

Comparative sites are employed to either show comparable or different patterns and thus possible explanations for the results. In this way, a more comprehensive understanding of these burials in Cape Town is revealed. The comparative samples include prehistoric populations such as Oakhurst, K2 with Mapungubwe, Toutswe, dry savanna, wet savanna and forest; proto-historic populations such as Griqua, Riet River and Kakamas; historic populations such as Colesberg, Wolmaransstad, American slave populations and African mining migrant labourers; and medieval Dutch and British populations. They include foragers, pastoralists, African agriculturalists, historic poor and European historic farmers. These populations can further be divided according to their subsistence strategy:

Prehistoric South African foragers:

- Oakhurst hunter-gatherers also dependent on marine resources (Patrick, 1989, Sealy et al., 1992)
- Riet River hunter-gatherers with pastoral activities (Morris, 1984)

Prehistoric and early historic South African pastoralists:

- Griqua pastoralists also growing agricultural products (Peckmann, 2002)
- Kakamas pastoralists (Morris, 1984)

Prehistoric African agriculturalists:

- Dry savanna agriculturalists with cattle (Dlamini, 2006)
- Wet savanna agriculturalists (Dlamini, 2006)
- Forest agriculturalists (Dlamini, 2006)
- Toutswe agriculturalists (Mosothwane, 2003)
- K2 and Mapungubwe agriculturalists (Steyn, 1994)

Historic poor communities:

- Colesberg agriculturalists and domestic workers (Peckmann, 2002)
- Wolmaransstad agriculturalists (Peckmann, 2002)
- Migrant mine labourers (Van der Merwe, 2006)
- South Carolina slave population (Rathbun, 1987)
- New York African burial ground (Blakey & Rankin-Hill, 2004)
- New Orleans urban slave population (Owsley et al., 1987)
- Dutch 'Sint Janskerkhof' burials (Maat et al., 2002)
- Newton Plantation slaves, Barbados (Corruccini et al., 1982)
- First African Baptist Church (ex-slaves and free born) (Angel et al., 1987)
- Catoctin Furnace industrial slaves, Maryland (Kelley & Angel, 1983)
- Cedar Grove, Arkansas (Rose, 1985)
- Suriname slaves (Khudabux, 1991)

European comparative populations:

- Dutch medieval populations (Maat et al., 1998)
- British medieval populations (Roberts & Manchester, 1997)
- Spitalfields (Molleson et al., 1993)

The expectation would be that the closest comparisons will be the historic poor from other South African and slave sites, but we require as broad a contest as possible in order to best understand what we see.

6.1 Technical Challenges

The accurate estimation of age and sex in fragmentary or poorly preserved skeletal material often presents a challenge to any researcher. This is the reason it is important according to Grauer & McNamara (1995) to use multiple techniques for ageing and sexing skeletal material as well as refining these techniques allow researchers to successfully achieve a greater degree of accuracy. These same challenges were present when analyzing the Marina Residence and Cobern Street skeletal samples as some of the specimens were well preserved and others were fragmentary and poorly preserved. Multiple techniques were employed with some garnering more success than others.

6.1.1. Age estimation

The determination of age at death of an individual is important to any skeletal investigation. Standard anthropological methods can give systematically biased distributions of adult age at death (Hoppa & Vaupel, 2003). Bocquet-Appel & Masset (1996) and Aykroyd et al. (1977) stated that there is an inherent inaccuracy and unreliability of all age estimation techniques because of the low correlation between skeletal age and chronological age. There was systematic tendency for age estimates regardless of the physiological indicator employed, to assign ages, which are too high for young individuals and too low for older individuals (Angel, 1969, Black, 1978). Iscan and Loth (1989) also argued that the differences between skeletal age and chronological age might increase as we go back in time. However, some of these problems of the standardization if age, are addressed when past skeletal samples of known age becomes available for study e.g. the Spitalfields project (Molleson et al., 1993) but these are few and far between. In view of this, Brooks & Suchey (1990) states that whenever possible multiple indicators of age should be employed as it is essential in obtaining the most precise age estimate available. This is precisely the decision made when studying the Marina Residence material, especially in the light that not many of the skeletons were complete. The fragmentary nature of the skeletal material especially the skulls and pelves, traditionally used to macroscopically age and sex individuals made this an extremely difficult exercise.

Traditional gross morphological assessment is still the dominant methodology in age estimation, but increasing interest has risen in the microscopic analysis of age changes on the histological level. Although histological techniques have the advantage of covering a wide adult age range spanning more than six decades, they also have some serious drawbacks, the most obvious of which is the mandatory destruction of bone (İşcan, 1988). Estimation of age at death from skeletal remains can be done with relative precision when the skeleton is not only complete but well preserved as well. As age estimates are based on multiple indicators, incomplete or poorly preserved skeletal remains do pose a problem (Stout, 1992, 1996, 1998, Stout et al., 1994).

The main reason for including this section in this thesis was not to develop standards for estimating age by using bone microstructure but to test the accuracy of the available standards and to establish a narrower range for the age-at-death estimated through macroscopic methods. As most of the excavated skeletons are incomplete, this would be an alternate technique of establishing age at death for incomplete skeletal material as the dependability of the macroscopic techniques is reduced.

We know that skeletal structures follow different growth patterns. Growth is the process through which bone increases in size by increasing the number of cells and the intercellular material between them (Stout, 1996). Bone modeling depends on growth and subsides at maturity. At maturity, although bone does not alter much in terms of size and shape it continues to remodel. Microscopic techniques measure the progression of bone remodeling that occurs at a comparatively steady pace within the cortical bone during ones life (Maat et al., 2003). This is because the internal structure of bone continually reconstructs itself as it enlarges (Stout, 1989). Remodeling results from the mechanical stress placed on bone during life (Ruff, 1992).

The anterior midshaft of the femur is used for the analysis as it is the most resistant to taphonomic deterioration. Its cortical surface is biomechanically stable and little influenced by traction of muscle attachments. To assess the age-dependent bone replacement for the prediction of age, only the percentage of non-remodeled surface in transverse sections has been counted. This counted area is equivalent to the area covered by osteons, osteon fragments and resorption canals, but it is easier to view and thus less time consuming to count (Maat, et al. 2006). Bone replacement during ageing results in a gradual decrease of the percentage of non-remodeled circumferential lamellar bone.

Although excellent results were obtained from the bone histology, it was not without any problems. The original methodology had to be adjusted a few times to accommodate the fact the this was not very well preserved archaeological bone. The bone was extremely porous and as such thicker sections had to be cut. Consultations with various histologists and Professor Maat resulted in cyanoacrylate ("super glue") being embedded in the bone, however when a certain thickness was reached, the specimens were still breaking. After four trials and its associated errors it was eventually decided to embed the bone in an epoxy resin, however one of the stages in this process failed i.e. the vacuum stage had not embedded the resin consistently throughout the bone making it impossible to cut the specimens on a microtome and the slices were cut in a rock-slicing machine and manually sanded down to the desired thickness for viewing. Counting the osteons and osteon fragments had to be done between sanding down the sections as most of the slices were uneven. It thus became a case of sanding down, view and sand down to view the next section, in most cases destroying the previous section viewed. Despite these frustrations, the results were gratifying and bone histology should be a standard method employed to estimate age in skeletal material.

6.1.2. Sex estimation

Reconstruction of biology and behaviour of past populations relies on accurate determination of sex from bony elements. Considerable overlap in the size and degree of robusticity in male and female skeletons complicates the determination of sex. Environmental and behavioural influences on robusticity also result in incorrect determination of sex (Meindl et al., 1985, Walrath et al., 2004). The accurate estimation of sex was important especially when comparing activity patterns, dental disease and stress patterns among and between males and females. As previously stated, as most of the excavated skeletons are incomplete and fragmentary, alternate techniques for estimating sex had to be applied.

The two techniques chosen were the femoral neck method by Seiderman et al., (1998) and the distal humeri method by Rogers (1999). The two regions studied is said to have higher intact preservation than the femoral head and humeral head respectively.

The femoral neck method developed by Seiderman et al., (1998) and tested by Frutos (2003) has a reported 87 – 92 % accuracy as it relies on the size difference in the femoral neck. This study did not find this to be true. The method gave 100% accuracy for the Cobern Street females but only a 66.7% for Marina Residence females and 82.2% accuracy for Marina Residence males but only predicted 57.5% of Cobern Street males correctly. Thus, three of the four samples yielded results well below the reported results. The difference between what was reported and this study could well be as a result of activity patterns and sexual dimorphism changes with age. This was corroborated by a similar study currently being done on the age changes in the human skeleton and its implication for the metric determination of sex (Ms V Wanek Vance, personal communications, 2007).

The distal humeri method developed by Rogers (1999) has a reported 80% accuracy and relies on the sexual dimorphism of the distal humerus. Better results were obtained using this method. An above average accuracy of 91,9% was found at Cobern Street compared to the 73.5% for Marina Residence which was slightly below average. The discrepancy between the results could possibly be that the Cobern Street males and females are more sexually dimorphic than their Marina Residence counterparts. With the better results obtained using the Rogers method, these were the sex estimates used and applied to the skeletal material throughout the analyses. This method complemented the standard visual macroscopic methods set out by Buikstra & Ublaker (1994).

6.1.3. Analysis of disease

According to Ortner (1998), infectious disease undoubtedly has played a significant role in the evolution of modern humans. Thus, archaeological human remains offer insight into some aspects of this process, but interpreting the evidence is challenging since some of the potential factors affecting the process are unknown and those that are known are difficult or impossible to control.

Skeletal involvement in infectious disease occupies a transitional position on the continuum of the immune responses that ranges from rapid death at one end to complete recovery with no adverse complications or lingering effects at the other.

The important, and paradoxical, point is that the human body needs a relatively good immune response to have bone involvement from infection, but not too good as so to allow recovery with no skeletal involvement (Ortner, 1998, Aufderheide & Rodriquez-Martin, 1998).

Factors that affect the expression of infectious disease include, age, nutritional status, immune response, point of entry of the disease and the effectiveness of the subsequent treatment. Only a small percent of individuals who have an infectious disease will exhibit evidence of the disease in the gross anatomy of the skeleton. This means that in a skeletal sample, those skeletons showing evidence of infection may not be representative of all the individuals in the total sample who have had infectious disease. Virtually all the infectious disease encountered in human skeletal remains is the result of chronic conditions in which the patient survived the disease for many years and skeletal involvement was late in the disease process (Ortner, 1998). The study of the skeleton for disease nearly always gives a static picture of the individual only at the time of death (Allison et al., 1974). Recognition of the extent of disease and disability also provides insights to the community in which they lived. Identification of disease is predicted on identifying all alterations in osseous structure by reactive bone formation or remodeling (Rothschild, 1992).

6.1.3.1. Infectious disease

Most infectious disease rarely leaves any traces on skeletal material. However some infectious disease do affect the skeleton and these tell us much about human adaptation to their environment. Some infectious diseases that affect the skeleton may be mild while others are acute (Goodman & Martin, 2002, Ortner, 2003). Inflammation in bone is a general response to the presence of an infectious agent. This inflammation can affect the outer surface, compact bone or the inner surface of the bone. Osteitis is used to describe compact bone inflammation. Osteomyeltis is used to describe an infectious condition that starts in the marrow cavity and affects the inner (endosteal) surface. Periostitis is an inflammation within the periosteum that will primarily affect the outer surface of bone (Ortner, 2003).

Periostitis is the most common undifferentiated, non-specific, lesion found on long bones in archaeological skeletons. However, periostitis has both a common descriptive usage as a term and a discrete usage (Ortner, 2003). Thus, periostitis is part of a disease syndrome such as syphilis, but it is also a specific disease itself. Periostitis can be of a primary or secondary nature. Primary periostitis is most often the result of two pathological conditions, trauma and infection. It is often difficult to determine which of the two conditions gave rise to the lesion in an archaeological setting. The periosteum is also activated during a fracture, but periosteal reaction can also be stimulated by injury that does not produce fracture such as localised infection foci (Mensforth et al., 1978, Mann & Murphy, 1990, Larsen, 1997, Ortner, 2003).

6.1.3.2. Non-specific indicators of pathological processes

Some pathological conditions, like dental caries and syphilis, leave very specific lesions on bone and others do not. Nutritional deficiencies and environments with a high pathogenic load can leave non-specific markers on bone (Roberts & Manchester, 1997, Buzon, 2006). Nevertheless, these non-specific markers are also important indicators of stress in a population because findings concerning prehistoric populations can be related to the course of certain phenomena observed in contemporary populations (Ribot & Roberts, 1996, Hoppa, 1992). The difficulty comes when trying to accurately identify different pathological conditions in ancient osteological remains when these different pathological conditions have similar osteological manifestations (Byers & Roberts, 2003).

These problems occurred frequently when trying to identify disease processes in the Marina Residence and Cobern Street samples. Often diagnoses could not go beyond the terms "infection" or "periostitis" as the markers were either too non-specific or too few and fragmentary skeletal remains were present.

6.2 Reconstructing Life History at the Cape

6.2.1. Mortality Patterns

The system of slavery had an enormous impact on the demography of the population at the Cape. This system determined the distribution and numbers of certain populations and in doing so affected their fertility, mortality, morbidity and longevity. In turn, these factors shaped the ability of these people to adapt to their new environment. This was an environment that not only included the surrounding physical environment, but also the cultural environment – the system of slavery and / or poverty. Were the Marina Residence and Cobern Street groups a reflection of the living population of the Cape during that time? And similarly, were the mortality patterns of the skeletal populations comparable to other cemetery populations?

According to Weiss (1973) the general pattern for mortality as seen in historical human populations from death records and excavated cemeteries should include high infant and juvenile mortality (~20%), lower sub-adult mortality (~14%) and higher younger adult (~16%) and older adult mortality (~45%). These data are taken from cemetery excavations collected over time and thus involve ageing from skeletal material. Only the Cobern Street site represents this 'normal' mortality profile for historic populations, as there are relatively larger numbers of infants and juveniles (in comparison to Marina Residence), fewer sub-adults and more adults. There are also more males (n = 37) than females (n = 26) at this site. In contrast, the Marina Residence site does not represent a 'normal' mortality profile for historic populations. There are twice as many sub-adults (n = 4) than infants (n = 1) and juveniles (n = 1). There is also more than twice the amount of males (n = 52) than females (n = 20). This sex discrepancy (2.6 females to every male) at the Marina Residence site is not likely to reflect excavation bias and is therefore indicative of a different demographic dynamic from the Cobern Street site (Table 6.01). Damon (1964) states that women have higher morbidity i.e. they are often sicker for longer periods whereas men have a higher mortality at all ages. But why were so few women, children, juveniles and sub-adults found at the Marina Residence site?

Site	**Sex Ratio M : F**	**Source**
Cobern Street	1.4 : 1	This study
Marina Residence	2.6 : 1	This study
Riet River	1.2 : 1	Morris, 1984
Kakamas	1.1 : 1	Morris, 1984
K2 and Mapungubwe	1 : 1	Steyn, 1994
Gladstone	5.6 : 1	Van der Merwe, 2006
Suriname	2 : 1	Khudabux, 1991

Table 6.01: Comparison of sex ratios

The sex ratio of Cobern Street has a similar pattern to that displayed by the Morris (1984) samples of Riet River and Kakamas and the Steyn (1994) sample of K2 and Mapungubbwe i.e. the male to female ratio was more or less equal. However, it can be noted that the slave population of Suriname (Khudabux, 1991) and the Gladstone samples showed similar unequal male to female number discrepancies as Marina Residence. Khudabux (1991) explained this inequality by saying that either there was a surplus of male slave importation to Suriname and / or there was a high mortality rate for males. He further explains that this higher male mortality rate proved true for the British Caribbean were a high number of widowed women were recorded as a result of this higher male mortality. He also noted that from other slave plantations until 1822, 80% of slaves imported were male (Khudabux, 1991). Furthermore, the Gladstone population represents a migrant labour scenario where the men came from other areas to work in the diamond mines at Kimberley, thus explaining the inequality of its male to female ratio there.

The death demographics in an archaeological site do not automatically characterize the greater population living at the time (Howell, 1986, Owsley et al., 1987, Grauer & McNamara, 1995). The only characteristics shared by all the subjects are their burial in the same cemetery. The distribution of adult skeletons produced by palaeodemographic studies is biased. The mortality profile findings thus essentially mirror the distribution of a reference sample used to age the skeletal sample (Bocquet-Appel & Masset, 1996) and there is often a lack of living populations with similar demographic structures as these are created from skeletal populations (Angel, 1969, Johansson & Horowitz, 1986, Bocquet-Appel & Masset, 1996). A possible explanation for the sex discrepancy at Marina Residence could be that this burial site was connected to the building of the harbour and these were the labourers that died or that this site was connected to the hospital and more men were dying. Thus there would be fewer children and juveniles present. A cemetery represents the people who have died, not those who are still alive. Thus, skeletal samples are not really an accurate representation of all individuals.

The original preliminary examination of the Cobern Street site material suggested it could have included convicts; there was a shackle around one individual's ankle and people brought into the Cape as possible labourers or slaves because dental modifications were found on some individuals and it is known that dental modification by filing was not practiced at the Cape during the 18th and early

19th centuries (Apollonio, 1998). At the Marina Residence site, many were buried without coffins, possibly indicating a poor community, a few of whom could have possibly been slaves because they also exhibited some dental modification in the form of filing.

It is difficult to compare this study to any other studies as the entire community was not convicts, nor were they all possibly slaves. They were all poor. They represent the non-indigenous population of the Cape at the time.

According to Laidler & Gelfand (1971), people living at the Cape rarely exceeded 50 years and vast numbers died between the ages of 40 and 50 years. The age of 60 was rarely exceeded. The average adult age at death for the Cobern Street cohort was 36.9 years for the males and 30.8 years for the females; and 43.2 years for Marina Residence males and 45.6 years for their females. Only known males and females adults were used to calculate these averages, adults of indeterminate sex were disregarded.

Site	Mean Age at Death			Source
	Males	Females	Average	
Cobern Street	36.9	30.8	33.9	This study
Marina Residence	43.2	45.6	44.4	This study
Riet River *	35.3	35	35.2	Morris, 1984
Kakamas *	33	32.6	32.8	Morris, 1984
K2 and Mapungubwe *	38.3	29.6	33.9	Steyn, 1994
Newton Plantation, Barbados	~	~	29.3	Corruccini et al., 1982
South Carolina Plantation	35	40	37.5	Rathbun, 1987
New York African Burial Ground	38	35.9	37	Blakey & Rankin-Hill, 2004
First African Baptist Church, Philadelphia	44.8	38.9	41.9	Angel et al., 1987
Catoctin Furnace, Maryland	41.7	35.2	38.5	Kelley & Angel, 1983
St Peter Street, New Orleans	20-24	40-49	~	Owsley et al., 1987
Cedar Grove, Arkansas	41.2	37.7	39.5	Rose, 1985
Gladstone *	32.4	35	33.7	Van der Merwe, 2006

* Estimated averages calculated from excavation data

Table 6.02: Comparison of adult mean age at death for various sites

Comparison of the adult mean age at death (in years) for males and females (Table 6.02) yields some favourable results. The Cobern Street males are similar to the K2 and Mapungubwe (Steyn, 1994) and the New York African Burial Ground (NYABG) (Blakey & Rankin-Hill, 2004) groups, while the Marina Residence males are comparable to the Catoctin Furnace (Kelley & Angel, 1983), Cedar Grove (Rose, 1985) and First African Baptist Church (FABC) (Angel et al., 1987) groups. The Cobern Street females are shows similarity to the K2 and Mapungubwe (Steyn, 1994) and Kakamas (Morris, 1984) groups, while the Marina Residence females are comparable to the St Peter Street (Owsley et al., 1987) group. When one looks at the overall adult mean age at death, the Cobern Street site is comparable to the Kakamas (Morris, 1984), K2 and Mapungubwe (Steyn, 1994) and Gladstone (Van der Merwe, 2006) sites. The Marina Residence site is comparable to the FABC (Angel et al., 1987) non-slave group. The different overall adult mean age at death for Cobern Street and Marina Residence shows that there are different selective pressures working on the two populations. The Cobern Street group could be involved in harder labour that negatively influences their lifespan, which might not be the case for the Marina Residence group.

It is important to know the sex of a skeleton regardless of its state of preservation. Great accuracy can be attained through molecular analyses of bone (Safont et al., 2000), however this is beyond the scope of this thesis. According to Hoppa (2000) and Müller et al., 2002, a fundamental assumption made by skeletal biologists is that both the pattern and rate of age-related morphological changes observed in modern reference populations are not significantly different than in past populations. Thus estimates of individual age from human remains must assume uniformity (Bello et al., 2006).

6.2.2 Lifestyle and Activity Patterns

6.2.2.1. Activity patterns and Musculoskeletal stress markers

Musculoskeletal stress markers (MSSM) are muscle markings found on the surface of bones. Activity related or occupational stress is one of the keys to understanding the daily lives of our ancestors. Many methods have been used to explore activity-related stress in the skeleton, such as osteoarthritis, but none are as movement specific as musculoskeletal stress markers. These are changes involving bone formation or lytic processes at entheses, which are the attachment sites for muscle, tendon and ligament to bone (Hendersen & Gallant, 2007). Because MSSM are directly related to the soft tissues that move the skeleton, they are perceived to be the best indicator of limb movement and have been widely utilised and discussed as indicators of activity related stress (Angel et al., 1987, Hawkey, 1988, Jurmain, 1980, Mann & Murphy, 1990, Robb, 1994, Steen & Lane, 1998, Molnar, 2006, Hendersen & Gallant, 2007). The study of activity related MSSM formation has the potential to highlight differences in activity levels in past populations. These differences can provide information on e.g. social hierarchies and changes in lifestyle relating to changes in subsistence strategies (Eshed et al., 2004, Hawkey & Merbs, 1995, Hendersen & Gallant, 2007).

Markers of occupational stress are one expression of bone plasticity under pressure of external and internal forces that are not attributable to disorders of disease, metabolism, biochemistry, hormonal and enzymatic imbalances and vascular disorders (Kennedy, 1989, 1998, Robb, 1994). The idea that bone form reflects in some way its mechanical loading history during life is fundamental to many palaeontological and bioarchaeological studies of skeletal material. While physical context and material culture give clues to past behaviour, analysis of the skeletons themselves is the most direct way to reconstruct individual behaviour (Ruff, 1992, Ruff, et al., 2006). The degree of the expression of these MSSM is related to activity (duration) and influenced by age, sex, metabolism and nutrition (Wilczak, 1998, Knüsel et al., 1996, Ledger et al., 2000, Robb, 1994, Sanders, 2001).

Wolff's Law of Transformation describes responses of bone to mechanical forces whereby remodeling takes place in order to resist stress. This occurs so that the load may be dissipated and lowered per unit area. The results of severe and prolonged stress form the marker of occupational stress that can be observed macroscopically (Kennedy, 1989, Stirland, 1998). Average skeletal development of all muscle sites in a skeleton is tied primarily to the individual's age. Deviations from the norm within and between skeletons may be linked to activities performed even when specific activities cannot be deduced. This gives us information about ways of life and social organisation of activities. One of the primary functions of the skeleton is to anchor and provide leverage for the muscles. Muscular action can affect the skeleton in several ways. As traction and biomechanical forces stimulate bone growth, the bony architecture of the body remodels to support functional stresses and provide adequate areas of muscle attachment. Accumulated micro-trauma at the site of muscle origins and insertions leave traces in the form of surface markings. The accumulated micro-trauma can lead to the formation of bony muscle markings. These muscle markings are not a discontinuous phenomenon but form a continuous range of surface markings. Muscle markings begin to accumulate only after the bone has finished its growth, regardless of lifestyle. Biologically this is probably due to the fact that during immaturity the muscle insertion site continually migrates as the bone grows. From biological maturity through to about 50 years, muscle scores progressively increase (Robb, 1994).

Sex and age are important factors when analyzing MSSM's (Tables 5.15 to 5.18). Robb (1994), Sanders (2001) and Peckmann (2002) found statistically significant relationships between muscle score and age of the individual i.e. muscle markings increased steadily through the adult life span. This did not coincide with the present study and was instead similar to Ledger et al., (2000) who found no significant relationship between expression of muscle markings and age of the individuals for Cobern Street. This could be due to the small sample sizes and a narrower age range for the available samples. Robb (1994), Ledger et al., (2000) and Peckmann, (2002) demonstrate significant differences in the degree of MSSM scores between males and females, this is inconsistent with this project.

The diet breadth model to predict labour intensity among prehistoric Khoisan peoples was used by Churchill & Morris (1998). They suggest that the lower limb reflect "foraging mobility" and the upper limb "handling costs". Stock & Pfeiffer (2004) also states that the terrain in which one is working will dictate the loading intensity of the muscle on the bone and thus dictate limb robusticity. Also, the differences in the intensity of the labour will result in variable limb robusticity. The high leg MSSM scores for the Marina Residence site thus suggests that both the males and the females were involved in 'search costs' (Table 6.03), especially the Marina Residence younger adult females. In contrast, at Cobern Street, the younger adult females have high arm MSSM scores while the older adult males have high legs scores. The younger females were 'processing items' and the older men were involved in 'search costs'. The younger adult males and the older adult females have similar scores. Thus they were equally involved in 'search and processing'.

	Marina Residence	Cobern Street
YA Males	legs	arms
YA Females	legs	similar
OA Males	legs	similar
OA Females	legs	legs

Table 6.03: Highest entheseal scores for the various groups

When comparing the present study to the Peckmann (2002) study (Table 6.04), there are many similarities and differences. The younger adult males from Marina Residence show a similar pattern of the legs having the highest muscle marker scores. In the younger females, the Cobern Street sample is more similar to the 2002 study. For the older adult males, Marina Residence is more similar to the Griqua and Wolmaransstad samples and both the Cobern Street and the Colesberg samples are different. The Cobern Street, Marina Residence and Colesberg samples are similar for the older adult females but different from the Griqua sample. According to Peckmann (2002), the Griqua were growing gardens, hunting and some also kept livestock, the Colesberg men were involved in agricultural labour activities and their women were employed as domestic servants, the Wolmaransstad men were associated with animals and livestock pens while their women were responsible for cultivation, harvesting and preparing food. Thus the Marina Residence and Cobern Street males and females would be involved in similar activities i.e. cultivation of the Company or private gardens, harvesting and working with livestock. The similar enthuseal scores seen in tables 6.05 and 6.06 corroborate this.

Musculoskeletal stress marker lesions at the loci of muscular insertions are caused by hypertrophy of the relevant muscles forming rough patches, irregularities and osteophytes on bone. These may be induced by mechanical strain from forces external to the body as with carrying heavy burdens on the head. The harder physical labour in which men engage imposes greater musculoskeletal robusticity upon bones, the sizes of which may be under genetic or hormonal factors. Since greater force is placed upon areas of muscle insertion than on areas of muscle origin, those portions of tubular bones bearing insertions are characteristically more robust (Kennedy, 1989). A conceivable explanation for the sex and age related differences is not only a

	Marina Residence	Cobern Street	Griqua*	Colesberg*	Wolmaranstad *
YA Males	legs	arms	legs	legs	legs
YA Females	legs	similar	similar	arms	same
OA Males	legs	similar	legs	arms	legs
OA Females	legs	legs	arms	legs	~

* Data from Peckmann (2002)

Table 6.04: Highest enthuseal scores with comparative data

	Marina Residence		Cobern Street		Griqua*		Colesberg*		Wolmaransstad*	
	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males
UPPER LIMB										
Subscapularis	1.5	3.0	2.2	2.5	3.0	2.8	3.4	2.5	~	4
Supraspinatus / Infraspinatus	2.0	2.7	2.7	2.5	2.6	3.0	2.8	2.0	~	~
Pectoralis major	1.3	2.5	2.4	3.0	3.0	3.0	3.0	2.0	~	4
Latissimus dorsi	1.3	2.4	2.8	3.0	2.9	2.9	2.7	2.2	~	4
Deltoid tuberosity anterior	2.0	2.5	2.6	2.7	2.5	3.0	2.5	2.8	3.0	4.5
Deltoid tuberosity posterior	1.8	2.2	2.7	2.5	2.5	3.0	2.6	2.8	3.0	4.5
Common extensors	2.3	2.8	2.9	2.5	3.2	3.4	3.0	4.0	~	4
Common flexors	3.3	2.4	2.8	2.8	2.7	3.4	~	~	~	4
MEAN	**1.9**	**2.6**	**2.6**	**2.7**	**2.8**	**3.0**	**2.8**	**2.6**	**3.0**	**4.2**
LOWER LIMB										
Patellar ligament	4.0	3.1	2.8	2.3	2.9	3.1	2.1	2.5	~	4.5
Soleus	4.0	3.5	2.8	2.6	2.7	3.5	2.7	3.3	3.0	4.5
MEAN	**4.0**	**3.3**	**2.8**	**2.5**	**2.8**	**3.3**	**2.5**	**3.1**	**3.0**	**4.5**

* Data from Peckmann (2002)

Table 6.05: Comparison of musculoskeletal markers in younger adults

	Marina Residence		Cobern Street		Griqua*		Colesberg*		Wolmaransstad*	
	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males
UPPER LIMB										
Subscapularis	3.5	3.4	3.3	3.1	3.9	3.3	~	2.0	~	4.5
Supraspinatus / Infraspinatus	3.3	3.3	3.5	2.9	3.7	3.0	~	~	~	4.0
Pectoralis major	3.0	3.3	3.3	3.3	3.9	3.0	~	~	~	4.0
Latissimus dorsi	3.0	2.9	3.3	3.3	3.7	2.9	2.0	3.0	~	4.0
Deltoid tuberosity anterior	2.5	3.0	3.0	3.0	3.6	2.8	3.0	4.0	~	4.0
Deltoid tuberosity posterior	2.3	2.8	2.8	2.9	3.6	2.8	3.0	4.0	~	4.0
Common extensors	2.5	3.0	2.8	3.4	3.7	2.9	~	~	~	4.5
Common flexors	3.0	2.8	2.8	3.3	3.8	3.0	~	~	~	4.5
MEAN	**2.9**	**3.1**	**3.1**	**3.1**	**3.7**	**2.9**	**2.7**	**3.3**	**~**	**4.2**
LOWER LIMB										
Patellar ligament	3.5	3.5	3.2	3.4	2.9	3.5	2.0	2.0	~	4.0
Soleus	3.2	3.6	3.2	3.4	3.0	3.4	4.0	3.0	~	4.5
MEAN	**3.3**	**3.6**	**3.2**	**3.4**	**2.9**	**3.5**	**3.0**	**2.5**	**~**	4.3

* Data from Peckmann (2002)

Table 6.06: Comparison of musculoskeletal markers in older adults

division of labour between the sexes, but also of changing workloads in different time periods of a person's life. If not taken into consideration, the increase of entheseal reactions with age may limit the prospects of detailed interpretations of prehistoric specific activities based on MSSM data (Molnar, 2006).

6.2.2.2. Degenerative joint disease

Both diarthrodial and amphiarthrodial joints may be affected by degenerative joint disease (DJD). Diarthrodial joints are also known as synovial joints and they allow flexibility and movement of the body. The amphiarthrdial joints allow stabilization at a bone junction through fibrocartilage connections e.g. intervertebral discs and pubic symphysis.

Osteoarthritis is slowly progressive and demonstrable bone changes are preceded by alterations of the articular cartilage (Steinbock, 1976, Roberts & Manchester, 1997, Goodman & Martin, 2002, Ortner, 2003). There are two types of osteoarthritis. Primary osteoarthritis tends to occur in later life as a result of multiple factors, including biomechanical stress and trauma. Secondary osteoarthritis develops early in life in joints that are abnormal because of other pathological conditions e.g. metabolic problems or increased prolonged physical activity. Secondary osteoarthritis may also occur inlater life as a result of malaligned fractures. There may also be a genetic predisposition to osteoarthritis (Steinbock, 1976, Roberts & Manchester, 1997, Larsen, 1997, Mays, 2000, Ortner, 2003)

The condition is most likely to occur in adults over the age of 40 years (Steinbock, 1976, Aufderheide & Rodriquez-Martin, 1998). Three major components are involved in the skeletal pathology of osteoarthritis. This includes the breakdown of articular cartilage, which may result in bone on bone contact and abnormal abrasion of the subchondral bone, resulting in reactive bone formation both in the subchondral compact bone and in the trabeculae underlying the affected subchondral compact bone, this is often followed by new bone and cartilage growth at the joint margins (osteophytes) (Steinbock, 1976, Roberts & Manchester, 1997, Aufderheide & Rodriquez-Martin, 1998, Ortner, 2003).

The elbow, hip and knee joints are the most commonly involved, and lesions are often seen bilaterally in dry bones (Steinbock, 1976, Roberts & Manchester, 1997, Aufderheide & Rodriquez-Martin, 1998). Spinal osteoarthritis occurs in almost

	Marina Residence		Cobern Street		Griqua*		Colesberg*		Wolmaransstad*	
	Females	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**	**Males**
UPPER LIMB										
Subscapularis	3.5	3.4	3.3	3.1	3.9	3.3	~	2.0	~	4.5
Supraspinatus / Infraspinatus	3.3	3.3	3.5	2.9	3.7	3.0	~	~	~	4.0
Pectoralis major	3.0	3.3	3.3	3.3	3.9	3.0	~	~	~	4.0
Latissimus dorsi	3.0	2.9	3.3	3.3	3.7	2.9	2.0	3.0	~	4.0
Deltoid tuberosity anterior	2.5	3.0	3.0	3.0	3.6	2.8	3.0	4.0	~	4.0
Deltoid tuberosity posterior	2.3	2.8	2.8	2.9	3.6	2.8	3.0	4.0	~	4.0
Common extensors	2.5	3.0	2.8	3.4	3.7	2.9	~	~	~	4.5
Common flexors	3.0	2.8	2.8	3.3	3.8	3.0	~	~	~	4.5
MEAN	**2.9**	**3.1**	**3.1**	**3.1**	**3.7**	**2.9**	**2.7**	**3.3**	**~**	**4.2**
LOWER LIMB										
Patellar ligament	3.5	3.5	3.2	3.4	2.9	3.5	2.0	2.0	~	4.0
Soleus	3.2	3.6	3.2	3.4	3.0	3.4	4.0	3.0	~	4.5
MEAN	**3.3**	**3.6**	**3.2**	**3.4**	**2.9**	**3.5**	**3.0**	**2.5**	**~**	4.3

* Data from Peckmann (2002)

Table 6.06: Comparison of musculoskeletal markers in older adults

division of labour between the sexes, but also of changing workloads in different time periods of a person's life. If not taken into consideration, the increase of entheseal reactions with age may limit the prospects of detailed interpretations of prehistoric specific activities based on MSSM data (Molnar, 2006).

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The elbow, hip and knee joints are the most commonly involved, and lesions are often seen bilaterally in dry bones (Steinbock, 1976, Roberts & Manchester, 1997, Aufderheide & Rodriquez-Martin, 1998). Spinal osteoarthritis occurs in almost everyone over the age of 40 (Ortner, 2003). It is thus the most common form of joint pathology (Aufderheide & Rodriquez-Martin, 1998).

6.2.2.2.1. Osteoarthritis

Analysis of the skeletal manifestations of labour-related changes may reveal sex and locational distinctions as can be seen from the musculoskeletal markers study as well as the study of changes at the synovial joints. There are gender differences for arthritic changes such as lipping. They vary by the joints involved. Degeneration was more common in the elbow joints followed by the shoulder joints for Marina Residence females. If these women were involved in domestic labour, the activities surrounding this labour type could result in this form of joint degeneration. By contrast, for their males, osteoarthritis was more common at the hip joint followed by the shoulder joint. The males were thus more involved in lifting objects and walking. The Cobern Street males and females experienced more osteoarthritis in their elbow joints followed by their knee joints. This could be indicative of lifting and bending work such as agricultural labour using a hoe and axe. Degenerative joint disease is positively associated with age within all major joints investigated. However, the relative effects of age vary between joints, being of greater importance in the hip and shoulder than in the knee and elbow. The shoulder and hip are distinctly more age correlated on both sides of the body than the more peripheral joints. The knee and elbow, being the more exposed joints, should be expected to be more under the influence of stress and correspondingly less influenced by more systemic factors such as age according to Jurmain (1980).

The relatively higher prevalence of osteoarthritis in the younger adults compared to the older adult males and females at Cobern Street, suggests that the degenerative changes are not a product of age alone, but rather more likely to have developed from physical stress. Similar patterns of stress-related skeletal changes were noted for slaves during the American Colonial period (Kelley & Angel, 1987) and for American free urban blacks (Angel et al., 1987). These historical accounts of severe labour demands on slaves are numerous.

SITE	Total overall rates of Osteoarthritis (%)
Marina Residence (this study)	50.0
Cobern Street (this study)	50.0
Riet River **	7.0
Griqua*	7.2
Kakamas **	7.9
Colesberg*	3.1
Wolmaransstad *	18.8

*Data from Peckmann, 2002
**Data from Morris, 1984

Table 6.07: Comparison of overall osteoarthritis rates

Comparisons among different studies are more challenging because of a lack of standardized scoring systems and differing interpretations of the results. The overall rate of osteoarthritis when compared to the Peckmann (2002) and Morris (1984) studies, show that the incidence was much higher in the present study despite the small sample sizes in all the studies (Table 6.07).

6.2.2.2.2. Osteophytosis and Spondylosis

Bony outgrowths on the edges of the vertebral bodies characterise vertebral osteophytosis. They develop in response to the degeneration of the fibro-cartilagenous joints (Steinbock 1976). Osteophytosis is both aetiologically and pathogenetically distinct from osteoarthritis due to the involvement of different cartilage types (Jurmain, 1980). It develops as a result of age, activity and increased weight. The intervertebral disc starts degenerating due to the excessive stress placed on it and this results in the stimulation of new bone growth on the surfaces and antero-lateral margins of the vertebral bodies. Increased weight or intensive physical labour can predispose anyone to this disease (Steinbock, 1976, Rogers et al., 1985, Khudabux, 1991, Roberts & Manchester, 1995, Larsen, 1997).

Osteophytosis comparisons (Table 6.08) showed more prevalent in the males than in the females, except for the Griqua of Peckmann (2002) where the females' rate was higher than the males. The Marina Residence and Cobern Street males are more comparable to the Morris (1984) Riet River population than any of the other

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Osteophytosis comparisons (Table 6.08) showed more prevalent in the males than in the females, except for the Griqua of Peckmann (2002) where the females' rate was higher than the males. The Marina Residence and Cobern Street males are more comparable to the Morris (1984) Riet River population than any of the other samples. The females were more comparable with the Peckmann (2002) Griqua group.

Site	Osteophytosis Male	Osteophytosis Female
Marina Residence	87.5	75.0
Cobern Street	81.8	71.4
Riet River**	66.5	50.0
Kakamas**	20.0	0
Griqua*	60.0	63.6
Colesberg*	35.7	22.2

*Data from Peckmann, 2002
**Data from Morris, 1984

Table 6.08: Comparison of osteophytosis in males and females

As already mentioned, degenerative joint disease occurs either as part of the normal ageing process or secondary to trauma in or around a joint. Spondylotic fusion of the vertebral column often occurs in individuals over 60 years and is found more often in males than in females (Aufderheide & Rodriquez-Martin, 1998). Vertebral osteoarthritis was found in both the younger adults and the older adults. Osteophytosis and centrum degeneration, clearly seen in MR 33, a 25 – 40 year old male, were relatively frequent. At both sites, the males dominated when all adults were combined. Spondylotic fusion occurred in two male individuals from Marina Residence, one a younger adult and the other of unknown age. One individual from Cobern Street (UCT 526, an older adult male) also presented with thoracic fusion. Vertebral fusion has been seen more often in the past in males because it was more likely they who undertook heavy physical labour in life thereby suggesting that the affliction is occupationally related (Lovell, 1997, Gruspier, 1999). Vertebral osteoarthritis is a direct result of spinal stress. The severity may reflect the influence of lifestyle or occupation on its development (Gruspier, 1999). It can be concluded from looking at the high values of degenerative joint disease, musculoskeletal stress markers, and trauma patterns as well as the harsh living conditions at the early Cape that the Marina Residence and Cobern Street led hard and active lives.

6.2.2.3. Assymetry

Postcranial robusticity is used to infer the activity levels of prehistoric populations and changes in robusticity are often used to support scenarios of adaptive change. The morphology of any skeletal feature, including robusticity, develops from many influences, both proximate and ultimate. Proximate causes of variation include immediate environmentally determined factors that act to alter an individual's morphology within their lifespan. Ultimate causes of variation are factors that produce genetic differences in the way the skeleton grows and remodels. Differences in lifestyle produce morphological variations in response to regimes of mechanical loading of the skeleton (Pearson, 2000). If historical sources show that there is a clear division of labour, the skeletons of men and women would be expected to differ in the development of markers related to physical activity. The presence of markers depends on the physical activity of the individual but is also influenced by the sex, age, hormonal levels and genetic differences (Al-Oumaoui et al., 2004).

The results of the present study is consistent with other studies (Wilczak, 1998, Pearson, 2000, Al-Oumaoui et al., 2004), which show that the right side is mostly dominant over the left, there is some dominance of the left over the right and even no measurable asymmetry in some instances. In general, given the equal work of each leg in locomotion, the arms are usually more asymmetrical than the legs, around 95% of modern humans present right-handedness. A minimal difference between the sides is an indicator of heavy work in which both arms participate equally (Al-Oumaoui et al., 2004). One of the reasons for greater asymmetry in the upper limb is that people perform many intricate actions that necessitate a given muscle to be recruited bilaterally or which stimulate different muscles on each side. There are also differences in hand preferences depending on the type of task performed. Handedness is more important in performing fine motor tasks that produce far less stress on the skeletal system than heavy lifting and carrying with both hands (Wilczak, 1998).

Musculoskeletal stress markers also do not show consistent sex differences in asymmetry frequencies as was seen in tables 6.04 and 6.05 (already discussed under MSSM's). This may result from the range of unilateral or bilateral manual tasks performed by all the individuals in both study sites which then results in a reduction of the lateral differences caused by the tendency for greater right side usage and thus development. It is also important to remember that patterns of limb use are complex as muscles work in groups and not alone.

6.2.3 Stress and Disease

6.2.3.1. Stress

Periostitis, involving only the outer cortical bone and resulting in the inflammation of the periosteum, is the most frequently observed reaction of bone inflammation. An infected site on the bone is immediately inflamed by dilating blood vessels producing a swelling or oedema, which in turn elevates the periosteum because of compression. As a consequence, the inner surface of the periosteum reacts to the insult by forming outer layers of woven bone (Ribot, 1992, Jacobi et al., 1992, Buckley & Tayles, 2003).

Longevity can be regarded as the total outcome of 'life stresses' on the individual. These are the 'stresses' for which we find evidence in the skeletal remains. 'Life stresses' include all the usual external forces affecting any individual, e.g. inadequate diet, disease, occupation, accidents and violence. Some stresses are pathological. Nutritional stresses during childhood and adolescent growth show in a complex of indicators, e.g. stature, caries and abscesses (Cook, 1979, Kelley & Angel, 1987, Roberts & Manchester, 1997).

In the case of prehistoric populations, stress is analysed as a human system's response to the factors determining living conditions, detectable in the course of morphological and histological examination of the human skeleton (Goodman et al., 1988). From among the factors making up living conditions, mainly nutritional and health status of populations are chosen for analysis due to limited possibilities of reconstruction of socio-economic situation of prehistoric populations (Hoppa, 1992, Nowak & Pointek, 2002).

Indicators of stress include growth disruption, disease and death. The consequences of stress experienced by individuals depend on a number of factors such as genetic susceptibility, age, sex and resiliency. If the individual lacks the reserves necessary to meet the challenges, then there is likely to be an increased level of physiological disruption. Soft tissues are generally more rapidly and severely affected by stress than skeletal materials. Thus stress would have to be severe and/or of long duration to cause observable skeletal changes (Goodman et al., 1988, Hoppa, 1992).

The response of the human skeleton to stress is simple. Osteons can either be deposited or resorbed or there can be a response in which both of theses processes alternatively occur. The skeletal system is responsible for support of the muscles, protecting the vital organs such as the brain and the eyes, producing red blood cells and maintaining chemical balance in the body. When these functions are disrupted, we find skeletal evidence of stress (Goodman et al., 1988)

6.2.3.1.1. Harris lines

Harris lines were first described in the early years of the 20th century. The structure responsible for the line is a lattice of dense horizontally orientated trabeculae. They are visible most commonly in the long bones where they are oriented approximately transverse to the long axis of the bone. Their occurrence is associated with episodes of childhood illness and nutritional deficiencies. Factors other than illness and nutritional deficiency may also cause line formation. This suggests that psychological stress may also cause Harris lines (McHenry, 1968, McHenry & Schultz, 1976, Clarke, 1982, Mays, 1995).

After growth arrest, resumption of bone growth is needed for line formation. This does not mean that complete recovery from disease or "good nutrition" is needed, merely sufficient resources to permit the resumption of endochronal bone growth (McHenry, 1968, McHenry & Schultz, 1976, Mays, 1995, Nowak, 2000, Ameen et al., 2005). A complication that needs to be born in mind when interpreting Harris line frequencies is that lines are gradually removed by bone remodeling. Metabolic activity is greatest in the bones of young children but bone turnover continues throughout life. Thus many lines may be removed both during childhood and during adult life (Mays, 1995). A study of the x-ray with some simple calculations enables one to determine with some degree of precision the year at which the illness occurred up to the cessation of bone growth. Once the bone has stopped growing no additional lines can be formed. The illness that caused the lines cannot be readily ascertained with any degree of accuracy. Since the lines appear during the first 16 years of life and the individual may die many years later, whatever produced the illness had in all probability disappeared by death. Some lines are resorbed in later life (Garn et al., 1968, Allison et al., 1974, Grolleau-Raoux et al., 1997). The investigation of Harris lines has contributed to the understanding of the essence of individual growth and development processes. Individuals age-at-death is important in analysing stress factors such as Harris lines since they are formed only over the period of longitudinal bone growth (Nowak & Pointek, 2002).

Harris lines are regularly used in palaeopathology as indicators of episodic general non-specific stress. The link between the number of Harris lines observed in a bone and the number of stresses that an individual has undergone is not absolute. Though Harris lines only appear during the period of linear growth of the long bones, there are peaks in the appearance of Harris lines (Grolleau-Raoux et al., 1997).) Investigations into the formation of transverse lines have concerned themselves most frequently with nutritional aspects as observed in children. The high frequency age ranges coincide with peaks in the occurrence of the usual childhood diseases, measles, mumps and chicken pox. The frequency is considerably higher in boys particularly at younger ages but the persistence is longer in girls (Gindhart, 1969).

More males (n = 15) than females (n = 3) exhibited Harris lines at Marina Residence. At the Cobern Street the male to female ratio was similar (n = 10 and n = 9, respectively). Because a number of individuals had no long bones or only very fragmentary long bones, not all individuals could be evaluated. Multiple lines tended to occur in most individuals.

The number lines peaked at between 8 to 14 years for Marina Residence and 10 to 15 years for Cobern Street. Although the adolescent period is generally associated with good health and low mortality, the high rate of growth arrest lines could be correlated to the adolescent growth spurt (Aufderheide & Rodriquez-Martin, 1998). According to Steinbock (1976) and Grolleau-Raoux et al. (1997) only about a quarter of Harris lines present in sub-adults persist into adulthood. The lines that persisted the longest were in an adult Marina Residence individual of indeterminate sex. Marina Residence showed 3.1 lines per individual and the Cobern Street showed 2.8 lines, thus the Marina Residence individuals appear more stressed.

Work incorporating Harris lines as indicators of stress has been hindered in adult skeletal populations due to the unpredictable and frequent remodeling of the lines. Males and females have different rates of remodeling and stresses as mild as an inoculation or as severe as malnutrition may cause a cessation of growth and the development of a line. Also, the individual would need to recover from the stress in order to display a line. Therefore, continually stressed people may not have visible transverse lines (Lewis & Roberts, 1997).

Even though there are limitations in recording and interpreting Harris lines, it is still important to compare the prevalence of lines in individuals from this study to other populations. Comparison of the results of the present study with other studies is done in order to get a better insight about the stress experience of different populations, which could be related to specific behavioural, environmental and dietary conditions.

Site	HARRIS LINES			Source
	No. of indiv. with long bones	No. of individuals with Harris lines	%	
Marina Residence	57	19	33.2	This study
Cobern Street	63	19	30.3	"
Oakhurst	22	11	50.0	Patrick, 1989
Griqua	135	14	10.4	Peckmann, 2002
Dry Savanna	16	8	50.0	Dlamini, 2006
Wet Savanna	35	7	20.0	"
K2	43	12	28.6	Steyn, 1994
Colesberg	52	3	5.8	Peckmann, 2002
Wolmaransstad	39	4	10.3	"
South Carolina Plantation	22	7	31.8	Rathbun, 1987
Suriname	38	12	31.6	Khudabux, 1991

Table 6.09: Comparison of Harris lines in other populations

Table 6.09 is a comparison of this present study with Dlamini (2006) and Steyn (1994) both from Iron Age agriculturalist populations, Peckmann (2002) Northern Frontier pastoralist and agriculturalist populations, Patrick (1989) hunter-gatherer population and Rathbun (1987) and Khudabux (1991) slave populations. The Harris lines intensity seen at Cobern Street and Marina Residence is most similar to and the contemporary Rathbun (1987) and Khudabux (1991) slave populations followed by the Steyn (1994) Iron Age population. The Frontier's populations appear less stressed than the coastal populations of this study.

6.2.3.1.2. Cribra orbitalia and Porotic hyperostosis

Many researchers have investigated the prevalence of cribra orbitalia and porotic hyperostosis in pre-historic populations and its association with iron-deficiency order to display a line. Therefore, continually stressed people may not have visible transverse lines (Lewis & Roberts, 1997).

Even though there are limitations in recording and interpreting Harris lines, it is still important to compare the prevalence of lines in individuals from this study to other populations. Comparison of the results of the present study with other studies is done in order to get a better insight about the stress experience of different populations, which could be related to specific behavioural, environmental and dietary conditions.

Site	HARRIS LINES No. of indiv. with long bones	No. of individuals with Harris lines	%	Source
Marina Residence	57	19	33.2	This study
Cobern Street	63	19	30.3	"
Oakhurst	22	11	50.0	Patrick, 1989
Griqua	135	14	10.4	Peckmann, 2002
Dry Savanna	16	8	50.0	Dlamini, 2006
Wet Savanna	35	7	20.0	"
K2	43	12	28.6	Steyn, 1994
Colesberg	52	3	5.8	Peckmann, 2002
Wolmaransstad	39	4	10.3	"
South Carolina Plantation	22	7	31.8	Rathbun, 1987
Suriname	38	12	31.6	Khudabux, 1991

Table 6.09: Comparison of Harris lines in other populations

Table 6.09 is a comparison of this present study with Dlamini (2006) and Steyn (1994) both from Iron Age agriculturalist populations, Peckmann (2002) Northern Frontier pastoralist and agriculturalist populations, Patrick (1989) hunter-gatherer population and Rathbun (1987) and Khudabux (1991) slave populations. The Harris lines intensity seen at Cobern Street and Marina Residence is most similar to and the contemporary Rathbun (1987) and Khudabux (1991) slave populations followed by the Steyn (1994) Iron Age population. The Frontier's populations appear less stressed than the coastal populations of this study.

6.2.3.1.2. Cribra orbitalia and Porotic hyperostosis

Many researchers have investigated the prevalence of cribra orbitalia and porotic hyperostosis in pre-historic populations and its association with iron-deficiency anaemia (Caffey, 1951, Mensforth et al., 1978, Weinberg, 1984, Walker, 1986, Palkovich, 1987, Dallman, 1987, Stuart-Macadam, 1987, 1989, 1992, 1998, Fairgrieve & Molto, 2000, Waldron, 2000, Wapler et al., 2004, Sullivan, 2005, Blom, et al., 2005). Several factors determine the body's dietary need for iron, since nutrient uptake is never equivalent to intake. Consequently, diets deficient in protein or certain vitamins can limit the body's access to iron. Thus dietary iron deficiency commonly accompanies other types of malnutrition (Blom, et al., 2005). Sandford et al. (1983) stated that the presence of hair in their excavated sample at the Sudanese Nubia site made the prevalence of cribra orbitalia together with its apparent relationship to iron deficiency anaemia an ideal condition to test the relationship of the two through trace element analysis. This would provide direct qualitative evidence. It was found that a comparison of all individuals with cribra orbitalia to those without the lesion produced statistically significant differences in three elements i.e. magnesium, iron and manganese. These were all lower in individuals with the orbital lesion.

Many studies concluded that porotic hyperostosis is more frequent and severe in populations that depend on maize agriculture (El-Najjar et al., 1976, Lallo et al., 1977, Mensforth et al., 1978, Clark et al., 1992, Blom et al., 2005), since maize is low in iron. Additionally, populations that rely on both marine and agricultural resources may also have greater prevalence of diet-related anaemia because of the high phosphoric content of marine foods might reduce iron uptake. Cribra orbitalia and porotic hyperostosis have also been cited as having relatively high frequencies in lowland and coastal areas (Stuart-Macadam 1992, El-Najjar et al., 1976).

Infectious disease processes are often implicated in the etiology of iron-deficiency anaemia (Lallo et al., 1977, Mensforth et al., 1978, Stuart-Macadam, 1992). During infectious bouts humans can become anaemic because the bacteria need iron to survive and reproduce thus reducing the content of iron in the blood. Stuart-Macadam (1991) states that porotic hyperostosis should be seen as an adaptation to high disease load and not necessarily associated with and iron deficient diet. However, porotic hyperostosis is not direct evidence of anaemia but an indicator of the body's attempt to overcome anaemia through marrow hyperplasia. It indicates the body's attempt to correct the deficiency. Skeletal material displaying active lesions may suggest the disease was still present upon death while skeletal material displaying signs of remodeling suggests that the body was rallying or had rallied from the condition. Remodeled lesions therefore remain as signs of past episodes of disease in the life of the individual and become critical to the evaluation of disease patterns within the population (Grauer, 1993).

One individual, UCT 511, a young sub-adult female still had active cribra orbitalia and porotic hyperostosis lesions upon her death.

The low incidence of cribra orbitalia and porotic hyperostosis at Marina Residence and Cobern Street could mean that iron deficiency anaemia may not have been very prevalent at the Cape. This was most improbable as porotic hyperostosis was linked to populations with a high dependency on carbohydrate-based diets. The diet of the poor at the Cape was mainly carbohydrate based with some protein as is evident from the historical records (see below). Acquired deficiencies such as cribra orbitalia and porotic hyperostosis that arise due to malnutrition, are common in impoverished populations throughout the globe. The diet at Cobern Street and Marina Residence may have been adequate enough to prevent higher incidences of these acquired diseases. Also, much of the cranial material was of such a fragmentary nature that the incidence could very well be under-reported especially when looking at comparative data from Dlamini (2006), Peckmann, (2002) and Steyn (1994) (Table 6.10) who reported much higher incidences of cribra orbitalia and porotic hyperostosis from other African populations. However, the Morris (1984) data, which also reported relatively low incidences of cribra orbitalia, is more comparable to the Marina Residence and Cobern Street data.

Site	% Cribra orbitalia	Source
Marina Residence	6.9	This study
Cobern Street	7.1	This study
Oakhurst	63.2	Patrick, 1989
Riet River	9.5	Morris, 1984
Griqua	42.7	Peckmann, 2002
Kakamas	3.8	Morris, 1984
Dry savanna	57.8	Dlamini, 2006
Wet savanna	55.6	"
Forest	64.9	"
K2	37.8	Steyn, 1994
Colesberg	34.6	Peckmann, 2002
Wolmaransstad	50.0	"

Table 6.10: Comparison of cribra orbitalia

6.2.3.1.3. Sexual dimorphism

Sexual dimorphism is not a simple trait controlled by a single selective factor. Long-term selection on the genotype and short-term fluctuation of the phenotype are components of any estimation of sexual dimorphism for a particular population. Age may influence estimates of dimorphism in that measurements in sexual dimorphism may show a tendency to change in a secular manner with each generation. There is also a change in skeletal dimensions with ageing in each individual. Continuing bone remodeling after 20 years of age and throughout life has been demonstrated for the crania and face, mandible and femur. The overall effect involves an increase in dimorphism with age (Hamilton, 1982, Lieberman, 1982).

The long bones were selected to show whether sexual dimorphism exists in the two study populations. These were the humerus, radius, femur and tibia. According to Holland (1991), the tibia exhibits sexual dimorphism, as it is one of the major load-bearing elements in the human body. This is because the ends of the tibia are subjected to heavy stress during life and because the stress may be a sexual component. However, circumference measurements have a higher accuracy than length. Sexual dimorphism in long bones was also a population or race phenomenon (İşcan and Miller-Shavitz, 1984). Clark (1988) states that the same features used to estimate sex is used to establish sexual dimorphism. Hrdlička (1939) also commented that the more cultured the groups of people from which skeletal parts are derived, the more difficult will be the sex determination and the same is true for groups that have become physically weakened.

Comparisons of some post-cranial features (Table 6.11) gave some surprising results. Of the two most sexual dimorphic features noted, Cobern Street had the same second most dimorphic feature to the Negro (Morris, 1984), Cape Nguni, Sotho and Venda (Lundy, 1986), the humerus head diameter. The Negro (Morris, 1984), Cape Nguni and the Sotho (Lundy, 1986) shared the same two most dimorphic features, humerus head diameter and femur head diameter. The Cobern Street group's most sexually dimorphic feature is shared with the Khoisan (Morris, 1984) group's most dimorphic feature, humerus epicondylar width. Marina Residence shares a similarity with the Venda (Lundy, 1986) group having the femur epicondylar width as it most sexually dimorphic feature. Thus, it would appear that Marina Residence is more sexually dimorphic in the lower limb and Cobern Street more dimorphic in their upper

Post cranial feature	Marina Residence	Cobern Street	Negro*	Khoisan*	Cape Nguni**	Sotho**	Venda**
Humerus max L	8.7	6.2	7.8	4.9	7.0	6.7	6.9
Humerus head D	12.2	10.4	13.5	12.0	11.2	12.8	14.2
Epicondylar width	10.3	13.6	12.0	15.5	7.5	10.3	9.7
Ulna L	12.4	5.7	7.6	9.4	6.5	6.7	5.9
Radius L	12.5	9.2	7.9	9.7	7.8	7.3	8.3
Femur bicondylar L	13.0	2.0	6.9	4.9	6.7	5.7	6.4
Femur max head D	10.0	8.0	14.4	12.5	9.2	12.3	13.6
Epicondylar width	15.4	8.2	12.2	12.2	7.7	9.7	16.3
Tibia L	15.1	4.2	6.7	5.1	7.8	6.9	5.4

L= length
D= diameter

* Morris, 1984, unpublished data
** Lundy, 1986

Table 6.11: Comparison of sexual dimorphism in post-cranial features

limb. This is corroborated by the musculoskeletal marking results in that the loading intensity for the Marina Residence group was concentrated on the legs as shown by their entheseal markings whereas at Cobern Street the loading intensity was either concentrated on the arms or the same for their arms and legs. The Marina Residence males were also the tallest individuals in both groups.

6.2.3.1.4. Adult stature and body size

According to Kemkes-Grottenthaler (2005), stature is a highly complex trait influenced by the dynamic interplay of genetic as well as environmental agents. It has become increasingly clear that individuals with adequate nutrition and a favourable disease history stand a greater chance of reaching their genetic growth potential than those who experience deprivation, malnutrition or poor health (Hoppa, 1992, Kemkes-Grottenthaler, 2005).

Taller individuals share a considerable survival advantage. This relationship is not causal but coincidental. Survival is influenced by a multitude of biological, environmental, economic and social factors, which operate synergistically and at different levels. Small stature is associated with several risk factors and directly with poor socio-economic status (Roberts & Manchester, 1997, Kemkes-Grottenthaler 2005). The average stature of an adult population may not remain stable from generation to generation. Secular factors influence change i.e. environmental conditions, genetic composition and natural selection (Trotter & Gleser, 1951, 1958).

While in all human societies males are on average taller than females, societies vary in the degree to which mean societal male height is greater than mean societal female height. Growth is influence by the quality and quantity of food resources. As a result, inadequate nutritional resources will be characterised by short males and short females and low sexual dimorphism in stature. With improved nutrition, both males and females are taller, but the male gain is greater than the female gain creating a greater dimorphism in stature (Wolfe & Gray, 1982).

The males were taller than the females at both study sites. However, the Marina Residence males proved to be the tallest individuals (168.2 cm) in the study groups and their females the shortest (154.1 cm). The Cobern Street males (160.0 cm) and females (155.4 cm) fell between the Marina Residence means. According to Roberts & Manchester (1997), stature is of relevance especially in the occurrence of disease. A reduced stature may indicate less than adequate nutrition and poor health when the person was growing. Nutritional status, genetic make-up, environment and disease will all affect the attainment of final stature. Bearing this in mind, it would appear that some of the Marina residence females as well as the Cobern Street males and females might have had a nutritional and health stress disadvantage throughout their lives.

Comparison of the present study statures to other research work (Table 6.12) showed that the Marina Residence males are comparable to the forest group (Dlamini, 2006), South Carolina Plantation slaves (Rathbun, 1987), K2 (Steyn, 1994), 'Negro' (Wilson & Lundy, 1994), Spitalfields historic population (Molleson et al., 1993) and the South African Negro medium (Tobias, 1972) group. The Cobern Street males are comparable to the Griqua (Peckmann, 2002), white males (Trotter, 1970), K2 (Steyn, 1994), San and Negro (Wilson & Lundy, 1994), Nama 'Hottentots' and the South African Negro short (Tobias, 1972) groups.

The Marina Residence females are comparable (Table 6.13) to the Griqua (Peckmann, 2002), white females (Trotter, 1970), South African black females (Feldesman & Fountain, 1996), K2 (Steyn, 1994), Spitalfields (Molleson et al., 1993) and the San and Negro (Wilson & Lundy, 1994) groups. The Cobern Street females are comparable to the Spitalfields (Molleson et al., 1993), Wolmaransstad (Peckmann, 2002), K2 (Steyn, 1994) and the San and Negro (Wilson & Lundy, 1994) groups.

Table 6.14 compares indices between the present study and the unpublished Morris (1984) and Lundy (1986) data. There are numerous points of comparison between the present study and the comparative data but an anomaly occurs when looking at the humero-femoral index and the intermembral index of the Marina Residence females. This is as a result of their much shorter stature. This could be one of the reasons the females had such a high musculoskeletal marking score, because of their shorter legs, when walking, they had to work that much harder than their Cobern Street counterparts.

6.2.3.2. Diseases

Although the aetiology of disease in past populations cannot be definitively determined, the prevalence and general patterns of pathology in the past can often shed light on evolution and bio-cultural aspects of disease (Damon, 1964, Buikstra,

Population Group	Stature Range (cm)	Source
MALES		
Marina Residence	168.2	This study
Cobern Street	160.0	"
Griqua	162.1	Peckmann (2002)
Dry Savanna	174.3	Dlamini (2006)
Wet Savanna	170.1	"
Forest	167.7	"
K2	156.7 - 173.1	Steyn (1994)
Colesberg	155.9	Peckmann (2002)
Wolmaramsstad	172.4	"
South Carolina Plantation	167.4	Rathbun (1987)
Dutch medieval (early period)	171.8	Maat et al. (1998)
Dutch medieval (late period)	170.8	"
Suriname	162.9	Khudabux, 1991
Spitalfields	167.9 - 170.3	Molleson et al., 1993
White males	160.4	Trotter (1970)
Black males	158.1	"
White males	157.0	Feldesman & Fountain (1996)
Black males	154.5	"
European mixed males	170.4	"
South African Black males	162.9	"
San	144.1 - 164.8	Wilson & Lundy (1994)
Negro'	149.4 - 176.5	"
Magon & Motokwe Bushmen	146.5 - 148.2	Tobias (1962)
Nama 'Hottentots'	161.9 - 163.3	Tobias (1972)
South African Negro (short)	150.0 - 160.0	"
South African Negro (medium)	160.0 - 170.0	"
South African Negro (tall)	170.0 - 180.0	"

Population Group	Stature Range (cm)	Source
FEMALES		
Marina Residence	154.1	This study
Cobern Street	155.4	"
Griqua	152.8	Peckmann (2002)
Dry Savanna	163.2	Dlamini (2006)
Wet Savanna	158.6	"
Forest	161.3	"
K2	151.4 - 154.6	Steyn (1994)
Colesberg	147.2	Peckmann (2002)
Wolmaramsstad	1554.2	"
South Carolina Plantation	160.6	Rathbun (1987)
Dutch medieval (early period)	164.4	Maat et al. (1998)
Dutch medieval (late period)	162.2	"
Suriname	156.8	Khudabux, 1991
Spitalfields	154 - 158.5	Molleson et al., 1993
White females	152.8	Trotter (1970)
Black females	150.9	"
White females	151.9	Feldesman & Fountain (1996)
Black females	149.6	"
European mixed females	169.1	"
South African Black females	154.1	"
San	135.6 - 159.4	Wilson & Lundy (1994)
Negro'	141.3 - 166.9	"
Magon & Motokwe Bushmen	157.4 - 158.6	Tobias (1962)

Tables 6.12 and 6.13: Comparison of adult stature with other samples

Indices	Marina Residence		Cobern Street		Negro*		Khoisan*		Cape Nguni**		Sotho **		Venda**	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
Humero-radial index	77.3	74.7	78.9	76.7	78.6	78.5	79.4	75.9	79.1	75.8	78.3	77.9	80.6	79.6
Humero-femoral index	72.5	75.4	72.4	69.5	70.1	69.6	68.1	68.1	71.3	70.1	71.8	71.0	71.5	71.2
Tibio-femoral index	84.3	82.8	85.4	83.6	85.6	85.8	84.4	84.2	84.8	84.3	85.0	84.1	85.4	86.3
Intermembral index	69.7	72.0	69.8	66.9	67.5	66.8	66.3	65.0	69.1	68.8	69.1	68.6	69.6	68.6

*Morris, 1984 (unpublished data)
**Lundy, 1986

Figure 6.14: Comparison of indices

1976, Jacobi et al., 1992, Agarwal & Grynpas, 1996, Bosch, 2000). Infections in bone can be classified as either specific or non-specific, the latter being more common in archaeological remains (Hershkovitz et al., 1992, Keenleyside, 1998). Many diseases leave diagnostic patterns on bone. Tuberculosis and syphilis cause skeletal changes that are specific to the pathogen. Many pathogens however leave only generalised changes in the skeleton. One frequently observes a reaction in the bone periosteum reflecting a pathogenic change that results from an inflammation. The periosteal reaction to inflammation leaves a roughened appearance to the outer layer of bone. Due to the limited amount of ways in which the skeletal system responds to adverse conditions, we are compromised in our ability to make inferences about specific proximate causes. Mortality is the ultimate consequence of failure to rally from stressful conditions. Socio-economic conditions are able to generate, reproduce and intensify stressful conditions often leading exposed groups to higher levels of insults (Goodman et al., 1988, Buzhilova, 1999, Formicola & Buzhilova, 2004). According to Maat, et al. (2002), a low standard of living gives rise to expected poor nutritional and health performance in poorer people.

6.2.3.2.1. Infectious diseases

Syphilis

Treponemal diseases like syphilis is an infection that causes symmetrical bone alterations when present (Rothschild, 1992). Inflammation of the entire periosteum initiates a subperiosteal response resulting in thickening and possible bone deformation. Gumma (nodes / expansion with superficial cavitation) formation may occur periosteally or in the medullary cavity resulting in both proliferative and degenerative changes. Generally the affected bone appears roughened and irregular because of thickening and increased density. The medullary cavity particularly in the tibia is greatly narrowed by cortical thickening. Hands and feet are rarely affected (Baker & Armelagos, 1988).

Venereal syphilis has an incubation period of 10 – 90 days before the primary lesion appears in the anogenital region. Secondary lesions usually develop on the skin and mucous membranes. Since asymptomatic bone lesions usually go undetected in early syphilis, skeletal involvement may be underestimated (Hackett, 1975, Baker & Armelagos, 1988, Hillson et al., 1998).

Skeletal involvement in venereal syphilis most often affects the cranial vault, nasal area and the tibia (Figure 6.01). Together, these three locations comprise 70% of all tertiary syphilitic bone lesions (Ortner & Putschar, 1985). The major diagnostic criterion of skeletal syphilis is the caries sicca sequence which results in the "worm eaten" appearance of the outer table of the cranial vault, characterised by the formation of stellate scars (Hackett, 1975, Baker & Armelagos, 1988, Mann & Murphy, 1990). These stellate scars may be deep or wide and flat (Hackett, 1975).

At the Marina Residence site, there were three individuals who presented with possible syphilitic lesions on their post cranials. Only one individual, MR SF 56 (Marina Residence shaft fill 56 – shaft fills are out-of-context disturbed burials), an older adult male, had an associated skull with caries sicca lesions. Of the four individuals at Cobern Street presenting with possible syphilitic lesions, only one had lesions severe enough to positively identify as syphilis. The other three had lesions that were either not very specific or only had one tibia present thus leaving the examiner unable to identify whether the bilateral lesions were present or not. These individuals at the study sites represent the first possible documented cases of syphilis at the Cape.

Table 6.15 compares the present study with findings of treponematosis in other populations. This study is similar to the Rothschild et al. (1995) study of the Hamann-Todd skeletal collection in infection rates and far below the other studies.

Site	n	No. affected by condition	%	Source
Marina Residence	72	3	4.2	This study
Cobern Street	83	4	4.8	"
Gladstone	107	10	9.3	Van der Merwe, 2006
Suriname	25	8	32.0	Khudabux, 1991
Metaponto	272	47	17.3	Henneberg & Henneberg, 1993
Dominican Republic	440	39	8.8	Rothschild, 2001
Gognga -Gunn	213	40	18.7	Rothschild et al., 1995
Hamann -Todd	2906	135	4.6	"

Table 6.15: Comparison of treponematosis in various populations

Were the findings at the Cape yaws or syphilis? According to Buckley & Tayles (2003), differentiating between the treponemes based on skeletal evidence is

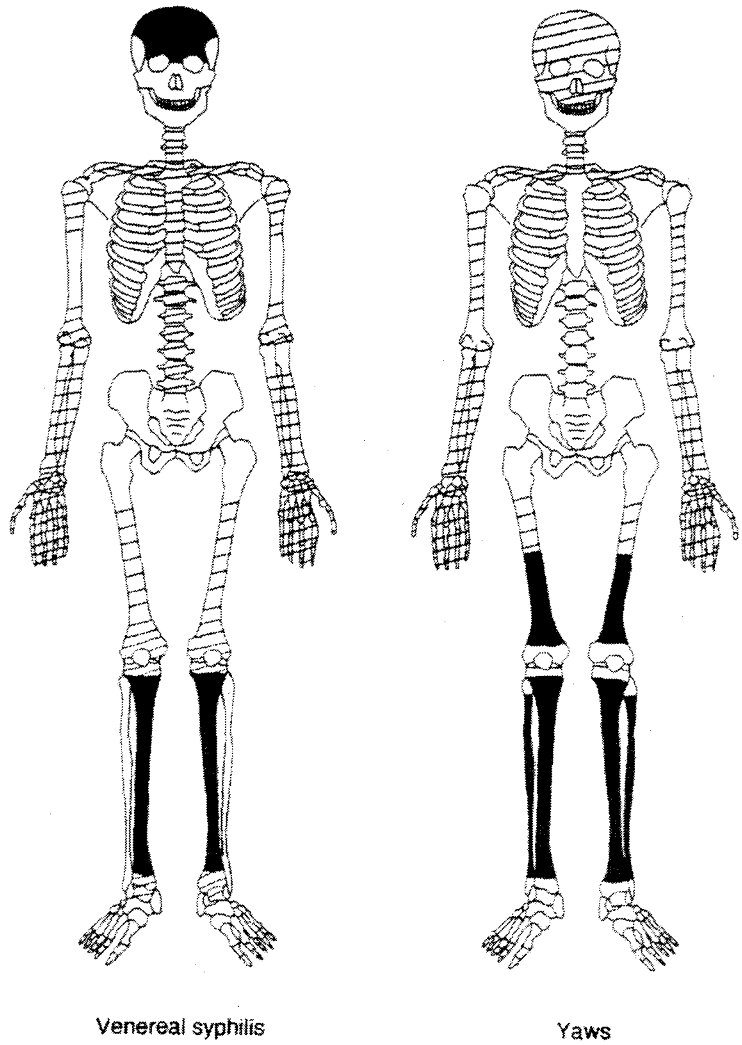

Figure 6.01: Skeletal elements affected by venereal syphilis and yaws (Lovell, 2000: 239). Solid shaded areas are those most often affected, partially shaded areas are affected to a lesser extent.

difficult especially when the skeletal material is incomplete as was the case for the skeletal material at the two study sites (Figure 6.01). Often only partial post cranials were present. Morris (1988) (in commentary on Baker & Armelagos, 1988) speaking from an urban historical viewpoint, states that the venereal form of the disease was present in the Cape Colony from at least the 1690's and was rampant amongst slaves, sailors and soldiers by the 1730's and according to Steyn (1994), speaking from a physical anthropological standpoint, there are virtually no reported cases of venereal syphilis in southern African rural prehistory.

Tuberculosis

Tuberculosis is an infectious contagious disease caused by a bacterium from the *Mycobacterium* complex that affects a variety of domestic and wild animals. In humans, *M. tuberculosis* may cause a chronic or acute infection of the bone and/or soft tissues (Collins, 1982, Aufderheide & Rodriquez-Martin, 1998, Haas et al., 2000, Mays et al., 2001, Santos & Roberts, 2001, 2006). *M. bovis* can be acquired via inhalation of contaminated aerosol from live infected animals or carcasses producing pulmonary disease. It can also be transmitted by consumption of contaminated milk or meat in which case the primary lesion is located in the cervical lymph nodes (Mays et al., 2001).

Important osseous signs of this disease may not have been described before because many individuals could die before skeletal modifications can take place. Also, bony lesions that do appear may be misinterpreted because bone has a limited response and careful differential diagnosis is required for confident identification of a specific disease (Santos & Roberts, 2001, 2006). Tuberculosis may affect any organ in the body including the skeleton. Skeletal tuberculosis is almost without exception a result of hematogenous spread of infection from soft tissue foci. Skeletal lesions only occur in the minority of instances. These lesions permit the identification of tuberculosis in skeletal remains. Although disease due to both *M. tuberculosis* and *M. bovis* may affect the skeleton, it is impossible to distinguish the two forms of tuberculous disease using osteological criteria, as bony lesions caused by the two pathogens are anatomically similar (Mays et al., 2001).

One individual from Cobern Street, UCT 552, a younger adult male of 30 – 35 years of age, presented with tuberculosis lesions on the ribs and associated vertebrae.

The tuberculosis was diagnosed according to the morphology of the lesions and their skeletal distribution. Account was taken of the diagnostic criteria presented by Aufderheide & Rodriquez-Martin (1998) and Kelley & El-Najjar (1980). The more important of these include lesions that are mainly destructive, producing cavitation in the cancellous bone of long bone ends or vertebral bodies with little new bone formation. This is the first and earliest case of tuberculosis recognised at the Cape.

Any skeletal signs of the epidemics?

There were reported periods of epidemics of smallpox, measles, plague and typhoid that repeatedly swept through the Cape during the 18th and 19th centuries. The smallpox virus has a reported 80 – 90% fatality rate among previously unexposed populations, at all ages (Aufderheide & Rodiquez-Martin, 1998). No physical signs of these epidemics have been found on this skeletal material. Although increased levels of iron deficiency anaemia as seen in increased reports of cribra orbitalia and porotic hyperostosis is said to be indicative of smallpox infections, as the smallpox virus needs iron to multiply (Jackes, 1983, Peckmann, 2003). Both the Marina Residence and Cobern Street sites had very low incidences of both cribra orbitalia and porotic hyperostosis.

Acute infectious diseases are likely to have led to rapid death after the initial exposure or infection by the invading organism. The time between exposure and death would have been too short a time for the skeleton to be affected (Ortner & Putschar, 1985, Roberts & Manchester, 1997, Aufderheide & Rodiquez-Martin, 1998).

6.2.3.2.2. Non-infectious diseases

Paget's disease is a chronic bone abnormality, which may affect a single, several or many bones but never involves the entire skeleton. The cause remains unknown. It occurs commonly in population of European descent but is rare in black Africans and Asians. It occurs mainly in people over 40 years of age and mostly in men (Ortner, 2003).

Paget's disease is a focal disorder that chronically affects the turnover rate of bone resulting in skeletal, vascular and articular complications. The trademark of this bone is the excessive and disorganised activity of the bone. The disease involves the rapid deposition of new bone resulting in an increased percentage of osteoid on the bone surface leading to deformities in the bone (Aufderheide & Rodriquez-Martin, 1998, Gruspier, 1999). It is an affliction that is uncommon in archaeological material. The disease begins with bone destruction (osteolytically), followed by a bone forming (sclerotic) phase in which the osteoblasts overproduce both woven and lamellar bone. This results in enlarged bones over a period of time. Affected bones will usually deform or disfigure as in the case of the skull and facial bones. Stress fractures are not uncommon during the lytic phase of the disease and they may progress to complete fractures (Gruspier, 1999).

One individual from Marina Residence (MR 4, an older adult female) presented with Paget's disease. Unfortunately only fragments of the skull were recovered and not enough to attempt any reconstruction. The associated post-cranial skeleton also exhibits signs of Paget's disease in the increased cortical thickness of the long bones as well as other skeletal pathologies. This is the first possible case of Paget's disease at the Cape in a historical population.

6.2.3.3. Trauma patterns linked to lifestyle

The evidence of trauma in a population may reflect many factors about the lifestyle of individuals. For example, their material culture, economy, living environment, interpersonal violence and occupation (Ortner, 1998, Torres-Rouff & Junqueira, 2006). The state of healing of their injuries may indicate dietary status, availability of treatment and the occurrence of complications (Beisel, 1982, Roberts & Manchester, 1997). According to Merbs (1989), trauma occurs as a result of violent encounters with environmental hazards, inter- and intraspecies conflicts and in some instances, self-mutilation and suicide.

Although great advances have been made in palaeopathological diagnosis and interpretation in recent years, inconsistencies in descriptions and interpretations of trauma in the literature, particularly as they affect our understanding of the nature and extent violence, have made it difficult to compare the results of different studies and to accept with confidence some conclusions (Lovell, 1997).

The Marina Residence site displays 8.9% (n = 7) occurrence of skeletal trauma and the Cobern Street site shows 9.3% (n = 11) occurrence. The locations of the injuries on the skeleton provide information about the type of activity that was responsible for the injury. Two individuals at Marina Residence presented with bony ankylosis of the distal end of the tibia and fibula. Direct injury to the joint surfaces can cause this type of joint alteration (Aufderheide & Rodriquez-Martin, 1998). The occurrence of bony ankylosis is uncommon to rare according to Mann & Murphy (1990). One older adult male, MR 54, presented with myositis ossificans on the fibula in conjunction with the ankylosis. Myositis ossificans is usually produced by avulsion of tendinous and / or muscle attachment to bone, generating a hematoma. Because of the proximity of the hematoma to the bone's injured periosteum, the periosteum may initiate calcification and ossification of the hematoma (Aufderheide & Rodriquez-Martin, 1998). Once again, the occurrence is uncommon to rare. It is most frequently seen on the posterior surface of the tibia and femur (Mann & Murphy, 1990).

Herniation of the intervertebral disc develops gradually and is associated with the ageing process usually seen in individuals over the age of 40 years (Larson, 1997, Lovell, 1997, Aufderheide & Rodriquez-Martin, 1998). Here, Schmorl's nodes have been included under trauma as seven of the eight individuals presenting with these lesions are under the age of 40 years, one of them a sub-adult. It is known that the presence of Schmorl's nodes is indicative of early degenerative disc disease (Roberts & Manchester, 1995, Lovell, 1997). The presence of these nodes in sub-adults and young adults are uncommon (Mann & Murphy, 1990, Lai & Lovell, 1992). According to Kelley & Angel (1987), occupational stresses involving heavy lifting often leads to Schmorl's nodes. These nodes are also seen in younger individuals that have had a traumatic episode to the spine such as a fall (Mann & Murphy, 1990, Lai & Lovell, 1992, Roberts & Manchester, 1995). It can thus be inferred, that the young individuals presenting with the Schmorl's nodes were involved in strenuous activities.

Septic arthritis can be caused by the entry of bacteria into the synovium and the joint cavity by the bloodstream by extension of the infection from the bone or soft tissue or direct introduction through a wound. Occasionally any joint may be involved but about one third of the cases involve the knee and one-third the hip joint. The causative agents are often staphylococci or streptococci, however other gram-negative rods also cause septic arthritis (Ortner, 2003). The acute phase of septic arthritis is limited to the synovial membrane and the articular cartilage and will not be recognisable in dry bone unless the subchondral bone has become involved and eroded. Unrelieved septic arthritis will often terminate in bony ankylosis (Steinbock, 1976, Ortner, 2003). Ankylosing may be a product of the healing process (Aufderheide & Rodriquez-Martin, 1998). One younger adult male at Cobern Street (UCT 501) presented with septic arthritis with ankylosis of the knee joint. The infectious agent could have entered the body either via direct trauma to the knee or through the blood and opportunistically found itself near the joint.

Five individuals presented with healed fractures. The majority of fractures were to the post-cranial skeleton. However, an older adult male, MR 43B, has a healed fracture of the right orbit as well as a Parry fracture of the ulna. This individual could very well have been the victim of interpersonal violence. Parry fractures are usually obtained as a defensive wound in an attempt to ward off attack to the head or upper body (Larson, 1997). One female individual, UCT 540, presented with an un-united fracture. The diagnosis of non-union is applied when the fracture fragments fail to unite and the marrow cavity seals. Non-union may result from inadequate bone healing due to infection, inadequate blood supply, insufficiency of vitamin D or C and calcium, excessive movement between bone fragments during healing, soft tissue being caught between the fragment ends and inadequate contact between the fragments (Lovell, 1997). Non-union results from failure to effect complete immobilisation of the separated parts thus making it impossible for the developing bone callus to consolidate. Inadequate splinting may also allow sufficient movement to prevent union. In many cases a fracture may go undetected with no attempt to immobilise the bone (Merbs, 1989). An older adult male, MR 54 had extensive healed fractures all over his body with the upper and lower limbs involved. This could have been due to a bad accidental fall or interpersonal violence. Many of the fractures seen were well healed and this suggests that medical attention was available to the poorer populace. However, the misaligned clavicular fracture seen on MR 54 could be as a result of limited medical attention. These patterns of well healed fractures resulting from medical attention and misaligned fractures resulting from limited medical attention is also seen in the Gladstone population (Van der Merwe, 2006). Fracture trauma is a common pathological lesion observed in archaeological skeletal material and represents the accumulation of physical traumatic events in an individual's life that resulted in broken bones. Most fractures heal successfully, but problems may arise that affect the function of the bone, joint or soft tissue or threaten the survival of the individual (Judd & Roberts, 1999).

Two Cobern Street individuals presented with fused calcanei either to the navicular (UCT 508, an older adult female) or the talus (UCT 498, a younger adult male). The calcaneus and talus on the left side are ankylosed and the normal anatomical relationship between them has been altered. Both could have resulted from chronic bacterial infection resulting in periostitis and osteomyelitis. These conditions may also be associated with trauma.

An autopsied skull was found at Marina Residence, MR 46 (a younger adult male) (Figure 6.02). This is most unusual and is the first indication that has been described from an early Cape burial ground. This may be an indication that there was a connection to the early Somerset hospital, then located at the corner of Alfred, Chiappini, Prestwich and Hospital streets and is likely to have been done after the British occupation (Halkett, 2000). This however was not the earliest autopsy at the Cape, the first was held during 1660 on a boatswain's mate who had been stabbed to death and was undertaken at Van Riebeeck's direction (Laidler & Gelfand, 1971).

Certain types of trauma will leave instantaneous signs on bone and teeth, e.g. intentional mutilation, complete or compound fractures, weapon wounds. However, because the effects of other kinds of trauma – such as stress and fatigue fractures – as well as those of occupational stress and various infectious diseases accumulate over years, they may not be detectable at the time of the individual's death. Thus the number of potential assaults on an individual's body is greater than the number that might leave telltale signs on the bone or tooth (Schwartz, 1995, Judd & Roberts, 1998, 1999). Overall, both study sites show less than 10% traumatic lesions on the skeletal material.

6.2.3.4. Other skeletal features

Despite the relatively small sample sizes of the sites under study, there were numerous skeletal features and anomalies. These include three individuals with scoliosis, one with premature sagittal suture closure (MR 48, an older adult male), one with L5 sacralisation (UCT 526, an older adult male), one with rheumatoid arthritis (MR 4, an older adult female), sixteen individuals (two from Marina Residence and fourteen from Cobern Street) with flared distal humeri, eleven with septal apertures (six from Marina Residence and five from Cobern Street).

Table 6.16 shows a comparison of the present study to the Lundy (1986) study showing the prevalence of septal apertures in South African Negro populations. The prevalence in the Marina Residence and Cobern Street samples are very much less than the 1986 study. This could very well be because the present study samples represent mixed groups of people and not wholly 'Negro' populations.

Figure 6.02: Autopsied skull of MR 46

	Septal aperture	
	Male	Female
Marina Residence	5.9	8.9
Cobern Street	8.1	5.4
Cape Nguni*	20.4	25.0
Natal Nguni*	16.5	36.6
Sotho*	27.9	40.2
Venda*	0	33.3

* Data from Lundy, 1986

Table 6.16: Comparison of septal apertures in South African populations

6.2.4. Dental Disease and Diet

The physical condition of teeth, as observed in archaeological material can provide valuable information on individual health status and cultural influences. The susceptibility of the teeth to disease is enhanced because they act and react with the environment both physically and chemically (Aufderheide & Rodriquez-Martin, 1998). Oral health indicators have frequently been used to reconstruct the dietary patterns and lifestyles of skeletal populations (Erdal & Duyar, 1999). Acquired dental pathologies are the result of complex processes including factors such as the presence of oral bacteria, plaque, carbohydrates and enamel solubility (Schneider, 1986). The study of dental diseases such as caries, antemortem tooth loss, attrition and abscesses can improve our understanding of the health and diet of past populations (Hillson, 1998, Ortner, 2003).

6.2.4.1. Attrition

Dental attrition is defined as tooth-to-tooth wear. It can be natural from normal masticatory activity or abnormal. The degree of attrition is also dependent on the amount of abrasive material present in the food or incorporated into it during its preparation. These abrasives can advance physiological attrition to pathological status (Kaidonis et al., 1992, Aufderheide & Rodriquez-Martin, 1998). Attrition of occlusal surfaces may destroy enamel and expose the underlying dentin. Attrition beyond this point will expose the pulp cavity. In response, the odontoblasts begin forming secondary dentine in the threatened areas of the pulp cavity (Ortner, 2003).

Dental attrition is associated with biological ageing. Thus the degree of wear can also be used as a method of estimating age in skeletons (Ortner, 2003). Attrition among prehistoric populations is not only the most prevalent pathology but also the most destructive of dental hard tissue, often leading to caries, antemortem tooth loss and abscess formation (Aufderheide & Rodriquez-Martin, 1998).

The mean occlusal wear for both study sites range from slight to moderate, with a few individuals showing heavy wear, this is consistent with an agricultural diet (Tables 5.19 and 5.20). There are minimal differences in the degree of wear between age and sex groups, between and within the Marina Residence and Cobern Street sites. The males, in both the younger and older age categories, at both study sites, have higher attrition scores than the females. However, the Cobern Street older adult males have the highest mean score (2.7) and the Marina Residence younger adult females the lowest (1.2). Generally, the anterior, posterior and mean occlusal wear increased with age in both study sites. This pattern of wear is not an unusual.

In the younger adult group, the Marina Residence females showed greater wear in the premolar teeth, with the males showing greater wear in the first molar. For Cobern Street, the greatest wear was in the incisors and canines. In the older adult category, the first molar showed greater wear for Marina Residence males and females whereas the second molar and the incisors were more heavily worn for the Cobern Street females and males respectively. Overall, the total posterior attrition score is larger than the anterior attrition score, i.e. the posterior teeth show a greater degree of wear than the anterior teeth. This is more obvious in the older adult category. This decrease in posterior to anterior wear with age may be related to the anterior teeth being used for biting only and the posterior teeth for chewing thus being more heavily worn. The sex differences seen in these populations are significant, and are important indicators of behavioural variability in tooth use, as well as underpinning the roles played by men and women in different socio-cultural settings. These differences between males and females in masticatory practices may be greater reliance on agricultural foods in some age and sex categories that may promote tooth wear.

Alternatively, the higher occlusal attrition among males could simply be a reflection of the eating behavioural activities between the males and females. By tradition, the females were responsible for food preparation while the males worked outside. However, with possibly both males and females involved in domestic, pastoral and agricultural activities, and men doing the heavier work, this would imply that the men would consume more foods than women thus increasing the amount of abrasive elements consumed with the food. Although the exact reasons for the sex differences in the pattern and severity of occlusal wear cannot be fully understood in historic populations, their presence may reflect highly variable wear patterns between closely related populations. Interpretation of these results is also tempered by the small sample sizes available for analysis. Thus, the range of variation for males and females is not fully represented.

Dental wear occurs on the biting or occlusal surfaces of the teeth during grinding of the crowns against each other. Wear patterns reflect different masticatory and dietary behaviours (Larson, 1997). Attrition is not a dental disease *per se* but can predispose to other dental pathological conditions e.g. caries and abscesses. Today, modern diets tend to be much softer and easier to chew and digest than those in the past. One major factor affecting wear on teeth is the processing of foods. For example, grinding grain in a stone mortar incorporates tiny particles of that stone into the grain and food produced from it; this will accelerate the wear on teeth (Hillson, 1986, Roberts & Manchester, 1997). Enamel, dentine and related dental structures may undergo varying degrees of wear caused by the ingestion of abrasive particles by the grinding of the teeth in normal occlusion and by objects held or move about in the mouth when the dentition functions as a tool or accessory hand (Kennedy, 1989).

Comparative dental occlusal wear is presented in tables 6.17 and 6.18; these are used to determine lifestyle patterning within and between communities. The Kruskal-Wallis statistical test, employed when comparing three or more samples, is used to determine if there is a significant difference in dental wear between populations. Since sex and age are important variables, those individuals of indeterminate age and sex are not included in this discussion. Only adult skeletal material is used. The occlusal wear for Marina Residence and Cobern Street, the present study, is compared to the dry savanna, wet savanna and forest (Dlamini, 2006), Griqua (Peckmann, 2002), Colesberg, Wolmaransstad (Peckmann, 2002), Riet River and Kakamas (Morris, 1984) and K2 (Steyn, 1994) samples.

Generally, those populations who forage as a way of subsistence should have more severe dental wear than agricultural societies. More severe dental wear is equated with more rough; fibrous foods that also contain more introduced exogenous abrasive substances. The agriculturalists on the other hand, tend to eat softer and more processed food to facilitate the absorption of nutrients by digestive enzymes (Larsen, 1997). However, this is not always true because some processing methods, like grinding, do introduce abrasive elements that encourage tooth wear.

When one considers that the various researchers may have used slightly different comparison methods, some caution has to be employed when comparing the means recorded. Statistical analyses by means of t-tests do illustrate significant differences in the dental attrition of all the sites compared (Table 6.19). When different methods were used, statistical differences will occur. Thus the patterns of dental attrition are analysed and not the specific mean numbers.

When looking at the anterior attrition for the younger adults, the Marina Residence males have a similar wear pattern to the dry savanna and wet savanna agriculturalists samples (Dlamini, 2006). The Cobern Street males are similar to the Riet River hunter-gatherers (Morris, 1984). The Marina Residence younger adult females wear pattern is similar to the wet savanna agriculturalists while their Cobern Street counterparts have similar patterns to the Kakamas pastoralists (Morris, 1984) and the Mapungubwe and K2 agriculturalists (Steyn, 1984).

The posterior attrition for the younger adult males show similar wear patterns for the present study's samples, these are similar to the Riet River hunter-gatherers (Morris, 1984) and the Mapungubwe and K2 agriculturalists (Steyn, 1984). The females show similar patterns to dry savanna and forest agriculturalists (Dlamini, 2006) and the Kakamas pastoralists (Morris, 1984).

When looking at the anterior dentition for the older adults, the Marina Residence males have a similar pattern to the dry savanna and wet savanna agriculturalists samples (Dlamini, 2006). The Cobern Street males are similar to the Riet River hunter-gatherers (Morris, 1984). The females have the same attrition scores and are similar to the dry savanna and forest agriculturalists (Dlamini, 2006) and the Mapungubwe and K2 agriculturalists (Steyn, 1984).

The posterior attrition for the older adults of the Marina Residence males shows similarities to the Riet River hunter-gatherers and Kakamas pastoralists (Morris, 1984) and the Mapungubwe and K2 agriculturalists (Steyn, 1984). The Cobern Street males show similarities to the Griqua pastoralists (Peckmann, 2002), the Riet River hunter-gatherers and Kakamas pastoralists (Morris, 1984). The Marina Residence females show similarities to the Mapungubwe and K2 agriculturalists (Steyn, 1984). The Cobern Street females are similar to the Riet River hunter-gatherers (Morris, 1984) and the dry savanna agriculturalists (Dlamini, 2006).

Table 6.20 illustrates the ratio of anterior wear to posterior wear for the present study as well as the comparative samples. This ratio is calculated as follows:

$$\text{Ratio} = (\text{anterior attrition score} \div \text{posterior attrition score}) \times 100$$

In all the groups, except the Marina Residence, Colesberg and Riet River, the ratio of anterior to posterior wear decreases with age. Wear is equal (100%) for Cobern Street

Site	Male n*	Female n*	Anterior Attrition Score Male	Female	Total	Posterior Attrition Score Male	Female	Total	Mean Attrition score Male	Female	Total
Marina Residence (this study)	12	4.3	1.9	1.2	1.5	2.0	1.3	1.7	2.0	1.2	1.6
Cobern Street (this study)	12.8	12.8	2.4	2.0	2.2	2.1	1.6	1.8	2.2	1.8	2.0
Riet River **	17	15	2.3	2.5	2.4	2.1	2.1	2.1	2.2	2.2	2.2
Griqua *	12.5	12	2.8	3.2	3.1	2.4	2.5	2.5	2.6	2.8	2.7
Kakamas **	15	16	2.0	2.0	2.0	1.7	1.6	1.6	1.8	1.7	1.8
Dry Savanna^	10.3	8.3	1.8	1.9	1.9	1.3	1.5	1.4	1.6	1.7	1.7
Wet Savanna^	3.9	2.4	1.8	1.3	1.6	1.4	1.0	1.2	1.6	1.1	1.4
Forest^	5.1	6.6	1.4	1.7	1.6	1.0	1.2	1.1	1.0	1.4	1.2
Mapungubwe & K2 ***	6	4	2.0	2.0	2.0	1.9	1.8	1.7	2.0	2.0	2.0
Colesberg*	18	16.8	2.8	2.8	2.8	2.5	2.5	2.5	2.6	2.6	2.6
Wolmaransstad *	1	1	3.2	2.9	3.0	2.4	2.5	2.4	2.7	2.6	2.7

n* - number of individuals calculated differently between this study and comparative samples

^ Data from Dlamini (2006)
* Data from Peckmann (2002)
** Data from Morris (1984)
*** Data from Steyn (1994)

Table 6.17: Comparison of Dental attrition scores in younger adults

Site	Male n*	Female n*	Anterior Attrition Score Male	Anterior Attrition Score Female	Anterior Attrition Score Total	Posterior Attrition Score Male	Posterior Attrition Score Female	Posterior Attrition Score Total	Mean Attrition score Male	Mean Attrition score Female	Mean Attrition score Total
Marina Residence (this study)	8.8	4	2.2	2.3	2.3	2.4	2.0	2.2	2.3	2.2	2.2
Cobern Street (this study)	8.5	5.5	2.8	2.3	2.5	2.6	2.3	2.5	2.7	2.3	2.5
Riet River **	6	7	2.7	3.0	2.9	2.5	2.4	2.5	2.6	2.7	2.6
Griqua *	13	6	3.4	3.8	3.7	2.7	3.5	3.2	3.1	3.7	3.4
Kakamas **	4	5	2.4	3.0	2.7	2.5	2.7	2.6	2.4	2.8	2.6
Dry Savanna^	6.6	3	2.0	2.3	2.2	1.9	2.2	2.1	1.9	2.2	2.1
Wet Savanna^	6.4	2.4	2.0	1.3	1.7	1.6	1.0	1.3	1.8	1.1	1.5
Forest^	4	1.4	1.9	2.1	2.0	2.1	1.6	1.9	2.0	1.8	1.9
Mapungubwe & K2 ***	2	1	~	2.1	2.0	2.2	2.0	2.0	~	2.0	2.0
Colesberg*	3.8	2	3.7	3.0	3.5	3.4	2.5	3.0	3.5	2.3	3.2
Wolmaransstad *	10	0	3.5	~	3.5	3.0	~	3.0	3.3	~	3.3

n* - number of individuals calculated differently between this study and comparative samples

^ Data from Dlamini (2006)
* Data from Peckmann (2002)
** Data from Morris (1984)
*** Data from Steyn (1994)

Table 6.18: Comparison of Dental attrition scores in older adults

older adults and the Mapungubwe and K2 older adults from Steyn (1994) for the front and back dentition. There is an increase in anterior wear in the Marina Residence, Colesberg and the Riet River samples.

	All sites*
Younger Adult	
amount of occlusal wear	< 0.001
Older Adult	
amount of occlusal wear	< 0.001

$P \leq 0.05$ is significant,
<u>All sites include</u>: the present study, Dlamini (2006), Peckmann (2002), Steyn (1994) and Morris (1984).

Table 6.19: Significant differences in dental attrition p-values (sexes pooled) – All sites combined

Site	Younger adults	Older adults
Marina Residence (this study)	88.0	104.5
Cobern Street (this study)	122.2	100.0
Riet River **	114.3	116.0
Kakamas **	125.0	103.8
Griqua *	124.0	115.6
Dry Savanna^	135.7	104.8
Wet Savanna^	133.3	130.8
Forest^	145.5	105.3
Mapungubwe & K2 ***	117.6	100.0
Colesberg*	112.0	116.7
Wolmaransstad *	125.0	116.7

^ Data from Dlamini (2006)
* Data from Peckmann (2002)
** Data from Morris (1984)
*** Data from Steyn (1994)

Table 6.20: Dental attrition ratios (sexes pooled) – anterior versus posterior wear

The attrition patterns would imply that the Marina Residence and Cobern Street people were eating diets of less refined food. They seem to have dental wear patterns similar to African agriculturalists and pastoralist activities and the Cobern Street people also had similar patterns to the foragers. Another explanation for heavier dental wear could also be as a result of the food preparation techniques employed. For example, stone ground flour will have a lot more sand particles in the flour leading to increased abrasive particles in the resultant food produced from it.

6.2.4.2. Caries

Dental caries is a multifactorial, multibacterial disease of the calcified teeth tissues. It is characterised by demineralisation of the inorganic portion and destruction of the organic component (Aufderheide & Rodriquez-Martin, 1998). Dental caries rates provide us with valuable information on adaptation to physical and cultural environments (Erdal & Duyar, 1999). Pindborg (1970) describes dental caries as an infectious and transmissible disease in which the progressive destruction of the tooth structure, crown or root is initiated by microbial activity on the tooth surface. A variety of factors including food composition, salivary contents, oral hygiene, genetic predisposition, enamel defects, mineral composition of drinking water and oral bacterial flora affect carious lesions. Varying amounts of carbohydrates processed in the oral cavity is the most common explanation of caries frequency in prehistory (Roberts & Manchester, 1997, Larson, 1997, Hillson, 1996, Pechenkina et al., 2002). In the dental crown, acid-producing bacteria in plaque initiate the process by partial and very local demineralisation of enamel. Although bacterial activity is a necessary condition for the development of dental caries, factors intrinsic to the tooth structure may affect the development and location of caries. Developmental defects in the quality of the enamel may also create conditions favourable to cariogenic activity.

Dental caries usually progresses slowly. Molars are most commonly affected followed by premolars and then the anterior teeth (Hillson, 1996). Dental caries rates provide us with valuable information on adaptation to physical and cultural environments (Erdal & Duyar, 1999). Acquired dental pathologies are the result of complex processes including factors such as the presence of oral bacteria, plaque, carbohydrates and enamel solubility (Schneider, 1986).

When looking at the summaries of caries rates by tooth type (Tables 5.28 and 5.29, Figures 6.03 and 6.04), for the younger adults at Marina Residence and Cobern Street, the highest rate is at the second molar for the females and the third molar for the males. For the older adults, it is the second and third molars for both males and

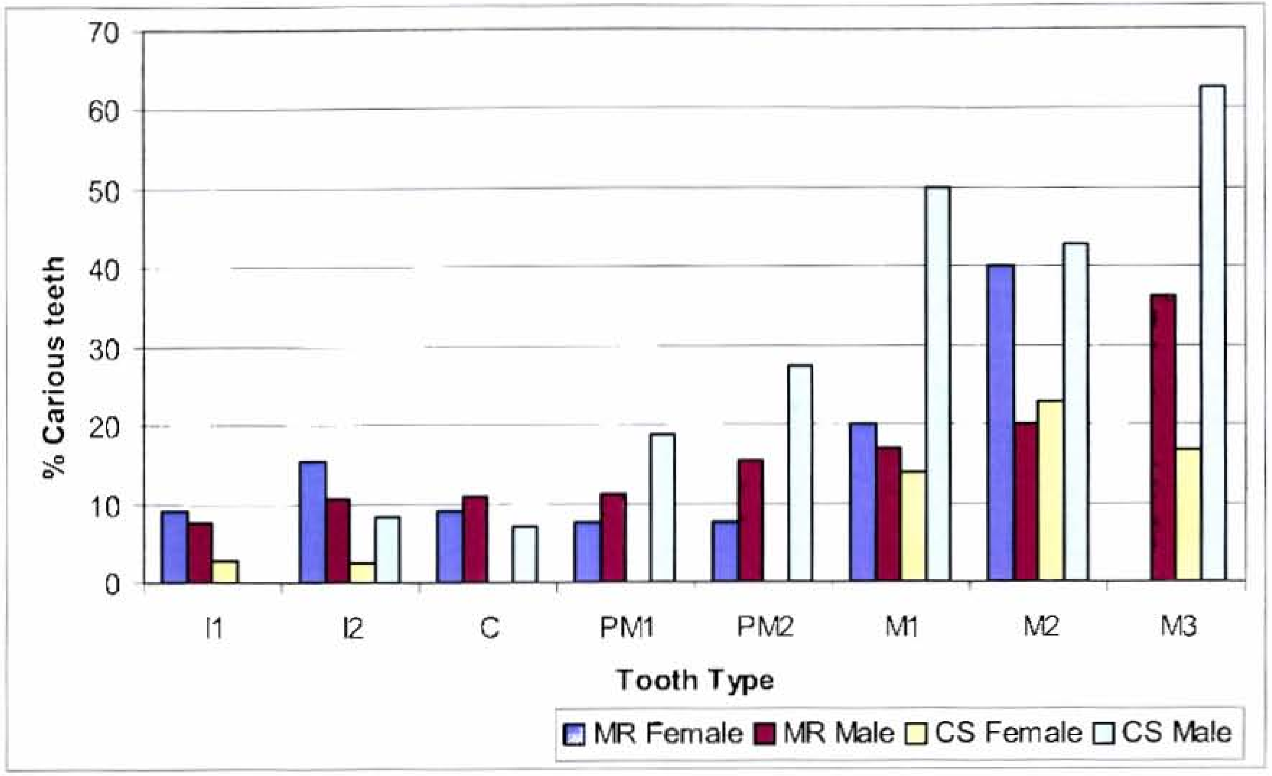

Figure 6.03: Pattern of dental caries in younger adults

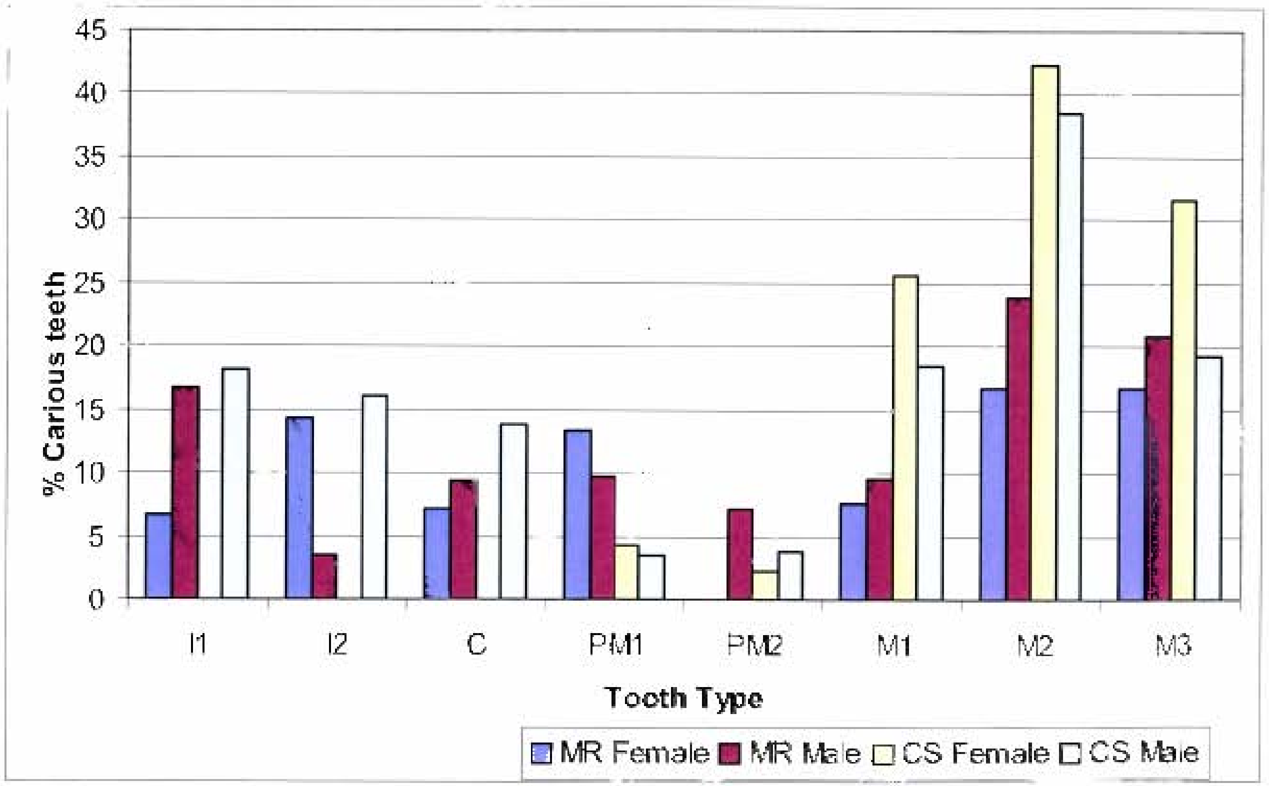

Figure 6.04: Pattern of dental caries in older adults

Site	Number teeth present	Carious teeth	%	Reference
Marina Residence	717	98	13.7	This study
Cobern Street	990	130	13.1	"
Oakhurst	192	34	17.7	Sealy et al., 1992
S-W Cape coast	948	246	2.6	"
Faraoskop	138	12	8.7	"
Griqua	1101	32	2.9	Peckmann, 2002
Dry Savanna	900	27	3.7	Dlamini, 2006
Wet Savanna	532	40	7.6	"
Forest	548	45	8.2	"
Toutswe	587	20	3.4	Mosothwane, 2003
Colesberg	1067	41	3.8	Peckmann, 2002
Wolmaransstad	552	29	5.5	"
Spitalfields, London^^	1626	311	19.1	Molleson et al., 1993
South Carolina Plantation	~	~	4.2	Rathbun, 1987
St Peters Street, New Orleans	~	~	22.3	Owsley et al., 1987
NYABG	~	~	4.6	Blakey & Rankin-Hill, 2004
Dutch 'Sint Janskerkhof'	2176	449	20.7	Maat et al., 2002
Suriname	315	29	9.2	Khudabux, 1991
Jarrow, Co. Durham	957	42	4.4	Roberts & Manchester, 1997
St Helen-on -the -Walls, York	7806	345	4.4	"
Blackfriars, Ipswich	461	28	6.1	"
Glasgow Cathedral	716	46	6.4	"
Blackfriars, Gloucester	1112	81	7.3	"
Dutch medieval (early period)	762	58	7.6	Maat et al., 1998
Dutch medieval (late period)	527	65	12.3	"

^^ Spitalfields individuals considered adult from 17 years old

Table 6.21: Comparative data of the percent of carious teeth in different populations

Site	Caries Presence No. carious teeth	%	Caries Frequency No. individuals with caries	%	Source
Marina Residence	98	13.7	23	79.3	This study
Cobern Street	130	13.1	31	78.5	"
Oakhurst	34	17.7	11	84.6	Sealy et al., 1992
Riet River	46.5	4.3	19	40.9	Morris, 1984
Kakamas	13	1.3	8	18.8	"
Griqua	32	2.9	15	29.1	Peckmann, 2002
Dry Savanna	37	3.7	13.8	35.5	Dlamini, 2006
Wet Savanna	23	7.6	6.5	48.1	"
Forest	36	8.2	10.9	55.4	"
Toutswe	20	3.4	10	21.7	Mosothwane, 2003
Colesberg	41	3.8	20	49.4	Peckmann, 2002
Wolmaransstad	29	5.5	11	42.4	"

Table 6.22: Comparison of caries frequency and caries presence

females. The individuals with the overall highest caries rates were the older adult females at Cobern Street with 4.7 carious teeth per mouth followed by the Marina Residence younger adult males with 4.3 carious teeth per mouth.

The comparative, table 6.21, the caries rates of Marina Residence and Cobern Street are much higher than those listed and comparable only to the Dutch late medieval period (Maat, 1998). When comparing the caries presence and frequencies, (Table 6.22) once again the present two study sites display far higher presence and frequencies than the other comparative samples except for the Oakhurst sample (Sealy et al., 1992), which is even higher. Yet a third option of comparing dental caries with other samples (Table 6.23) demonstrates that the number of individuals with caries at the present study is superceded by the "Urban Negro" group of Staz (1938) and the Spitalfields group of Molleson et al. (1993) who also had the only comparable number of carious teeth per mouth at 4.4 and 4.9 respectively, compared to 3.4 and 3.3 for Marina Residence and Cobern Street respectively. The other samples had far less individuals presenting with dental caries and thus also less carious teeth per mouth.

Carbohydrates are recognised as important etiological factors with respect to both balanced human nutrition and the expression of dental caries. High levels of carbohydrate provide important sources of energy in many non-industrialised societies and their presence in the oral cavity provides acidogenic bacteria in dental

Site	n*	% Indivs. with caries	Tot. No. of teeth	% Teeth carious	Ave. No. carious teeth per mouth	Source
Marina Residence (this study)	29	79.3	717	13.7	3.4	This study
Cobern Street (this study)	29.5	78.5	990	13.1	3.3	"
Riet River	46.5	41.7	1061	4.3	1.0	Morris, 1984
Kakamas	42.5	18.8	989	1.3	0.3	"
Griqua	51.5	29.1	1101	2.9	0.6	Peckmann, 2002
Dry Savanna	28.1	36.9	900	3.8	1.3	Dlamini, 2006
Wet Savanna	12.6	48.1	404	7.6	1.9	"
Forest	17.1	58.8	548	9.6	1.9	"
Mapungubwe & K2	47	48.9	485	14.0	1.4	Steyn, 1994
Gladstone	116	47.8	2694	4.3	1.3	Van der Merwe, 2006
Colesberg	40.5	20.0	1067	3.8	0.5	Peckmann, 2002
Wolmaransstad	21	11.0	522	5.5	1.4	"
Spitalfields^^	64	20.5	1626	19.1	4.9	Molleson et al., 1993
Rural "Primitive Negro"	300	38.3	9226	2.3	0.7	Staz, 1938
"Urban Negro"	300	90.0	9178	14.3	4.4	"

n* = number of individuals calculated differently between this study and comparative samples
^^ Spitalfields individuals considered adult from 17 years of age

Table 6.23: Dental caries comparisons with other populations (Modified from Peckmann, 2002)

plaque with fermentable substrates. As plaque formation increase, a permeable tooth coating for bacterial acids is provided (Schneider, 1986).

Dental caries is not usually thought of as a life-threatening condition. However, in prehistoric times, cavities resulting from caries continue too grow in size and are prone to infection that can spread to surrounding bone and soft tissue (Larson, 2002). It is known that dental caries affect populations worldwide, at all ages, both sexes and socioeconomic divisions. Abscess of the tooth frequently leads to its loss and is followed by remodeling that obliterates the alveolus (Pindborg, 1970, Schneider, 1986, Hillson, 1996, Larson, 2002). In order to analyse caries rates accurately, antemortem tooth loss (AMTL) must also be included in the examination.

6.2.4.3. Antemortem tooth loss

Antemortem tooth loss (AMTL) is a non-specific indicator of dental health. AMTL can be attributed to several factors including, untreated dental disease e.g. caries and abscess lesions, severe dental attrition, trauma and dental modification (Morris, 1992, Scott & Turner, 1997, Hillson, 1996). The exposure of the pulp cavity can lead to bacterial infection and subsequent abscessing of the surrounding alveolar bone that could result in loss of a tooth (Burns, 1999).

In societies where dental treatment is not common, tooth extraction is the only treatment for dental ailments. Antemortem loss of teeth has been linked to heavy attrition through the eventual destruction of the enamel leading to pulp cavity exposure, bacterial infection and resulting in tooth loss (Lucaks, 1989, Hillson, 1996, Keenleyside, 1998).

Dietary environment or behaviour has been implicated in the prevalence of AMTL in past populations (Hartnady & Rose, 1991, Larsen, 1997). Contrary to the decline in occlusal wear, the shift from a foraging to a farming economy was accompanied by an increase in tooth loss. Both minimal and severe dental wear have been associated with high incidences of tooth loss. However, dental wear alone, does not lead to AMTL i.e. factors such as bacteria on the tooth surfaces or periodontal tissues are involved in promoting some dental disease processes. Sometimes a reduction in dental occlusal wear as observed in agricultural populations, promotes bacterial growth in the grooves or fissures present in the posterior teeth (Larsen, 1997). Therefore, dental caries as a disease process is the main cause leading to tooth loss with reduced dental wear providing loci for the caries to develop.

There is an expectancy to find high incidences of AMTL in populations that rely on agricultural foods. A number of studies have reported high frequencies of AMTL in different settings (Roberts & Manchester, 1997). When comparing pre-historic foragers and farmers, there is an increase in tooth loss in the latter group. The cause of tooth loss is due to dental caries as a result of the highly caries causing diets like maize and wheat in combination with reduced dental wear of posterior teeth. The pre-historic foraging populations also show some tooth loss but at much lower rates reported for the farmers because their tooth loss is from extreme wear and not caries (Larsen, 1997, Sealy & Van der Merwe, 1992). A negative correlation between attrition rates and dental caries that results in tooth loss exists. The molars of sailors recovered from a 17^{th} and 18^{th} century Dutch whaling station in the Spitzberg Archipelago indicated that increased dental wear appears to be linked with less dental caries because of the reduction in fissures and grooves in the tooth crowns (Maat & Van der Velde, 1987).

Even though antemortem tooth loss was highest in both the older adult female and males from both study sites (Tables 5.31 to 5.38), the Marina Residence younger adult females have the most number of individuals with AMTL. The overall highest number of teeth lost antemortem being among the Cobern Street older adult female individuals. This is not surprising as their occlusal wear was not the highest thus possibly caries could easily have manifested in the fissures and grooves of their teeth increasing their susceptibility tooth loss.

The AMLT is higher in the females than in their male counterparts. The percentage of individuals with AMTL increases with an increase in age for the males at both study sites. However, there is an anomaly in the females AMTL rates in that it decreases with age. This could in part be attributed to the small sample sizes, which ruled statistical analysis out. Also, the younger females could be eating more cariogenic foods thus increasing their susceptibility to tooth loss. There is usually an inverse relationship between AMTL and caries i.e. a low AMTL is correlated with a high caries rate etc. This relationship is usually age dependent as older people typically have more tooth loss.

The percentage of AMTL can be seen in figures 6.05 and 6.06. The Marina Residence females show the highest rates of AMTL for the second and third molars in

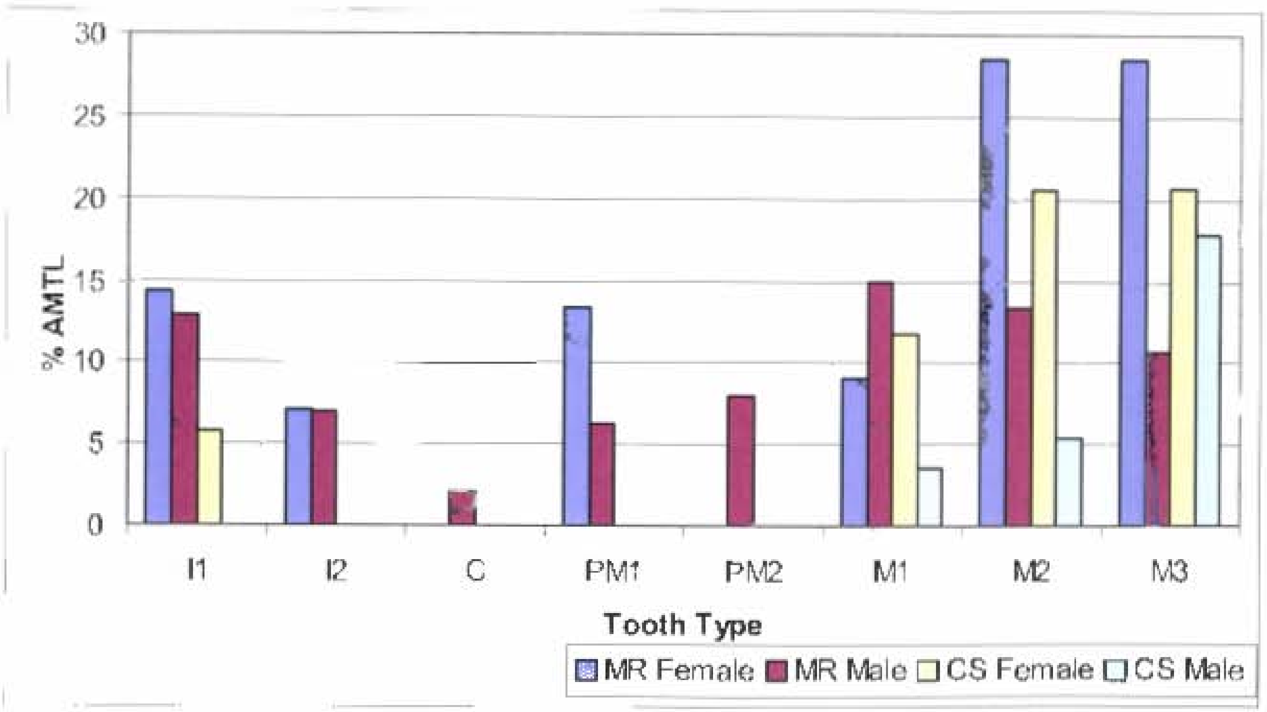

Figure 6.05: Antemortem tooth loss in younger adults

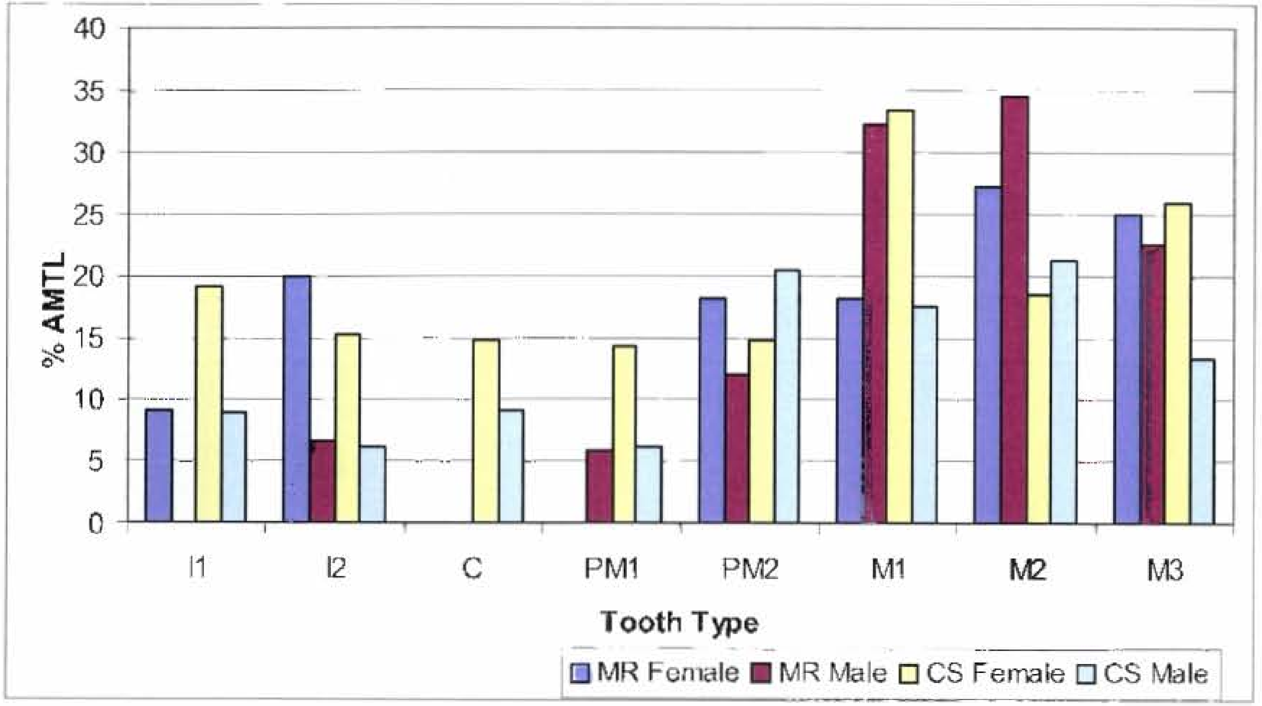

Figure 6.06: Antemortem tooth loss in older adults

the younger adult category. The Cobern Street older adult females and Marina Residence older adult males show similar AMTL rates in the first molar and the Marina Residence older adult males show the highest loss in the second molar. These were also most often the teeth with the highest caries rates.

Generally, most teeth affected by carious lesions are posterior teeth probably because of their morphology. This pattern is evident in most of the samples. The differences in AMTL prevalence between males and females may indicate the differences in food consumption between the sexes. At Marina Residence, the males displayed a higher caries rate (91.6%) but a lower AMTL rate (62.7%) than the females with a 48.5% caries rate and a 69% AMTL rate. At Cobern Street both the males and the females showed similar patterns i.e. high caries rates and lower AMTL rates. One of the less cited reasons for greater AMTL in females is that during pregnancy, women's teeth are often affected by stomach acids affecting teeth during vomiting thus making them more susceptible to tooth decay and subsequently tooth loss (personal conversations with a gynaecologist, 2007).

Site	Total teeth	n lost antemortem	%	Source
Marina Residence	900	92	10.2	This study
Cobern Street	1256	108	8.6	"
Griqua	1490	330	22.1	Peckmann, 2002
Dry Savanna	900	72	8.0	Dlamini, 2006
Wet Savanna	404	65	16.1	"
Forest	548	45	8.2	"
Colesberg	1329	201	15.1	Peckmann, 2002
Wolmaransstad	658	120	18.2	"
Sint Janskerkhof'	3200	528	16.5	Maat et al., 2002
Suriname	546	102	18.7	Khudabux, 1991
Jarrow, Co. Durham	1399	128	9.1	Roberts & Manchester, 1997
St Helen-on -the -Walls, York	9788	171	17.5	"
Blackfriars, Ipswich	1589	279	17.6	"
Spitalfields, London^^	2150	324	15.1	Molleson et al., 1993
South Carolina Plantation	~	~	9.0	Rathbun, 1987
Dutch medieval (early period)	1198	194	16.2	Maat et al., 1998
Dutch medieval (late period)	926	177	19.1	"

^^ Spitalfields individuals considered adult from 17 years old

Table 6.24: Comparison of antemortem tooth loss with other samples

When eating a westernised diet, as many people do today, one would expect the M1 to be the tooth most affected by caries and AMTL, as it is the first to erupt and therefore has a longer exposure time. This diet is cariogenic and very low in abrasive substances, the teeth are thus not automatically cleaned by chewing. This however is not the case for Marina Residence and Cobern Street where the M2 and M3 teeth were most frequently affected by caries and subsequent AMTL. This seems to indicate that these people were eating a cariostatic diet that were high in abrasives and thus this frequent mechanical cleaning protected the M1 but caused lots of wear on the M2 and M3 teeth leading to their more frequent loss (Morris, 1992).

The type of food consumed and the manner in which it is prepared strongly influence the incidence of caries and AMTL in human populations. Thus comparisons are once again drawn with other study populations (Table 6.24). The Marina Residence group is comparable to the Jarrow group from Durham (Roberts & Manchester, 1997) and the slave population from the South Carolina Plantation (Rathbun, 1987). Cobern Street is comparable to the dry savanna and forest groups (Dlamini, 2006). Both the present study groups have a smaller AMTL rate than the Griqua, Colesberg and Wolmaransstad groups (Peckmann, 2002), the early and late period Dutch medieval groups (Maat, 1998), the St Helen-on-the-Walls, Blackfriars and Ipswich groups (Roberts & Manchester, 1997).

Site	**AMTL Intensity**		**AMTL Frequency**		**Source**
	No. of teeth lost antemortem	**%**	**No. of indiv. with AMTL**	**%**	
Marina Residence	92	10.2	18	58.6	This study
Cobern Street	108	8.6	23	64.3	"
Riet River	95	6.1	17	35.1	Morris, 1984
Kakamas	54	4.1	7	17.1	"
Griqua	330	22.1	34	66.0	Peckmann, 2002
Dry Savanna	72	8.0	9.6	34.2	Dlamini, 2006
Wet Savanna	65	16.2	8	63.4	"
Forest	45	8.2	12.4	72.3	"
Toutswe	7	1.1	4	8.7	Mosothwane, 2003
Colesberg	201	15.1	26	57.1	Peckmann, 2002
Wolmaransstad	120	18.2	16	76.2	"

Table 6.25: Comparison of antemortem tooth loss intensity and frequency

When looking at the comparison of the present study to other studies the AMTL intensity and frequencies give different results (Table 6.25). For AMTL intensity, the Marina Residence sample is most similar the Cobern Street (this study), dry savanna and forest samples (Dlamini, 2006). However when looking at AMTL frequencies, Marina Residence is more similar to the Colesberg group (Peckmann, 2002) and the Cobern Street Group is more similar to the wet savanna (Dlamini, 2006) and Griqua (Peckmann, 2002) groups than to each other.

The relatively high prevalence of AMTL and caries in the Marina Residence and Cobern Street groups is consistent with populations subsisting on agricultural products. Socio-cultural factors such as intentional dental modification by filing have also played an important role in affecting the dental health of these populations. Differential access to food and other resources probably caused the differences observed between the males and the females.

6.2.4.4. Abscesses

Dental caries and occlusal wear can predispose to the development of a dental abscess through exposure of the pulp cavity from attrition or trauma and infiltration of the cavity by bacteria. Abscess formation can occur if an individual develops periodontal disease and a periodontal pocket. This is initiated by the accumulation of plaque between the soft tissue of the gum and teeth. Once microorganisms accumulate in the pulp cavity, inflammation begins and a body of pus collects and is termed an abscess. As the pus accumulates, pressure builds up and eventually a sinus develops on the surface of the jaw to allow the pus to escape. At this stage of the process, an abscess can be identified archaeologically. Prior to this stage identification is only possible by means of an x-ray (Mann & Murphy, 1990, Robert & Manchester, 1997, Aufderheide & Rodriquez-Martin, 1998, Burns, 1999). Possible reasons for the high caries rates has already been mentioned and should also be used to explain the incidence of abscesses.

Individuals presenting with abscesses are fairly low in the two study sites. At Marina Residence, seven individuals present with abscesses, thus there were only 0.5 abscesses per mouth. At Cobern Street the abscesses per mouth were slightly higher at 0.8 abscesses per mouth.

When comparing the present study to other groups (Table 6.26), the Marina Residence site is most similar to the British groups of Jarrow, St Helen-on-the-Wall and Blackfriars (Ipswich) (Roberts & Manchester, 1997) while the Cobern Street site is most similar to the British groups of Glasgow Cathedral and Blackfriars (Gloucester) (Roberts & Manchester, 1997). Both the present study groups were most dissimilar to the Griqua, Colesberg and Wolmaransstad (Peckmann, 2002), South Carolina Plantation (Rathbun, 1987) and the Dutch medieval (Maat, 1998).

Site	Tooth positions observed	n	%	Source
Marina Residence	900	13	1.4	This study
Cobern Street	1256	30	2.4	"
Griqua	1101	5	0.5	Peckmann, 2002
Colesberg	1067	5	0.5	"
Wolmaransstad	552	1	0.2	"
South Carolina Plantation	~	28	0.4	Rathbun, 1987
Jarrow, Co. Durham	1128	16	1.1	Roberts & Manchester, 1997
St Helen-on -the -Walls, York	9788	113	1.2	"
Blackfriars, Ipswich	1589	25	1.6	"
Glasgow Cathedral	897	14	2.0	"
Blackfriars, Gloucester	644	14	2.3	"
Dutch medieval (early period)	762	63	7.1	Maat et al., 1998
Dutch medieval (late period)	527	38	5.9	"

Table 6.26: Comparison of abscesses with other populations

Possible causes of dental abscesses include trauma, caries and attrition (Hillson, 1986, Kvaal & During, 1999). According to Roberts & Manchester (1997), it is likely that the estimate of the prevalence of dental abscess in the past is an underestimate of the true prevalence, especially when the high prevalence of caries and calculus deposits is considered in some populations. In both samples, abscesses and antemortem tooth loss were more common in older individuals, reflecting an increase in these forms of dental pathology with age. This being the case, it can be concluded that the diet of these people must have been high in foods causing poor oral health.

6.2.4.5. Diet at the Cape

The Cape was meant to be a refreshment station for the Dutch sea going vessels. The Company gardens were planted with fruit trees, such as lemon and orange trees;

vegetables, such as pumpkin, cucumber, sweet potatoes, radishes, cabbages, carrots, beetroot, watermelons, artichokes, peas, currants, strawberries, prunes, different types of beans and grain crops, such as wheat, rye, barley, oats and buckwheat. Passing ships also brought in supplies of rice, as this crop did not grow well at the Cape. Fresh meat was obtained from Robben Island where sheep, hare and pigs were bred.

These were supplemented with fresh fish caught along the coast (Burrows, 1958, Coetzee, 1977). The diet at the Cape was diverse among the different social classes. Hospital patients were fed bread. Soldiers ate mutton, vegetables and beef. The diet of the lower class at the Cape in the 18th and 19th centuries consisted mainly of rice, wheat, some meat and marine protein. Food also included, salted dassies (Procavia capensis), seal flesh, beef, fish (salted and fresh), salted penguin and smoked porcupine. Indian corn (mealies) had established itself as an important article of food by 1825 (Laidler & Gelfand, 1971).

When writing about the history of the early Cape, Bozarth (1987) states that slaves initially consumed large quantities of rice as their main staple diet until about the mid 1800's. Additional wheat was later cultivated to make bread for slave consumption. Seal meat supplemented their diets as well as fish, and domestic (sheep) and wild (game) animals but only the undesirable parts. The meat would be fresh, dried or salted. However, during times of shortage, no meat was given to the slaves. They then survived on bread, peas, beans and meal (Bozarth, 1987).

The diet of the people at that time would have had a profound effect on their dentition. According to Roberts & Manchester (1997), dental disease have been strongly linked to cultural behaviour. Oral health indicators have frequently been used to reconstruct the dietary patterns and lifestyles of skeletal populations (Keenleyside, 1998, Erdal & Duyar, 1999).

According to Schneider (1986), the shift from a hunting-gathering-fishing subsistence base to that focused on horticulture not only increased caries by introducing readily fermentable carbohydrate foodstuffs (which could have increased bacterial destruction of dental enamel) but also affected acquired dental pathology expression by altering the availability of elements present during enamel calcification. This shift from one form of subsistence to another could very well have taken place when people were brought to the Cape either as slaves, indentured workers or settlers.

The dentition of the Cobern Street and Marina Residence individuals shows high dental wear. As can be seen from the above information of diet at the early

Cape, they would not have had access to the choicest cut of meat and more refined foodstuffs. The higher caries rate found within the study groups would have been as a result of the large quantities of carbohydrates such as rice, wheat and corn consumed as part of their daily diets. The moderate antemortem tooth losses (AMTL) and abscesses could also be result of the carbohydrate rich diet. Poor oral hygiene would also have contributed towards this higher caries rate and moderate AMTL.

6.2.5. Dental modification

Modification to the teeth may be intentional or unintentional resulting from severe abrasion and excessive biting force or both (Aufderheide & Rodiquez-Martin, 1998). Here it is used to describe the intentional ritual alteration of the dentition. The three main methods of dental modification are tooth avulsion (extraction), true filing (filing either the occlusal or mesial and /or lateral surfaces of the teeth) and tooth chipping (medial and / or lateral surfaces and buccal and / or lingual surfaces). The modification is usually carried out so as to be bilaterally symmetrical and often involves the upper and / or lower incisors (Friedling, 2004).

According to Van Reenen (1977) and Bachmayer (1982), dental modification of the teeth was usually a tradition found amongst the people who practiced it. Many scientists (Davies, 1972, Van Reenen, 1977, Bachmayer, 1982, Gould et al., 1984, Scott & Turner, 1997) agree that the incentive for the modification may have related to rites of passage, status differentiation, religious connotation, simple cosmetics or other cultural motivations i.e. ethnic markers or tribal identification.

Dental modification through filing can weaken the teeth and added attrition over time often exposes the dental pulp cavity to infection. This can eventually lead to tooth loss.

6.2.5.1. Intentional dental modification

Dental modification is by no means a phenomenon unique to Africa. It has been practiced worldwide for centuries (Friedling, 2004, Friedling & Morris, 2005, 2007). The various reasons for the modification have long been studied and these often included tribal identification (Van Reenen, 1986), social stratification (Gould et al., 1984), beautification (Jones, 1992, 2001), initiation at puberty and punishment (Shaw, 1931). Ethnographic and archaeological evidence of the intentional modification of the incisors and often the canines has shown that this was a common practice done by numerous groups in sub-Saharan Africa (Morris, 1989, 1998, van Reenen, 1986, Friedling, 2004). Dental modification in the form of tooth extraction, filing and chipping has been documented among numerous population groups in southern Africa, both historic and current (Morris, 1989, 1998, van Reenen, 1986; Shaw, 1931, Erlandsson & Bäckman, 1999, Friedling, 2004, Friedling & Morris, 2005, 2007). The evidence for this practice in prehistory comes from skeletal populations from sites such as K2 and Mapungubwe, South Africa (Steyn, 1994), KwaGandaganda and Nanda, South Africa (Morris, 1998) and Toutswe, Botswana (Mosothwane, 2003). Thus the practice occurred in the northern parts of southern Africa.

Dental modification was practiced by some of the individuals from Marina Residence and Cobern Street. Most of those involved in the practice were males. The individuals from Marina Residence had the medial and / or lateral incisor borders filed. The Cobern Street individuals had three styles of dental modification; one similar to the Marina Residence group and the other two was the filing of the maxillary incisor buccal or lingual surface. No known form of dental modification was practiced at the Cape before the very late19th century. Interestingly, a style of dental modification not seen at either Cobern Street or Marina Residence is that of the removal of the upper four incisors, a style that has become quite prevalent in the Western Cape since the very late 19th and early 20th centuries and is being practiced even today (Friedling, 2004, Friedling & Morris, 2005, 2007).

Site	n*	Dental Modification No. with dental modification	%	Source
Marina Residence	29	4	13.8	This study
Cobern Street	39.5	13	32.9	"
Dry Savanna	28.1	4	14.2	Dlamini, 2006
Wet Savanna	12.6	1	7.9	"
Forest	17.1	9	52.6	"
K2 & Mapungubwe	22	4	18.2	Steyn, 1994

Table 6.27: Comparison of intentional dental modification

A comparison of dental modification with other study groups (Table 6.27) showed that the Marina Residence group was most similar in the percentage of individuals involved in the practice to the dry savanna group (Dlamini, 2006). The Cobern Street group was different from all the other groups. This could mean that a larger percentage of the Cobern Street population was brought to the Cape from elsewhere in Africa where dental modification could have been practiced as a part of their homeland culture. If this is the case, more of the Cobern Street group could have been brought to the Cape as slaves in comparison to the Marina Residence group, which had the relatively lower percentage of intentionally modified teeth.

6.2.5.2. Pipe stem wear

Pipe-smoker's wear is caused by clay pipe stems (abrasive material) being held in a steady position between the teeth over a long period of time. The wear on the teeth can be unilateral (pipe held only in one side of the mouth) or bilateral (pipe move from one side of the mouth to the other). Characteristically, the wear is on the lateral incisors and canines (Corrucini et al., 1982, Morris, 1988) but can involve the first premolars.

Both Marina Residence and Cobern Street had a number of individuals with pipe-smoker's wear. Although Cobern Street had more individuals with pipe-smoker's wear, Marina Residence had the higher frequency of the two sites.

Cultural and behavioural activities such as the intentional and unintentional alteration of the dentition can often be used to identify groups of people. In the case of the deliberate alteration of the dentition at the present two study sites, the styles of medial and / or lateral incisor border filing found at Marina Residence and Cobern Street are those most generally seen in East, West and Central Africa (Gould et al., 1984). Although the practice of dental modification has been found in South African historical populations, it can be assumed that these individuals found at Marina Residence and Cobern Street with dental modifications were most probably imported slaves.

Chapter 7

CONCLUSIONS

Although advances in our knowledge of the nature of Cape Town bio-history through osteological analysis are progressing, a fuller and more comparative understanding of the dynamics and effects of the elite versus the poor still needs additional skeletal research. The influx of slaves and free burghers from various places in Africa, Asia, Europe and the East made the Cape a "smeltering pot" for a variety of cultures and ethnicities. It is ironic that many came to the Cape to start a new life, free from persecution while others where brought into the Cape to lead a life of persecution. Colonial life under the Dutch brought slavery, yet in the time that the British ruled, even though they were apposed to the system of slavery, more slaves were imported under their rule than under Dutch rule!

When analysing the skeletal material, the variety of ageing and sexing techniques used were complimentary and helped to overcome the problems caused by analysing fragmentary, poorly preserved and incomplete samples.

The Marina Residence site had only 6 individuals under the age of 20 years; the other 64 were individuals with more males than females being present. In contrast, Cobern Street had a more even spread of individuals ranging from infants to old adults. Cobern Street better reflects a "normal" cemetery sample from a local population. Marina Residence is male dominant and is thus likely to reflect a labouring group of men, with fewer women and children in the community.

Occupational activities were assessed using a wide variety of osteological observations such as the presence of degenerative joint disease, trauma and muscle marking lesions. As would generally be anticipated, musculoskeletal marker mean scores proved higher for males than females in most cases. Some of the dissimilarities observed between males and females may well have derived from muscular activity patterns that were distinct to sex. Age proved to be a contributing factor to increased entheseal reaction. Observations of skeletal activity suggest that these groups led demanding, harsh existences that were borne out in the results from there muscle marking scores. The presence of degenerative joint disease shows that the groups were physically active and subject to strenuous activities. The Cobern Street group had similar muscle marking scores for their arms and legs whereas the

Marina Residence group had higher muscle making scores for the legs for all ages and both sexes.

One would expect the stress levels to be high in populations that are involved in strenuous activities, yet the stress levels for Cobern Street and Marina Residence is moderate.

Although infections were common in the samples, the ability to withstand pathogen assault and recovery was indicated by the numerous cases of remodeled bone in the form of non-specific markers. The Cobern Street site yielded the first documented case of tuberculosis at the Cape. The first probable treponemal infections such as yaws or syphilis were also documented with certainty. There were a few non-infectious diseases. The first case of Paget's disease was also recorded in a historical population at the Cape.

The incidence of trauma was low at both Cobern Street and Marina Residence. The most cases involved healed post-cranial fractures. The first case of an autopsied skull at the early Cape was recorded.

Dental caries and antemortem tooth loss revealed poor dental health at Marina Residence and Cobern Street. The study of dental occlusal surfaces of the teeth indicates consumption of hard foods associated with abrasives (such as stone ground flour) leading to excessive wear. This is consistent with a diet rich in carbohydrates and large quantities of unprocessed and unrefined food. Poor oral hygiene would also have played a role in caries and tooth loss.

The full scope of Cape Town history has yet to be recorded. The immediate reburial of these accidentally discovered skeletons would have been short-sighted in the light of the amount of information that has been gathered from them for the descendant communities. It is therefore of the utmost importance for us to continue studying the human skeletal remains of our past ancestors to be able to fill in the gaps of our history in Cape Town and the greater South Africa. I believe that this project has filled such a gap.

REFERENCES

ARCHIVES:

Maps:
ARTOPO 120F
ARTOPO 1585

Deeds Office:
Grant Volume 1, Number 79 92.2.1827, Diagram 15/1827

Agval SC & Grynpas MD. 1996. Bone quantity and quality in past populations. The Anatomical Record 246: 423 – 432.

Allison MJ, Mendoza D & Pezzia A. 1974. A radiographic approach to childhood illness in Precolumbian inhabitants of southern Peru. American Journal of Physical Anthropology 40: 409 – 416.

Al-Oumaoui I, Jimenez-Brobeil S & du Souich P. 2004. Markers of activity patterns in some populations of the Iberian Peninsula. International Journal of Osteoarchaeology 14: 343 – 359.

Ameen S, Staub L, Ulrich S, Vock P, Ballmer F & Anderson SE. 2005. Harris lines of the tibia across centuries: a comparison of tow populations, medieval and contemporoary in Cenral Europe. Skeletal Radiology 34(5): 279 – 284.

Angel JL, Kelley JO, Parrington M & Pinter S. 1987. Life stresses of the Free Black community as represented by the First American Baptist Church, Philadelphia, 1823 – 1841. American Journal of Physical Anthropology 74: 213 – 229.

Angel JL. 1966. Porotic hyperostosis, anemias, malarias and marshes in prehistoric eastern Mediterranean. Science 153: 760 – 763.

Angel JL 1969. The bases of paleodemography. American Journal of Physical Anthropology 30: 427 – 438.

Angel JL. 1981. History and development of paleopathology. American Journal of Physical Anthropology 55: 509 – 515.

Appolonio H. 1998. Cobern Street: Excavations at an unmarked burial ground in Cape Town, South Africa. African-American Archaeology Newsletter. 20: 2

Asala SA. 2001. Sex determination from the head of the femur of South African whites and blacks. Forensic Science International 117: 15 – 22.

Asala SA. 2002. The efficiency of the demarking point of the femoral head as a sex determining parameter. Forensic Science International 127: 114 – 118.

Aubry M, Mafart B, Donart B & Brau JJ. 2003. Brief communication: Study of noncarious cervical tooth lesions in samples of prehistoric, historic and modern populations from the south of France. American Journal of Physical Anthropology 121: 10 – 14.

Aufderheide AC & Rodriguez-Martin C. 1998. The Cambridge Encyclopaedia of Human Palaeopathology. Cambridge University Press.

Aykroyd RG, Lucy D, Pollard AM & Solheim T. 1997. Technical note: Regression analysis in adult age estimation. American Journal of Physical Anthropology 104: 259 – 265.

Baker BJ & Armelagos GJ. 1988. The origin and antiquity of syphilis: Paleopathological diagnosis and interpretation. Current Anthropology 29(5): 703 – 735.

Bachmayer DI. 1982. Tooth mutilating practices amongst the Barakwena and Vassakela Bushmen in West Caprivi and the peoples of Kavango. Journal of the Dental Association of South Africa 37: 173-177.

Beisel WR. 1982. Single nutrients and immunity. The American Journal of Clinical Nutrition 35 (Supplement): 417 – 468.

Bello SM, Thimann A, Signoli M, Dutour O & Andrews P. 2006. Age and sex bias in the reconstruction of past population structures. American Journal of Physical Anthropology 129: 24 – 28.

Black III TK. 1978. A new method for assessing the sex of fragmentary skeletal remains in femoral shaft circumference. American Journal of Physical Anthropology 48: 227 – 231.

Blackburn A & Knüsel CJ. 2006. Hand dominance and bilateral asymmetry of the epicondylar breadth of the humerus. Current Anthropology 47 (2): 377 – 382.

Blakey ML & Rankin-Hill LM. (Eds.). 2004. The New York African Burial Ground skeletal biology final report. Volume 1-2, Howard University, Washington DC.

Blom DE, Buikstra JE, Keng L, Tomczak PD, Shoreman E & Stevens-Tuttle D. 2005. Anemia and childhood mortality: Latitudinal patterning along the coast of Pre-Columbian Peru. . American Journal of Physical Anthropology 127: 152 – 169.

Bickford-Smith V. 1993. Slavery emancipation and the question of Coloured identity with particular attention to Cape Town 1975 –1910. In: The Societies of Southern Africa in the 19th and 20th centuries. University of London: Institute for Commonwealth Studies, London.

Bickford-Smith V. 1995. Ethnic pride and racial prejudice in Victorian Cape Town. Cambridge University Press, UK.

Bird W. 1966. The state of the Cape of Good Hope in 1822. Africana Collectanea Series Volume XIX. Struik (Pty), Ltd. Cape Town.

Bocquet-Appel JP & Masset C. 1996. Paleodemography: Expectancy and false hope. American Journal of Physical Anthropology 99: 571 – 583.

Bosch X. 2000. Look to the bones for clues to human disease. Lancet 355: 1248 -1249.

Boucher BJ. 1957. Sex differences in the foetal pelvis. American Journal of Physical Anthropology, 15: 581-600.

Boxer CB. 1965. The Dutch Seaborne Empire 1600 – 1800. Hutchinson & Co. Ltd, London.

Bozarth DC. 1987. Burgher, boer and bondsman: A survey of slavery at the Cape of Good Hope under the Dutch East India Company, 1652 – 1795. PhD Thesis, Faculty of the Graduate School, University of Maryland, USA.

Bradlow E & Bradlow F. 1979. William Somerville's narrative of his journeys to the Eastern Cape Frontier and to Lattakoe 1799 – 1802. Van Riebeeck Society, 2nd Series, No.10. Cape Town

Briedenhann SJ & Van Reenen JF. 1985. Tooth extraction and tooth mutilating practices amongst the Herero-speaking peoples of South West Africa (Namibia). Journal of the Dental Association of South Africa 40:531-536.

Briedenhann SJ. 1987. Maxillary midline diastema and its association with ritual extraction of mandibular incisors in the Herero-speaking people of Kaokoland. Journal of the Dental Association of South Africa 42: 461-468.

Brooks S & Suchey JM. 1990. Skeletal age determination based on the os pubis: A comparison of the Acsádi-Nemeskeri and Suchey-Brooks methods. Human Evolution 5(3): 227 -238.

Brothwell DR. 1981. Digging up bones. London: British Museum of Natural History.

Buckberry JL & Chamberlain AT. 2002. Age estimation from the auricular surface of the ilium: A revised method. American Journal of Physical Anthropology 119: 231 – 239.

Buckley HR & Tayles N. 2003. Skeletal pathology in a prehistoric Pacific Island sample: Issues in lesion recording, quantification and interpretation. American Journal of Physical Anthropology 122: 303 – 324.

Buikstra JE. 1976. The Caribou Eskimo: General and specific disease. American Journal of Physical Anthropology 45: 351 – 368.

Buikstra JE & Ubelaker DH. 1994. Standards: For data collection from human skeletal remains. Arkansas Archaeological Survey Research Series No. 44.

Burns KR. 1999. Forensic anthropology training manual. New Jersey: Prentice Hall.

Burrows EH. 1958. A history of medicine in South Africa up to the end of the 19th century. AA Balkema, Cape Town.

Buzhilova A. 1999. Medieval examples of syphilis from European Russia. International Journal of Osteoarchaeology 9: 271 – 276.

Buzon MR. 2006. Health of the Non-Elites at Tombos: Nutritional and disease stress in New Kingdom Nubia. . American Journal of Physical Anthropology 130: 26 – 37.

Byers SN. 1991. Technical note: Calculation of age at formation of radiopaque transverse lines. American Journal of Physical Anthropology 85: 339 – 343.

Byers SN & Roberts CA. 2003. Bayes' Theorum in palaeopathological diagnosis. American Journal of Physical Anthropology 121: 1 – 9.

Caffey J. 1951. Cooley's erthroblastic anemia: Some skeletal findings in adolescents and young adults. American Journal of Roentgenography and Radium Therapy 65(4): 547 – 560.

Campbell J. 1815. Travels in South Africa undertaken at the bequest of the Missionary Society. Black, Parry and Company, London.

Churchill SE & Morris AG. 1998. Muscle marking morphology and labour intensity in prehistoric Khoisan foragers. International Journal of Osteoarchaeology 8: 390 – 411.

Clark GA. 1988. New method for assessing changes in growth and sexual dimorphism in paleoepidemiology. American Journal of Physical Anthropology 77: 105 – 116.

Clark NG, Sheard NF & Kellehaer JF. 1992. Treatment of iron-deficiency anemia complicated by scurvy and folic acid deficiency. Nutrition Reviews 50(5): 134 – 137.

Clarke SK. 1982. The association of early childhood enamel hypoplasias and radioplaque transverse lines in a culturally diverse prehistoric skeletal sample. Human Biology 54(1): 77 – 84.

Coetzee R. 1977. The South African culinary tradition. Struik, Cape Town.

Collins TFB. 1982. The history of South Africa's first tuberculosis epidemic. South African Medical Journal 62: 780 – 788.

Constant DA & Louw GJ. 1997. Age and sex distributions for the Cobern Street Collection. Paper delivered t the 27th Annual Congress of the Anatomical Society of Southern Africa, Cape Town, South Africa.

Cook D. 1979. Subsistence base and health in prehistoric Illinois Valley: Evidence from the human skeleton. Medical Anthropology 3: 109 – 123.

Corruccini RS, Handler JS, Mutaw RJ & Lange FW. 1982. Osteology of a slave burial population from Barbados, West Indies. American Journal of Physical Anthropology 59: 443 – 459.

Cox G. 1999. Cobern Street burial ground: Investigating the identity and life histories of the underclass of 18th century Cape Town. MSc Thesis in Archaeology, University of Cape Town.

Cruwys E & Foley RA. (Eds.). 1986. Teeth and Anthropology. BAR International Series 291. Oxford, England.

Dallman PR. 1987. Iron deficiency and the immune response. American Journal of Clinical Nutrition 46: 329 – 334.

Damon A. 1964. Some host factors in disease: Sex, race, ethnic group and body form. American Journal of Physical Anthropology 22: 375 – 382.

Davids A. 1992. Muslim-Christian relations in 19th century Cape Town. Kronos 19: 80-101.

De Kock V. 1950. Those in bondage. NG Kerkpers, Cape Town.

Dlamini N. 2006. An assessment of the health status by non-specific stress indicators in early farming populations. MSc Thesis, University of Cape Town.

El-Najjar MY, Ryan DJ, Turner II CG & Lozoff B. 1976. The etiology of porotic hyperostosis among the prehistoric and historic Anasazi Indians of southwestern United States. American Journal of Physical Anthropology 44: 477 – 488.

Elphick R. 1977. Kraal and Castle. Yale University Press, New Haven.

Elphick R. 1979. The Khoisan to c.1770. In: Elphick R & Giliomee (Eds.). The shaping of South African Society. Longman Ltd, London. Pp 3 – 40.

Elphick R & Shell R. 1989. Intergroup relations: Khoikhoi, Settlers, Slaves and Free Blacks, 1652 –1795. In: Elphick R & Giliomee H. (Eds.). The shaping of South African society 1652 – 1840. Maskew Miller Longman Pty Ltd. Cape Town. Pp 184 – 239.

Erasmus Z. (Ed). 2001. Coloured by history shaped by place. Kwela Books and South African History Online, Cape Town, South Africa.

Erdal YS & Duyar İ. 1999. Brief communication: A new correction procedure for calibrating dental caries frequency. American Journal of Physical Anthropology 108: 237 –240.

Erlandsson A-L & Bäckman B. 1999. A case of dental mutilation. Journal of Dentistry for Children 66: 278-279.

Eshed V, Gopher A, Galili E & Hershkovitz I. 2004. Musculomarkers stress markers in Natufian hunter-gatherers and Neolithic farmers in the Levant: The upper limb. American Journal of Physical Anthropology 123: 303 – 315.

Eshed V, Gopher A, Gage TB & Hershkovitz I. 2004. Has the transition to agriculture reshaped the demographic structure of prehistoric populations? New evidence from the Levant. American Journal of Physical Anthropology 124: 315 – 329.

Fairgrieve SI & Molto JE. 2000. Cribra orbitalia in two temporally disjunct population samples from the Dakhleh Oasis, Egypt. American Journal of Physical Anthropology 111: 319 – 331.

Feldesman MR, Kleckner JG & Lundy JK. 1990. The femur/stature ratio and estimates of stature in mid- and late- Pleistocene fossils hominids. American Journal of Physical Anthropology 83: 359 – 372.

Feldesman MR & Fountain RL. 1996. "Race" specificity and the femur/stature ratio. American Journal of Physical Anthropology 100: 207 – 224.

Formicola V & Buzhilova AP. 2004. Double child burial from Sunghir (Russia): Pathology and inferences for Upper Paleolithic funerary practices. American Journal of Physical Anthropology 124: 189 – 198.

Friedling LJ. 2004. Dental modification practices on the Cape Flats in the Western Cape. MSc Thesis, University of Cape Town.

Friedling LJ & Morris AG. 2005. The frequency of culturally derived dental modification practices on the Cape Flats in the Western Cape. South African Dental Journal 60(3): 97 –102.

Friedling LJ & Morris AG. 2007. Pulling teeth for fashion: Dental modification in modern day Cape Town, South Africa. South African Dental Journal 62(3): 106 –113.

Frost HM. 1958. Preparation of thin undecalcified bone sections by rapid manual method. Stain Technology 33: 272 – 276.

Frutos LR. 2003. Brief communication: Sex determination accuracy of the minimum supero-inferior femoral neck diameter in a contemporary rural Guatemalan population. American Journal of Physical Anthropology 122: 123 – 126.

Garn SM, Silverman FM, Hertzog KP & Rohmann CG. 1968. Lines and bands of increased density, their implication to growth and development. Medical Radiography and Photography 44(3): 58 – 89.

Gilder SSB. 1984. South African medicine in the 1880's. South African Medical Journal 66: 247 – 249.

Gillet RM. 1991. Determination of age at death in human skeletal remains: a comparison of two techniques. International Journal of Anthropology 6(2): 179 – 189.

Gindhart PS. 1969. The frequency of appearance of transverse lines in the tibia in relation to childhood illnesses. American Journal of Physical Anthropology 31: 17 – 22.

Goldin I. 1987. The reconstitution of Coloured identity in the Western Cape in: The politics of race, class and nationalism in twentieth century South Africa. Marks. S and Trapido, S (Eds.). Longman:158, New York.

Gonzalez-Reimers E, Mas-Pascual MA, Arnay-de-la-Rosa M, Velasco-Vasquez J, Santolaria-Fernandez F & Machado-Calvo M. 2004. Noninvasive estimation of bone mass in ancient vertebrae. American Journal of Physical Anthropology 125: 121 – 131.

Goodman AH, Thomas RB, Swedlund AC & Armelagos GJ. 1988. Biocultural persepectives on stress in prehistoric, historical and contemporary population research. Yearbook of Physical Anthropology 31: 169 – 202.

Goodman AH & Martin DL. 2002. Reconstructing health profiles from skeletal remains. In: Steckel, R. H. and Rose, J. C. (Eds.). The backbone of history: Health and nutrition in the Western hemisphere. Cambridge University Press. Pp 11 – 60.

Gould AR, Farman AG & Corbitt D. 1984. Modifications of the dentition in Africa. Quintessence International 1: 89-94.

Grabiner MD. 1989. The elbow and radioulnar joints. In: Rasch P. J., (Ed). Kinesiology and applied anatomy. Lea and Febiger, London. Pp 136-150.

Grauer AL. 1993. Patterns of anemia and infection from medieval York, England. American Journal of Physical Anthropology 91: 203 – 213.

Grauer AL & McNamara EM. 1995. A piece of Chicago's past: Exploring childhood mortality in the Dunning poorhouse cemetery. In: Grauer AL. (Ed.). Bodies of evidence. Wiley-Liss, New York. Pp 91 –104.

Grauer AL & Roberts CA. 1996. Paleoepidemiology, healing, and possible treatment of trauma in the medieval cemetery of St. Helen-on-the-Walls, York, England. American Journal of Physical Anthropology 100: 531 – 544.

Grolleau-Raoux J-L, Crubezy E, Rouge D, Brugne J-F & Saunders SR. 1997. Harris lines: A study of age-associated bias in counting and interpretation. American Journal of Physical Anthropology 103: 209 – 217.

Gruspier KL. 1999. Pathological changes on human skeletal remains: Before, during or after? In: Fairgrieve SI. (Ed), Forensic osteological analysis: A book of case studies. Charles C Thomas Publishers, USA.

Guyton AC. 1985. Anatomy and Physiology. CBS College Publishing, New York.

Haas CJ, Zink A, Molnar E, Szeimies U, Reischl U, Marcsik A, Ardagna Y, Dutour O, Palfi G & Nerlich AG. 2000. Molecular evidence for different stages of Tuberculosis in ancient bone samples from Hungary. American Journal of Physical Anthropology 113: 293 – 304.

Hackett CJ. 1975. An introduction to diagnostic criteria of syphilis, treponarid and yaws (treponematoses) in dry bones and some implications. Virchows Archaeology. Anatomical Pathology Anatomy and Histology 368: 229 – 341.

Hall M. 1993. The archaeology of Colonial settlement in South Africa. Annual Review of Anthropology 22: 177 – 200.

Halkett DJ. 2000. A report on the exhumation of human remains from a historic cemetery at the Marina Residential development, V & A Waterfront. Unpublished report from the Archaeology Contracts Office, University of Cape Town.

Hallema A. 1951. The Cape in 1776-1777: Aquarelles by Johannes Schumacher from the Swellengrebel collection at Breda. The Hague, AAM. Stols.

Hamilton ME. 1982. Sexual dimorphism in skeletal samples. In: Hall RL. (Ed.). Sexual dimorphism in *Homo sapiens*: a question of size. Praeger Publishers, USA. Pp 107-196.

Hartnady P & Rose JC. 1991. Abnormal tooth-loss patterns among the Archaic period inhabitants of the lower Pecos region, Texas. In: Kelley MA, Larsen CS (eds.) Advances in dental anthropology. New York: Wiley-Liss. Pp 267-278.

Hawkey DE. 1988. Use of upper extremity enthesopathies to indicate habitual activity patterns. MA Thesis, Arizona State University.

Hawkey DE & Merbs CF. 1995. Activity-induced musculoskeletal stress markers and subsistence strategy changes among ancient Hudson Bay Eskimos. International Journal of Osteoarchaeology 5: 324 – 338.

Henderson CY & Gallant AJ. 2007. Quantitative recording of entheses. Paleopathology Newsletter 134: 7 – 13.

Henneberg RJ & Henneberg M. 1993. Possible occurrence of treponematosis in the ancient Greek colony of Mtaponto, Italy. American Journal of Physical anthropology Suppl. 16: 107 – 108.

Henneberg M & Steyn M. 1994. Preliminary report on the paleodemography of the K2 and Mapungubwe populations (South Africa). Human Biology 66(1): 105 – 120.

Hershkovitz I, Spiers M, Katznelson A & Arensburg B. 1992. Unusual pathological condition in the lower extremities of a skeleton from ancient Israel. American Journal of Physical Anthropology 88: 23 – 26.

Hillson S. 1996. Dental Anthropology. Cambridge University Press, Great Britain.

Hillson S, Grigson C & Bond S. 1998. Dental defects of congenital syphilis. American Journal of Physical Anthropology 107: 25 – 40.

Holland TD. 1991. Sex assessment using the proximal tibia. American Journal of Physical Anthropology 85: 221 – 227.

Hoppa RD. 1992. Evaluating human skeletal growth: and Anglo-Saxon example. International Journal of Osteoarchaeology 2: 275 – 288.

Hoppa RD. 2000. Population variation in osteological aging criteria: An example from the pubic symphysis. American Journal of Physical Anthropology 111: 185 – 191.

Hoppa RD & Vaupel JW. (Eds.). 2003. Paleodemography: Age distributions from skeletal samples. Journal of Human Evolution 44: 641 – 643.

Howell N. 1986. Demographic anthropology. Annual Review of Anthropology 15: 219 – 246.

Humphrey LT. 1998. Growth patterns in the modern human skeleton. American Journal of Physical Anthropology 105: 57 – 72.

Hutchinson J. 1987. The age-sex structure of the slave population in Harris County, Texas: 1850 and 1860. American Journal of Physical Anthropology 74: 231 – 238.

Igarashi Y, Uesu K, Wakebe T & Kanazawa E. 2005. New method for estimation of adult skeletal age at death from the morphology of the auricular surface of the ilium. American Journal of Physical Anthropology 128: 324 – 339.

İşcan MY & Loth SR. 1989. Osteological manifestations of age in the adult. In: İşcan MY & Kennedy KAR. (Eds.). Reconstruction of life from the skeleton. Alan R. Liss, New York. Pp 23 – 40.

İşcan MY. 1988. Rise of Forensic Anthropology. Yearbook of Physical Anthropology 31: 203 – 230.

İşcan MY & Miller-Shaivitz P. 1984. Determination of sex from the tibia. American Journal of Physical Anthropology 64: 53 – 57.

Jackes MK. 1983. Osteological evidence of small pox: A possible case from seventeenth century Ontario. American Journal of Physical Anthropology 60: 75 – 81.

Jacobi KP, Collins-Cook D, Corruccini RS & Handler JS. 1992. Congenital syphilis in the past: Slaves at Newton Plantation, Barbados, West Indies. American Journal of Physical Anthropology 89: 145 – 158.

Jochelson KJ. 2001. The colour of disease: Syphilis and racism in South Africa 1880-1950. Palgrave, New York.

Johansson SR & Horowitz S. 1986. Estimating mortality in skeletal populations: Influence of the growth rate on the interpretation of levels and trends during the transition to agriculture. American Journal of Physical Anthropology 71: 233 – 250.

Jones A. 1992. Tooth mutilation in Angola. British Dental Journal, September Supplement: 177-178.

Jones A. 2001. Dental disfigurements in Borneo. British Dental Journal 191: 98-102.

Judd MA & Roberts CA. 1999. Fracture trauma in a medieval British farming village. American Journal of Physical Anthropology 109: 229 – 243.

Judd MA & Roberts CA. 1998. Fracture patterns at the medieval leper hospital in Chichester. American Journal of Physical Anthropology 105: 43 – 55.

Jurmain RD. 1980. The pattern on involvement of appendicular degenerative joint disease. American Journal of Physical Anthropology 53: 143 – 150.

Kagan N. 1975. The growth and development of the municipality of Green Point and Sea Point. BA (Honours) Thesis in History, University of Cape Town.

Kaidonis JA, Townsend GC & Richards LC. 1992. Brief communication: Interproximal tooth wear: A new observation. American Journal of Physical Anthropology 88: 105 – 107.

Katzenberg MA & Saunders SR. (Eds.). 2000. Biological anthropology of the human skeleton. Wiley-Liss, Inc, New York.

Keenleyside A. 1998. Skeletal evidence of health and disease in pre-contact Alaskan Eskimos and Aleuts. American Journal of Physical Anthropology 107: 51 – 70.

Kelley JO & Angel L. 1987. Life stresses of slavery. American Journal of Physical Anthropology 74: 199 – 211.

Kelley MA & El-Najjar MY. 1980. Natural variation and diagnosis of skeletal changes in tuberculosis. American Journal of Physical Anthropology 52(2): 153 – 167.

Kemkes-Grottenthaler A. 2005. The short die young: The interrelationship between stature and longevity – evidence from skeletal remains. American Journal of Physical Anthropology 128: 340 – 347.

Kennedy KAR. 1998. Markers of occupational stress: Conspectus and prognosis of research. International Journal of Osteoarchaeology 8: 305 – 310.

Kennedy KAR. 1989. Skeletal markers of occupational stress. In: İşcan MY & Kennedy KAR. (Eds.). Reconstruction of life from the skeleton. Alan R Liss, New York. Pp 129 - 160

Kerley ER. 1965. The microscopic determination of age in human bone. American Journal of Physical Anthropology 23: 149 – 164.

Khudabux MR. 1991. Effects of life conditions on the health of a Negro slave community in Suriname. PhD Thesis, Rijksuniversitieit, Leiden

Knüsel CJ, Roberts CA & Boylston A. 1996. Brief communication: When Adam delved…An activity-related lesion in three human skeletal populations. American Journal of Physical Anthropology 100: 427 – 434.

Konigsberg LW & Hens SM. 1998. Use of ordinal categorical variables in skeletal assessment of sex from the cranium. American Journal of Physical Anthropology 107: 97 – 112.

Konigsberg LW & Frankenberg SR. 2002. Deconstructing death in paleodemography. American Journal of Physical Anthropology 117: 297 – 309.

Krentz-Niedbala M. 2001. Biological and cultural consequences of the transition to agriculture in human populations on Polish territories. Variability and Evolution 9: 89 – 99.

Kvaal SI & During EM. 1999. A dental study comparing age estimations of the human remains from the Swedish warship *Vasa*. International Journal of Osteoarchaeology 9: 170 – 181.

Lai P & Lovell NC. 1992. Skeletal markers of occupational stress in the fur trade: a case study from a Hudson's Bay company fur trade post. International Journal of Osteoarchaeology 2: 221 – 234.

Laidler PW. 1926. A tavern of the ocean. Maskew Miller, LTD. Cape Town.

Laidler PW & Gelfand M. 1971. South Africa: its medical history 1652-1898. Struik. Cape Town.

Lallo JW, Armelagos GJ & Mensforth RP. 1977. The role of diet, disease and physiology in the origin of porotic hyperostosis. Human Biology 49(3): 471 – 483.

Langham-Carter RR. 1973. Cape Town's first graveyards. CABO 2(1): 16 – 22.

Larsen CS. 1997. Bioarchaeology: Interpreting behavior from the skeleton. Cambridge University Press, Cambridge.

Larsen CS. 2002. Bioarchaeology: The lives and lifestyles of past people. Journal of Archaeological Research 10 (2): 119 – 166.

Ledger M, Holtzhausen L-M, Constant D & Morris AG. 2000. Biomechanical beam analysis of long bones from a late 18th century slave cemetery in Cape Town, South Africa. American Journal of Physical Anthropology 112: 207 – 216.

Lewis ME & Roberts CA. 1997. Growing pains: The interpretation of stress indicators. International Journal of Osteoarchaeology 7: 581 – 586.

Lieberman LS. 1982. Normal and abnormal sexual dimorphic patterns of growth and development. In: Sexual dimorphism in *Homo sapiens*: a question of size. Hall RL. (Ed.). Praeger Publishers, USA. Pp 263 - 299.

Lieverse AR. 1999. Diet and the aetiology of dental calculus. International Journal of Osteoarchaeology 9: 219 – 232.

Lin LIK. 1989. A concordance correlation coefficient to evaluate reproducibility. Biometrics 45: 255 – 268.

Loth SR & Henneberg M. 1996. Mandibular ramus flexure: A new morphological indicator of sexual dimorphism in the human skeleton. American Journal of Physical Anthropology 99: 473 – 485.

Lovejoy CO, Meindl RS, Pryzbeck TR & Mensforth R P. 1985. Chronological metamorphosis of the auricular surface of the ilium: A new method for the determination of adult skeletal age at death. American Journal of Physical Anthropology 68: 15 – 28.

Lovejoy CO, Meindl RS, Mensforth RP & Barton TJ. 1985. Multifactorial determination of skeletal age at death: A method and blind tests of its accuracy. American Journal of Physical Anthropology 68: 1 – 14.

Lovell NC. 1997. Anaemia in the ancient Indus Valley. International Journal of Osteoarchaeology 7: 115 – 123.

Lovell NC. 1997. Trauma analysis in paleopathology. Yearbook of Physical Anthropology 40: 139 – 170.

Lukacs JR. 1995. The 'Caries correction factor': a new method of calibrating dental caries rates to compensatecfor antemortem tooth loss. International Journal of Osteoarchaeology 5: 151 – 156.

Lundy JK. 1986. Intertribal metrical and morphological variation in the postcranial skeleton of the South African Negro. In: Singer R & Lundy JK. (Eds.). Variation, Culture and Evolution in African populations. Witwatersrand University Press, Johannesburg. Pp 85 – 95.

Lundy JK & Feldesman MR. 1989. The femur / stature ratio: a method to estimate living height from the femur. Unpublished paper presented at the 41st Annual Meeting of the American Academy of Forensic Sciences, Las Vegas, Nevada, 13-18 February 1989.

Maat GJR & Van der Velde EA. 1987. The caries-attrition competition. International Journal of Anthropology 2: 281-292.

Maat GJR, Mastwijk RW & Van der Velde EA. 1995. Skeletal distribution of degenerative changes in vertebral osteophytosis, vertebral osteoarthritis and DISH. International Journal of Osteoarchaeology 5: 289 – 298.

Maat GJR, Onisto N & Bult EJ. 1998. Human remains from the infirmary "Oude en Nieuwe Gasthuis" of the City of Delft in the Netherlands 1265 – 1652 AD. Barge's Anthropologica , Leiden.

Maat GJR, Van den Bos RPM & Aarents MJ. 2002. Manual for the preparation of ground sections for the microscopy of bone tissue. Nr. 7. Barge's Anthroplogica. Leiden, The Netherlands.

Maat GJR, Mastwijk RW & Jonker MA. 2002. Citizens buried in the 'Sint Janskerkhof' of the 'Sint Jans' Cathedral of 's-Hertogenbosch in The Netherlands. Nr. 8. Barge's Anthroplogica. Leiden, The Netherlands.

Maat GJR, Aarents MJ & Nagelkerke NJD. 2003. Age predition fom bone replacement: remodelling of circumferential lamellar bone tissue. Nr. 10. Barge's Anthroplogica. Leiden, The Netherlands.

Maat GJR, Maes A, Aarents MJ & Nagelkerke NJD. 2006. Histological age prediction from the femur in a contemporary Dutch sample: The decrease of nonremodeled bone in the anterior cortex. The Journal of Forensic Science 51(2): 230 - 237.

Malan A. 1993. Households of the Cape 1750 – 1850: inventories and the archaeological record. PhD Thesis, University of Cape Town.

Malan A. 2005. Why are we digging up our cemeteries? Historical background to burial grounds in Green Point, Cape Town. In: Friedling J. (Ed.). Yes, Dead men do tell tales! Savage Printing, Cape Town.

Mann RW & Murphy SP. 1990. Regional atlas of bone disease: A guide to pathological and normal variation in the human skeleton. CC Thomas Publisher, Illinois, USA.

Mayhall JT. 2000. Dental morphology: Techniques and strategies. In: MA Katzenberg & SR Saunders (Eds.). Biological anthropology of the human skeleton. Wiley-Liss, Inc., New York. Pp 103-134.

Mays S, Taylor GM, Legge AJ, Young DB & Turner-Walker G. 2001. Paleopathological and biomolecular study of tuberculosis in a medieval skeletal collection from England. American Journal of Physical Anthropology 114: 298 – 311.

Mays S. 1995. The relationship between Harris Lines and other aspects of skeletal development in adults and juveniles. Journal of Archaeological Science 22: 511 – 520.

Mays S. 2000. Age-dependent cortical bone loss in women from 18th and early 19th century London. American Journal of Physical Anthropology 112: 349 – 361.

McHenry HM. 1968. Transverse lines in long bones of prehistoric California Indians. American Journal of Physical Anthropology 29: 1 – 18.

McHenry HM & Schultz PD. 1976. The association between Harris Lines and enamel hypoplasia in prehistoric California Indians. American Journal of Physical Anthropology 44: 507 – 512.

McMagh P. 1982. The three Lieschings: Their times and contributions to Cape medicine 1800 – 1843. Instaprint, Cape Town.

Meindl RS, Lovejoy CO, Mensforth RP & Don Carlos L. 1985. Accuracy and direction of error in the sexing of the skeleton: Implications for paleodemography. American Journal of Physical Anthropology 68: 79 – 85.

Mensforth RP, Lovejoy CO, Lallo JW & Armelagos GJ. 1978. The role of constitutional factors, diet and infectious disease in the etiology of porotic hyperostosis and periosteal reactions in prehistoric infants and children. Medical Anthropology 2: 1-59.

Merbs CF. 1989. Trauma. In: Iscan MY & Kennedy KAR. (Eds.). Reconstruction of life from the skeleton. Alan R. Liss, New York. Pp 161 – 189.

Milner G & Larsen C. 1991. Advances in Dental Anthropology. Wiley-Liss, New York.

Molleson T, Cox M, Waldron AH & Whittaker DK. 1993. The Spitalfields project. Volume 2: The anthropology. CBA Research Report 86. Bowes Morrell House, York.

Molnar P. 2006. Tracing prehistoric activities: Musculoskeletal stress markers analysis of a Stone-Age population on the Island of Gotland in the Baltic Sea. American Journal of Physical Anthropology 129: 12 – 23.

Morris AG. 1984. An Osteological analysis of the protohistoric populations of the northern Cape and western Orange Free State, South Africa. PhD Thesis, Department of Anatomy, University of the Witwatersrand, Johannesburg.

Morris AG. 1989. Dental mutilation in historic and prehistoric South Africa. Quarterly Bulletin of the South African Library. 43: 132-134.

Morris AG. 1992. The skeletons of contact: A study of protohistoric burials from the Lower Orange river Valley, South Africa. Witwatersrand University Press.

Morris AG. 1998. Dental mutilation in southern African history and prehistory with special reference to the "Cape Flats Smile". Journal of the South African Dental Association 53: 179-183.

Mosothwane MN. 2003. Skeletal characteristics and population demography as reflected by materials from Toutswe tradition sites in eastern Botswana, west of the Shashe-Limpopo basin. Masters Thesis, University of Pretoria.

Mossop EE (Ed.). 1947. The journal of Carel Frederik Brink of the journey into Great Namaqualand (1761-2) made by Captain Hendrik Hop. Van Riebeeck Society, No.28, Cape Town.

Mulhern DM & Jones EB. 2005. Test of revised method of age estimation from the auricular surface of the ilium. American Journal of Physical Anthropology 126: 61 – 65.

Muller CFJ (Ed.). 1981. Five hundred years: A History of South Africa. Academica Press, Pretoria

Müller H-G, Love B & Hoppa RD. 2002. Semiparametric method for estimating paleodemographic profiles from age indicator data. American Journal of Physical Anthropology 117: 1 – 14.

Murray EA & Perzigian AJ. 1995. A glimpse of early 19th century Cincinnati as viewed from Potter's Field: An exercise in problem solving. In: Grauer AL. (Ed.). Bodies of evidence: reconstructing history through skeletal analysis. Wiley-Liss, New York. Pp 173 - 184.

Nowak O. 2000. The influence of conditions of life on the formation of morphological features of human long bones in historical populations. Variability and Evolution 8: 129 – 134.

Nowak O & Piontek J. 2002. The frequency of appearance of transverse (Harris) lines in the tibia in relationship to age at death. Annals of Human Biology 29(3): 314 – 325.

Nyati LH, Norris SA, Cameron N & Pettifor JM. 2006. Effect of Ethnicity and sex on the growth of the axial and Appendicular skeleton of children living in a developing country. American Journal of Physical Anthropology 130: 135 – 141.

Ortner DJ. 1975. Ageing effects on osteon remodelling. Calcified Tissue Res. 18: 27 – 36.

Ortner DJ & Putschar WGJ. 1985. Identification of pathological conditions in human skeletal remains. Smithsonian Institution Press, Washington DC.

Ortner DJ. 1998. Male-female immune reactivity and its implications for interpreting evidence in human skeletal paleopathology. In: Grauer AL & Stuart-Macadam P. (Eds.). Sex and Gender in paleopathological perspective. Cambridge University Press, UK. Pp 79 – 92.

Ortner DJ. 2003. Identification of pathological conditions in human skeletal remains. 2nd Edition. Academic Press, New York.

Owsley DW, Orser Jr. CE, Mann RW, Moore-Jansen PH & Montgomery RL. 1987. Demography and pathology of an urban slave population from New Orleans. American Journal of Physical Anthropology 74: 185 – 197.

Palkovitch AM. 1987. Endemic disease patterns in paleopathology: Porotic hyperostosis. American Journal of Physical Anthropology 74: 527 – 537.

Patrick MK. 1989. An archaeological, anthropological study of the human skeletal remains from the Oakhurst Rock shelter, George, Cape Province, Southern Africa. MSc Thesis, University of Cape Town.

Pearson OM. 2000. Activity, climate and postcranial robusticity. Current Anthropology 41 (4): 569 – 607.

Pechenkina EA, Benfer Jr. RA & Zhijun W. 2002. Diet and health changes at the end of Chinese Neoloithic: The Yangshao/Logshan transition in Shaanxi Province. American Journal of Physical Anthropology 117: 15 – 36.

Peckmann TR. 2002. Dialogues with the dead: An Osteological Analysis of the Palaeodemography and Life History of the 18th and 19th Century Northern Frontier in South Africa. PhD Thesis, University of Cape Town.

Peckmann TR. 2003. Possible relationship between porotic hyperostosis and smallpox infections in 19th century populations in the northern frontier, South Africa. World Archaeology 35(2): 289 – 305.

Pickel B. 1997. Coloured Ethnicity and Identity – A case study in the former coloured areas in the Western Cape / South Africa. Lit Verlag, Hamburg.

Pindborg JJ. 1969. Dental mutilation and associated abnormalities in Uganda. American Journal of Physical Anthropology 31: 383-390.

Piontek J, Jerszyńska B & Nowak O. 2001. Harris Lines in subadult and adult skeletons from the medieval cemetery in Cedynia, Poland. Variability and Evolution 9: 33 – 43.

Putschar WGJ. 1976. The structure of the human symphysis pubis with special consideration of parturition and its sequelae. American Journal of Physical Anthropology 45: 589 – 594.

Rathbun TA. 1987. Health and disease at a South Carolina plantation: 1840 – 1870. American Journal of Physical Anthropology 74: 239 – 253.

Reidy MC. 1997. The admission of slaves and 'prize slaves' into the Cape Colony, 1797 – 1818. Honours Thesis, University of Cape Town.

Ribot I. 1992. The possible influence of various skeletal stress indicators on the growth of subadults from medieval populations. Masters Thesis, University of Bradford and University of Sheffield.

Ribot I & Roberts C. 1996. A study of non-specific stress indicators and skeletal growth in two medieval subadult populations. Journal of Archaeological Science 23: 67 – 79.

Robb J. 1994. Issues in the skeletal interpretation of muscle attachments. Paper presented at the annual meeting of the Paleoanthropology Society, Anaheim, California, April 19 – 20.

Roberts C & Manchester K. 1997. The archaeology of disease. 2nd Edition. Sutton Publishing Ltd. Cornell University Press.

Rogers L & Dieppe P. 1990. Skeletal paleopathology and rheumatic diseases: Where are we now? Annals of the Rheumatic Diseases 49: 885 – 886.

Rogers J, Watt I & Dieppe P. 1985. Paleopathology of spinal osteophytosis, vertebral ankylosis, ankylosing spondylitis and vertebral hyperostosis. Annals of the Rheumatic Diseases 44: 113 – 120.

Rogers TL. 1999. A visual method of determining the sex of skeletal remains using the distal humerus. Journal of Forensic Science 44(1): 57-60.

Rothschild BM & Woods RJ. 1991. Spondylarthropathy: Erosive arthritis in representative defleshed bones. American Journal of Physical Anthropology 85: 125 – 134.

Rothschild BM. 1992. Paleopathology. Pictures of record, Inc.

Rothschild BM & Rothschild C. 1995. Treponemal disease revisited: Skeletal discriminators for yaws, bejel and venereal syphilis. Clinical Infectious Disease 20: 1402 – 1408.

Rothschild BM. 1995. Origins of yaws in the Pleistocene. Nature 378: 343 – 344.

Rothschild BM, Arriaza B, Woods J & Dutour O. 1999. Spondyloarthropathy identified as the etiology of Nubian erosive arthritis. American Journal of Physical Anthropology 109: 259 – 267.

Rothschild BM, Luna Calderon F, Coppa A & Rothschild C. 2001. First European exposure to syphilis : The Dominican Republic at the time of Columbian contact. Clinical Infectious Disease 31: 936 – 941.

Ruff C. 1992. Biomechanical analyses of archaeological human skeletal samples. In: Skeletal biology of Past Peoples: Research methods. Wiley –Liss, Inc. pp 37 – 58.

Ruff C, Holt B & Trinkaus E. 2006. Who's afraid of the big bad Wolff?: "Wolff's Law" and bone functional adaptation. American Journal of Physical Anthropology 129: 484 – 498.

Safont S, Malgosa A & Subira E. 2000. Sex assessment on the basis of long bone circumference. American Journal of Physical Anthropology 113: 317 – 328.

Sambrook PN. 2000. The skeleton in rheumatoid arthritis: Common mechanisms for bone erosion and osteoporosis. The Journal of Rheumatology 27(11): 1541 – 2542.

Sanders V. 2001. An assessment of muscle insertion sites and biomechanical beam analysis in living subjects. MSc (Med.) Thesis, Department of Human Biology, University of Cape Town.

Sandford MK, Van Gerven DP & Meglen RR. 1983. Elemental hair analysis: New evidence on the etiology of cribra orbitalia in Sudanese Nubia. Human Biology 55(4): 831 – 844.

Santos AL & Roberts CA. 2001. A picture of tuberculosis in young Portuguese people in the early 20th century: A multidisciplinary study of the skeletal and historical evidence. American Journal of Physical Anthropology 115: 38 – 49.

Santos AL & Roberts CA. 2006. Anatomy of a serial killer: Differential diagnosis of Tuberculosis based on rib lesions of adult individuals from the Coimbra Identified Skeletal Collection, Portugal. American Journal of Physical Anthropology 130: 38 – 49.

Sauer NJ. 1998. The timing of injuries and manner of death: Distinguishing among antemortem, perimortem and post-mortem trauma. In: KJ Reichs (Ed.). Forensic Osteology: Advances in the identification of human remains. Second edition. Charles C. Thomas Publisher, Ltd., USA. Pp 321 – 332.

Saunders C. (Ed.). 1984. Studies in the history of Cape Town. Centre for African Studies, University of Cape Town. 1: 153 – 164.

Saunders SR. 2000. Subadult skeletons and growth-related studies. In: M.A. Katzenberg and S.R. Saunders (Eds.). Biological anthropology of the human skeleton. Wiley-Liss, Inc., New York. Pp 135 - 161.

Schneider KN. 1986. Dental caries, enamel composition and subsistence among prehistoric Amerindians of Ohio. American Journal of Physical Anthropology 71: 95 – 102.

Schulter-Ellis FP, Schmidt DJ, Hayek LA & Craig J. 1983. Determination of sex with a discriminant analysis of new pelvic bone measurements: Part 1. Journal of Forensic Science 28(1): 169 – 180.

Schutte GJ, Boeseken AJ & Robertson HM. (Eds.). 1982. Briefwisseling van Hendrik Swellengrebel Jr oor Kaapse sake 1778 – 1792. Van Riebeeck Society, 2nd Series, No. 13.

Schutte GJ. (Ed). 2003. Hendrik Cloete, Groot Constantia and the VOC 1778 – 1799. Van Riebeeck Society, 2nd Series, No. 34.

Schwartz JH. 1995. Skeletal keys: An introduction to human skeletal morphology, development and analysis. Oxford University Press.

Scott GR & Turner II CG. 1997. The anthropology of modern human teeth: Dental morphology and its variation in recent human populations. Cambridge University Press, U K.

Sealy J & van der Merwe N. 1992. On "approaches to dietary reconstruction in the Western Cape: are you what you have eaten?" – a reply to Parkington. Journal of Archaeological Science 19: 459-466.

Sealy JC, Patrick MK, Morris AG & Alder D. 1992. Diet and dental caries among Later Stone Age inhabitants of the Cape Province, South Africa. American Journal of Physical Anthropology 88: 123 – 134.

Seidemann RM, Stojanowski CM & Doran GH. 1998. The use of the supero-inferior femoral neck diameter as a sex assessor. American Journal of Physical Anthropology 107: 305 – 313.

Select Committee Reports. 1904. Somerset Road burial grounds. Committee appointed to consider and report on the Cemetery Bill. Cape Town. Saul Solomon.

Shaw JCM. 1931. The Teeth, the Bony Palate and the Mandible in Bantu Races of South Africa. John Bale, Sons and Danielsson, London.

Shell RC-H. 1994a. Children of bondage: A social history of the slave society at the Cape of Good Hope 1652 – 1838. Witwatersrand University Press, Johannesburg.

Shell RC-H. 1994b. The tower of Babel: The slave trade and creolisation at the Cape, 1652 –1834. In: Eldredge EE & Morten F. (Eds.). Slavery in South Africa. Westview Press, inc. / University of Natal Press. Pp 11 - 40.

Sinha A & Gupta V. 1995. A study on estimation of age from pubic symphysis. Forensic Science International 75: 73 – 78.

Staz J. 1938. Dental caries in South Africa. South African Journal of Medical Science 3 (suppl): 1 – 63.

Steckel RH, Sciulli PW & Rose JC. 2002. A health index from skeletal remains. In: Steckel RH & Rose JC. (Eds.). The backbone of history: Health and nutrition in the Western hemisphere. Cambridge University Press. Pp 61 – 93

Steele DG & McKern TW. 1969. A method of assessment of maximum long bone length and living stature from fragmentary long bones. American Journal of Physical Anthropology 31: 215 – 228.

Steen SL & Lane RW. 1998. Evaluation of habitual activities among two Alaskan Eskimo populations based on musculoskeletal stress markers. International Journal of Osteoarchaeology 8: 341 – 383.

Steinbock RT. 1976. Paleopathological diagnosis and interpretation: Bone diseases in ancient human populations. CC Thomas, USA.

Steyn M. 1994. An assessment of the health status and physical characteristics of the prehistoric population from Mapungubwe. PhD Thesis.

Stirland AJ. 1998. Musculoskeletal evidence for activity: Problems of evaluation. International Journal of Osteoarchaeology 8: 354 – 362.

Stock JT & Pfeiffer SK. 2004. Long bone robusticity and subsistence behaviour among Later Stone Age foragers of the forest and fynbos biomes of South Africa. Journal of Archaeological Science 31: 999 – 1013.

Stout SD. 1998. The application of histological techniques for age at death determination. In: KJ Reichs (Ed.). Forensic Osteology: Advances in the identification of human remains. Second edition. Charles C. Thomas Publisher, Ltd., USA. Pp 237 – 252.

Stout SD. 1996. Histomorphic analysis of human skeletal remains. In: İşcan MY & Kennedy KAR. (Eds.). Reconstruction of life from the skeleton. Wiley-Liss. Pp 41 – 52.

Stout SD. 1992. Methods of determining age at death using bone microstructure. In: Saunders SR & Katzenberg MA. (Eds.). Skeletal biology of past peoples. Wiley –Liss. Pp 21 – 35.

Stout SD, Dietze WH, İşcan MY & Loth SR. 1994. Estimation of age at death using cortical histomorphometry of the sternal end of the fourth rib. Journal of Forensic Science. 39(3): 778 - 84.

Stuart-Macadam P. 1985. Porotic hyperostosis: Representative of a childhood condition. American Journal of Physical Anthropology 66: 391 – 398.

Stuart-Macadam P. 1987. A radiographic study of porotic hyperostosis. American Journal of Physical Anthropology 74: 511 – 520.

Stuart-Macadam P. 1987. Porotic hyperostosis: New evidence to support the anemia theory. American Journal of Physical Anthropology 74: 521 – 526.

Stuart-Macadam P. 1989. Porotic hyperostosis: Relationship between orbital and vault lesions. American Journal of Physical Anthropology 80: 187 – 193.

Stuart-Macadam P. 1992. Porotic hyperostosis: A new perspective. American Journal of Physical Anthropology 87: 39 – 47.

Stuart-Macadam P. 1992. Cranial thickening and anemia. American Journal of Physical Anthropology 88: 109 – 110.

Stuart-Macadam P. 1998. Iron deficiency anemia: exploring the difference. In: Sex and Gender in paleopathological perspective. Grauer AL & Stuart-Macadam P. (Eds.). Cambridge University Press, UK. Pp 45 – 63.

Sullivan A. 2004. Reconstructing relationships among mortality, status and gender at the medieval Gilbertine Priory of St. Andrews, Fishergate, York. American Journal of Physical Anthropology 124: 330 – 345.

Sullivan A. 2005. Prevalence and etiology of acquired anemia in medieval York, England. American Journal of Physical Anthropology 128: 252 – 272.

Tajfel H. 1978. Differentiation between social groups. Academic Press, London.

Tajfel H. 1984. The social dimension. Cambridge University Press, London.

Theal GM. 1964. History of South Africa from 1795 to 1872. Vol.V. Cape Town

Tobias PV. 1972. Growth and stature in southern African populations. In: Vorster DJM (Ed.) The human biology of environmental change. Proceedings of I.B.P. conference held in Blantyre, Malawi, April 5-15, 1971.

Todeschini F & Japha D. 1989. Green Point and Sea Point conservation and restoration study. Centre for African Studies, University of Cape Town.

Torres-Rouff C & Junqueira MA. C. 2006. Interpersonal violence in prehistoric San Pedro de Atacama, Chile: Behavioural implications of environmental stress. American Journal of Physical Anthropology 130: 60 – 70.

Trotter M & Gleser GC. 1951. Trends in stature of American whites and Negroes born between 1840 and 1924. American Journal of Physical Anthropology 9: 427 – 440.

Trotter M & Gleser GC. 1958. A re-evaluation of estimation of stature based on measurements of stature taken during life and of long bones after death. American Journal of Physical Anthropology 16: 79 – 123.

Trotter M. 1970. Estimation of stature from intact long limb bones. In: Steward TD (Ed.). Personal identification in mass disasters. Smithsonian Institute, Washington DC. Pp 71 – 73.

Turner CJ. 1987. Rediscovering Social Group: A self-categorisation theory. Blackwell, Oxford and New York.

Ubelaker DH. 1978. Human skeletal remains: Excavation, analysis, interpretation. Aldine Publishing Company, Chicago, U.S.A.

Van der Merwe AE. 2006. Human skeletal remains from Kimberley: an assessment of health in a 19th century mining community. MSc Thesis, University of Pretoria.

Van Heyningen EB. 1989. Public health and society in Cape Town 1880 –1910. PhD Thesis, University of Cape Town.

Van Reenen JF. 1977. Swallowtail form of tooth mutilation among Early Iron Age people living at Boederstroom, Transvaal, circa 500 AD. Journal of the Dental Association of South Africa 32: 529-533.

Van Reenen JF. 1986. Tooth mutilating and extraction practices amongst the peoples of South West Africa (Namibia). In: Singer R & Lundy JK. (Eds.). Variation, Culture and Evolution in African Populations: papers in honour of Dr Hertha de Villiers. pp 159-169. Witwatersrand University Press, Johannesburg.

Waldron HA. 2000. The study of the human remains from Nubia: The contribution of Grafton Elliot Smith and his colleagues to paleopathology. Medical History 44: 363 – 388.

Walrath DE, Turner P & Bruzek J. 2004. Reliability of the visual assessment of cranial traits for sex determination. American Journal of Physical Anthropology 125: 132 – 137.

Walker PL. 1986. Porotic hyperostosis in a marine-dependent California Indian population. American Journal of Physical Anthropology 69: 345 – 354.

Wapler U, Crubézy E & Schultz M. 2004. Is cribra orbitalia synonymous with anemia? Analysis and interpretation of cranial pathology in Sudan. American Journal of Physical Anthropology 123: 333 – 339.

Weinberg ED. 1984. Iron withholding: A defense against infection and neoplasia. Physiological Reviews 64(1): 65 – 102.

Weiss KM. 1973. Demographic models for anthropology. American Antiquity 38(2): Part 2, Memoir 27.

Wilczak CA. 1998. Consideration of sexual dimorphism, age and asymmetry in quantitative measurements of muscle insertion sites. International Journal of Osteoarchaeology 8: 311 – 325.

Wiley AS & Pike IL. 1998. An alternative method for assessing early mortality in contemporary populations. American Journal of Physical Anthropology 107: 315 – 330.

Wilson ML & Lundy JK. 1994. Estimated living statures of dated Khoisan skeletons from the south-western coastal region of South Africa. South African Archaeological Bulletin 49: 2 – 8.

Wilson M & Thompson L. (Eds.) 1969. The Oxford history of South Africa. Oxford University Press, Oxford.

Wood JW, Milner GR, Harpending HC & Weiss KM. 1992. The osteological paradox. Current Anthropology 33(4): 343 – 370.

Wolfe LD & Gray JP. 1982. A cross-cultural investigation into sexual dimorphism and stature. In: Hall RL. (Ed.). Sexual dimorphism in *Homo sapiens*: a question of size. Praeger Publishers, USA. Pp 197- 205.

Worden N, Van Heyningen E & Bickford-Smith V. 1998. Cape Town: The making of a city. David Philip Publishers, Cape Town.

Worden N & Groenewald G. (Eds.). 2005. Trials of slavery: Selected documents concerning slaves from the criminal records. Van Riebeeck Society, 2nd Series, No. 36.

Ziervogel C. 1944. Who are the Coloured People. Sixpenny Library, No. 11.

APPENDIX 1

Cobern Street Accession Numbers

Burials	
Grave No.	**Accession No.**
9	UCT 458.1
4	UCT 458.2
6	UCT 459.1
7	UCT 459.2
8	UCT 459.3
3	UCT 460
5	UCT 461
10	UCT 498
11	UCT 499
12	UCT 500
13	UCT 501
14	UCT 502
15	UCT 504
16	UCT 506
17	UCT 507
18	UCT 508
19	UCT 509
20A	UCT 510
20B	UCT 511
20C	UCT 512
21	UCT 514
22	UCT 515
23	UCT 516
24	UCT 517
25	UCT 518
26	UCT 519
27B	UCT 521
28	UCT 522
29	UCT 523.1
30	UCT 524
31	UCT 525
32	UCT 526
33A	UCT 527
33B	UCT 527
34	UCT 528
35	UCT 529
35	UCT 529
35	UCT 529
35	UCT 529
36	UCT 530
38	UCT 533.1
39	UCT 534

Burials	
Grave No.	**Accession No.**
40	UCT 535
41A	UCT 536
43	UCT 541
44	UCT 542
45	UCT 543
46	UCT 544
47	UCT 545
48	UCT 546
49	UCT 547
50	UCT 548
51	UCT 549
52	UCT 550
53	UCT 551
54	UCT 552
55	UCT 553
56	UCT 554
57	UCT 555
58	UCT 556
59	UCT 557
60	UCT 558
61	UCT 559.1
61	UCT 559.2
62	UCT 560
63	UCT 561
64	UCT 562
65	UCT 563
1 & 2	UCT 572.1
1 & 2	UCT 572.2
1 & 2	UCT 572.3

APPENDIX 1

Cobern Street Accession Numbers

Burials	
Grave No.	**Accession No.**
9	UCT 458.1
4	UCT 458.2
6	UCT 459.1
7	UCT 459.2
8	UCT 459.3
3	UCT 460
5	UCT 461
10	UCT 498
11	UCT 499
12	UCT 500
13	UCT 501
14	UCT 502
15	UCT 504
16	UCT 506
17	UCT 507
18	UCT 508
19	UCT 509
20A	UCT 510
20B	UCT 511
20C	UCT 512
21	UCT 514
22	UCT 515
23	UCT 516
24	UCT 517
25	UCT 518
26	UCT 519
27B	UCT 521
28	UCT 522
29	UCT 523.1
30	UCT 524
31	UCT 525
32	UCT 526
33A	UCT 527
33B	UCT 527
34	UCT 528
35	UCT 529
35	UCT 529
35	UCT 529
35	UCT 529
36	UCT 530
38	UCT 533.1
39	UCT 534

Burials	
Grave No.	**Accession No.**
40	UCT 535
41A	UCT 536
43	UCT 541
44	UCT 542
45	UCT 543
46	UCT 544
47	UCT 545
48	UCT 546
49	UCT 547
50	UCT 548
51	UCT 549
52	UCT 550
53	UCT 551
54	UCT 552
55	UCT 553
56	UCT 554
57	UCT 555
58	UCT 556
59	UCT 557
60	UCT 558
61	UCT 559.1
61	UCT 559.2
62	UCT 560
63	UCT 561
64	UCT 562
65	UCT 563
1 & 2	UCT 572.1
1 & 2	UCT 572.2
1 & 2	UCT 572.3

Scatter	
Grave No.	**Accession No.**
S95/1	UCT 473
S95/2	UCT 474
S95/3	UCT 475
S95/4	UCT 476
S95/7	UCT 477
Scatter A	UCT 478.1
Scatter A	UCT 478.2
Scatter B	UCT 479
Scatter C	UCT 480.1
Scatter C	UCT 480.2
Scatter D	UCT 481
Scatter E	UCT 482
Scatter F	UCT 483.1
Scatter F	UCT 483.2
Scatter F	UCT 483.3
Scatter G	UCT 484
Scatter H	UCT 485.1
Scatter H	UCT 485.2
Scatter I	UCT 486
Scatter J	UCT 487
Scatter J	UCT 487
Scatter J	UCT 487
Scatter K	UCT 488.1
Scatter K	UCT 488.2
Scatter M	UCT 489
Scatter N	UCT 490
Scatter O	UCT 491
Scatter P	UCT 492.1
Scatter P	UCT 492.2
Scatter Q	UCT 493
Scatter R	UCT 494.1
Scatter R	UCT 494.2
Scatter S	UCT 495
Scatter T	UCT 496
Scatter U	UCT 497

Scatter	
Grave No.	**Accession No.**
14A	UCT 503
15	UCT 505
20D	UCT 513
27A	UCT 520
27A	UCT 520
27A	UCT 520
27A	UCT 520
27A	UCT 520
27A	UCT 520
29	UCT 523.2
38	UCT 533.2
41B	UCT 537
41.2	UCT 538

LSA	
Grave No.	**Accession No.**
37A	UCT 531
37B	UCT 532
42A	UCT 539
42B	UCT 540

APPENDIX 2

Marina Residence

The 3 trials for ageing histologically.

Burial #	Trial 1	Trial 2	Trial 3	Total	Average	Histo. Age	Visual Age
MR 4	22	25	19	66	22.0	58	40-60
MR 5	50	53	51	154	51.3	28	25-40
MR 15 (1)	56	55	56	167	55.7	26	20-30
MR 15 (2)	34	35	33	102	34.0	44	35-50
MR 15 (3)	22	14	28	64	21.3	59	40-60
MR 15 (4)	56	58	55	169	56.3	25	20-30
MR 15 (5)	22	24	24	70	23.3	57	50+
MR 15 (7)	33	35	35	103	34.3	43	35-50
MR 15 (8)	58	58	59	175	58.3	26	20-30
MR 21	15	19	21	55	18.3	63	60+
MR 23	33	30	32	95	31.7	46	35-50
MR 24	69	70	70	209	69.7	21	20-25
MR 27	29	35	36	100	33.3	45	35-50
MR 28	38	40	45	123	41.0	38	30-40
MR 29	30	28	27	85	28.3	50	40-60
MR 32	23	19	18	60	20.0	60	50-60
MR 33	50	50	55	155	51.7	28	25-40
MR 34	54	55	50	159	53.0	28	20-30
MR 37	53	61	54	168	56.0	26	20-30
MR 37/38	37	35	38	110	36.7	41	
MR 38	28	31	33	92	30.7	48	35-50
MR 42	34	36	36	106	35.3	43	35-50
MR 44	28	25	26	79	26.3	53	50-60
MR 46	47	43	42	132	44.0	35	25-35
MR 48	41	37	42	120	40.0	39	35-45
MR 48A	35	36	36	107	35.7	42	35-45
MR 50	85	90	92	267	89.0	19	16-20
MR 52	35	37	38	110	36.7	41	35-45
MR 53	14	13	13	40	13.3	70	60+
MR 54	23	27	24	74	24.7	54	50
MR 61	21	21	22	64	21.3	59	40-60
MR SF 46	19	21	21	61	20.3	60	

APPENDIX 3

Marina Residence

Estimated sex using various methods.

Burial #	Standard Visual Method	Distal Hum. Method	Femoral Neck Method
MR 3	M	M	M
MR 4	F	M	M
MR 5	M	M	M
MR 6	F	-	-
MR 7	SA	?	-
MR 8	F	F	-
MR 9	A	-	-
MR 10	F	-	-
MR 12	F	-	-
MR 13	M	-	-
MR 14	M	M	M
MR 16	J	-	-
MR 17	?	-	-
MR 20	F	-	-
MR 21	F	F	F
MR 22	M	F	M
MR 23	M	-	-
MR 24	F	F	F
MR 25	M	M	M
MR 26	M	M	M
MR 27	M	-	F
MR 28	M	M	M
MR 29	M	M	M
MR 30	F	M	F
MR 31	M	M	M
MR 32	M	F	-
MR 33	M	M	M
MR 34	M	-	-
MR 35	I	-	-
MR 37	M	M	F
MR 38	F	F	F
MR 39	SA	M	-
MR 40	SA	-	-
MR 41	A	-	-
MR 42	M	M	-
MR 43A	F	-	-
MR 43B	M	M	M
MR 44	F	F	F
MR 45	A	-	-
MR 46	M	M	M
MR 47	M	-	-
MR 48	M	M	M
MR 49	M	M	M
MR 50	SA	M	-

Burial #	Standard Visual Method	Distal Hum. Method	Femoral Neck Method
MR 51	M	M	-
MR 52	M	M	M
MR 52 not artic.	M	-	-
MR 53	A	M	-
MR 54	M	M	F
MR 55	A	-	-
MR 56	M	F	F
MR 56A	M	-	-
MR 57	A	-	-
MR 58	F	F	M
MR 59	M	-	-
MR 60	M	-	-
MR 61	F	F	F
MR 63	M	-	M
MR 63(I)	M	-	-
MR 63(ii)	M	-	-
MR 15(1)	M	-	-
MR 15(2)	M	-	-
MR 15(3)	M	-	-
MR 15(4)	M	-	-
MR 15(5)	M	-	-
MR 15(6)	M	-	-
MR 15(7)	M	-	-
MR 15(8)	F	-	-
MR 15(9)	M	-	-
MR 15(10)	F	-	-
MR 15(11)	F	-	-

Cobern Street

Estimated sex using various methods.

Burial #	Standard Visual Method	Distal Hum. Method	Femoral Neck Method
UCT 458.1	F	F	F
UCT 458.2	J	-	-
UCT 459.1	M	-	-
UCT 459.2	M	-	-
UCT 459.3	J	-	-
UCT 460	M	M	F
UCT 461	F	-	F
UCT 473	M	-	-
UCT 474	M	-	-
UCT 475	F	-	F
UCT 476	M	-	-
UCT 477	A	-	-
UCT 478.1	F	-	F
UCT 478.2	SA	-	-
UCT 479	A	-	-
UCT 480.1	M	-	-
UCT 480.2	M	-	-
UCT 481	A	-	-
UCT 482	A	-	-
UCT 483.1	A	-	-
UCT 483.2	SA	-	-
UCT 483.3	J	-	-
UCT 484	F	-	F
UCT 485.1	M	-	-
UCT 485.2	F	-	F
UCT 486	M	-	-
UCT 487.1	A	-	-
UCT 487.2	A	-	-
UCT 487.3	J	-	-
UCT 488.1	A	-	-
UCT 488.2	I	-	-
UCT 489	J	-	-
UCT 490	F	F	F
UCT 491	F	-	F
UCT 492.1	M	-	-
UCT 492.2	J	-	-
UCT 493	F	-	F
UCT 494.1	I	-	-
UCT 494.2	A	-	-
UCT 495	M	-	-
UCT 496	F	-	F
UCT 497	A	-	-
UCT 498	F	F	F
UCT 499	F	F	F
UCT 500	M	M	F
UCT 501	M	M	F

Burial #	Standard Visual Method	Distal Hum. Method	Femoral Neck Method
UCT 502	F	F	F
UCT 503	I	-	-
UCT 504	M	M	-
UCT 505	J	-	-
UCT 506	I	-	-
UCT 507	I	-	-
UCT 508	F	F	F
UCT 509	M	-	M
UCT 510	M	M	M
UCT 511	F	F	F
UCT 512	I	-	-
UCT 513	A	-	-
UCT 514	F	F	F
UCT 515	J	-	-
UCT 516	F	F	F
UCT 517	M	-	-
UCT 518	M	M	-
UCT 519	M	-	F
UCT 520.1	A	M	M
UCT 520.2	A	-	F
UCT 520.3	A	-	-
UCT 520.4	J	-	-
UCT 520.5	J	-	-
UCT 520.6	J	-	-
UCT 521	M	M	-
UCT 522	F	M	F
UCT 523.1	I	-	-
UCT 523.2	F	-	F
UCT 524	I	-	-
UCT 525	I	-	-
UCT 526	M	M	F
UCT 527.1	A	-	-
UCT 527.2	A	-	-
UCT 528	J	-	-
UCT 529.1	A	-	-
UCT 529.2	A	-	-
UCT 529.3	A	-	-
UCT 529.4	J	-	-
UCT 530	I	-	-
UCT 531	A	F	F
UCT 533.1	J	-	-
UCT 533.2	A	-	-
UCT 534	I	-	-
UCT 535	J	-	-
UCT 536	M	M	M
UCT 537	M	-	-
UCT 538	M	M	-
UCT 539	A	-	M
UCT 541	M	-	M
UCT 542	F	-	F

Burial #	Standard Visual Method	Distal Hum. Method	Femoral Neck Method
UCT 543	M	M	M
UCT 544	F	-	F
UCT 545	M	-	M
UCT 546	F	F	F
UCT 547	M	M	-
UCT 548	M	-	F
UCT 549	M	-	M
UCT 550	F	F	F
UCT 551	M	M	F
UCT 552	M	M	F
UCT 553	J	-	-
UCT 554	M	M	M
UCT 555	F	M	-
UCT 556	F	F	F
UCT 557	M	M	M
UCT 558	F	F	F
UCT 559.1	F	F	F
UCT 559.2	M	M	-
UCT 560	J	-	-
UCT 561	I	-	-
UCT 562	M	M	M
UCT 563	F	F	F
UCT 572.1	F	-	F
UCT 572.2	M	-	-
UCT 572.3	J	-	-

APPENDIX 4

Marina Residence

Estimation of age (in years) for the various methods used.

Burial #	Histological Age	Standard Visual Age	Igarashi et al. Method	Suchey-Brooks Method	Meindl & Lovejoy Method
MR 3	-	30-40	34.9	29+/-5.9	30-39
MR 4	54-62	40-60	57.4	48.1+/-14.5	50-59
MR 5	27-30	25-40	28.3	29+/-5.9	25-29
MR 6	-	20-35	26.1	29+/-5.9	25-30
MR 7	-	~16	15.7	18.9+/-2.3	-
MR 8	-	45-55	-	-	-
MR 9	-	~25	-	-	-
MR 10	-	20-30	-	-	-
MR 12	-	20-30	-	-	-
MR 13	-	25-40	-	-	-
MR 14	-	-	-	-	-
MR 15 (1)	27	20-30	-	-	-
MR 15 (2)	43-46	35-50	-	-	-
MR 15 (3)	50-68	40-60	-	-	-
MR 15 (4)	25-27	20-30	-	-	-
MR 15 (5)	56-58	50+	-	-	-
MR 15 (6)	-	35-50	-	-	-
MR 15 (7)	42-44	35-50	-	-	-
MR 15 (8)	25-27	20-30	-	-	-
MR 15 (9)	-	25+	-	-	-
MR 15 (10)	-	35-50	-	-	-
MR 16	-	10	-	-	-
MR 20	-	25	-	-	-

Burial #	Histological Age	Standard Visual Age	Igarashi et al. Method	Suchey-Brooks Method	Meindl & Lovejoy Method
MR 21	58-68	60+	63.3	60+/-12.4	60+
MR 22	-	20-40	-	-	-
MR 23	45-48	35-50	-	-	-
MR 24	21	20-25	-	-	-
MR 25	-	25-30	-	-	-
MR 26	-	40-50	48.2	51+/-13.6	45-49
MR 27	42-50	35-50	44.6	36.8+/-9.6	45-49
MR 28	34-40	30-40	37.5	36.8+/-9.6	35-39
MR 29	50-51	40-60	50.4	51+/-13.6	50-59
MR 30	-	40-70	62.4	60+/-12.4	63
MR 31	-	20-30	26.1	29+/-5.9	20-30
MR 32	58-63	50-60	-	-	-
MR 33	26-30	25-40	27.6	29+/-5.9	30-39
MR 34	26-30	20-30	-	-	-
MR 35	-	18mnth	-	-	-
MR 37	24-27	20-30	25.9	24.7+/-4.3	25-29
MR 37/38	40-43	-	-	-	-
MR 38	45-51	35-50	48.2	48.1+/-14.5	45-49
MR 39	-	18	-	-	-
MR 40	-	15-25	-	-	-
MR 41	-	40+	-	-	-
MR 42	42-44	35-50	-	-	-
MR 43A	-	30-50	-	-	-
MR 43B	-	40-60	53.4	51+/-13.6	45-59
MR 44	50-55	50-60	52.8	48.1+/-14.5	50-59
MR 45	-	40-55	-	-	-
MR 46	32-37	25-35	35.1	36.8+/-9.6	35-39
MR 47	-	35-50	-	-	-

Burial #	Histological Age	Standard Visual Age	Igarashi et al. Method	Suchey-Brooks Method	Meindl & Lovejoy Method
MR 48	37-41	35-45	38.3	36.8+/-9.6	35-39
MR 48A	42	35-45	-	-	-
MR 49	-	35-50	-	-	-
MR 50	18-20	16-20	-	18.9+/-2.3	-
MR 51	-	30-40	36.9	36.8+/-9.6	35-39
MR 52	40-42	35-45	41.4	36.8+/-9.6	40-44
MR 52 not artic.	-	50+	54.3	51+/-13.6	50-59
MR 53	70	60+	-	-	-
MR 54	50-58	50	-	-	-
MR 56	-	25-40	38.9	36.8+/-9.6	40-44
MR 57	-	40+	-	-	-
MR 58	-	30-40	-	-	-
MR 61	59	40-60	59.1	48.1+/-14.5	50-59
MR 62	-	50+	-	-	-
MR SF 46	59-61	-	-	-	-

Cobern Street

Estimation of age (in years) for the various methods used.

Burial #	Standard Visual Age	Igarashi et al. Method	Suchey-Brooks Method	Meindl & Lovejoy Method
UCT 458.1	17-18	-	19.4+/-2.6	-
UCT 458.2	10-12	-	-	-
UCT 459.1	20-30	-	-	-
UCT 459.2	19	19.6	18.9+/-2.3	-
UCT 459.3	9-10	-	-	-
UCT 460	20	19.8	18.9+/-2.3	20-24
UCT 461	20-30	26.9	25+/-4.9	25-29
UCT 473	30-35	-	-	-
UCT 474	45-50	-	-	-
UCT 475	35-50	-	-	-
UCT 476	30-35	-	-	-
UCT 478.1	50-60	-	-	-
UCT 478.2	14-16	-	-	-
UCT 480.1	35-40	-	-	-
UCT 480.2	25-35	-	-	-
UCT 483.1	20-25	-	-	-
UCT 483.2	15-18	-	-	-
UCT 483.3	7-8	-	-	-
UCT 484	45-50	-	-	-
UCT 488.1	40	-	-	-
UCT 488.2	5	-	-	-
UCT 489	8-10	-	-	-
UCT 490	40-50	48.1	38.2+/-11	45-49
UCT 491	25-30	-	-	-
UCT 493	45-50	-	-	-
UCT 494.1	<5	-	-	-

Burial #	Standard Visual Age	Igarashi et al. Method	Suchey-Brooks Method	Meindl & Lovejoy Method
UCT 497	30-40	-	-	-
UCT 498	35-40	36.5	38.2+/-11	35-39
UCT 499	<40	-	-	-
UCT 500	35-45	40.2	36.8+/-9.6	35-44
UCT 501	30-40	-	-	-
UCT 502	45-55	53.1	48.1+/-14.5	50-59
UCT 503	1	-	-	-
UCT 504	25	-	-	-
UCT 505	13	-	-	-
UCT 507	<1	-	-	-
UCT 508	40-50	-	-	-
UCT 510	25-30	26.9	24.7+/-4.3	25-29
UCT 511	16	-	-	-
UCT 512	1.5-2	-	-	-
UCT 513	20-35	-	-	-
UCT 514	25-35	-	-	-
UCT 515	12-14	-	-	-
UCT 516	17-19	17.9	19.4+/-2.6	-
UCT 517	20-25	-	-	-
UCT 518	35-40	38.4	36.8+/-9.6	35-39
UCT 519	>50	-	-	-
UCT 521	40-50	-	-	-
UCT 522	50	-	-	-
UCT 523.1	<1	-	-	-
UCT 523.2	30-35	-	-	-
UCT 524	5	-	-	-
UCT 526	50-60	57.1	51+/-13.6	50-59
UCT 528	14-15	-	-	-

Burial #	Standard Visual Age	Igarashi et al. Method	Suchey-Brooks Method	Meindl & Lovejoy Method
UCT 533.1	7-9	-	-	-
UCT 534	<1	-	-	-
UCT 535	12	-	-	-
UCT 536	35-50	42.3	51+/-13.6	40-49
UCT 537	35-45	-	-	-
UCT 538	35-40	-	-	-
UCT 541	35-50	-	-	-
UCT 542	40-50	-	-	-
UCT 543	>50	-	-	-
UCT 544	35-50	47.9	38.2+/-11	40-49
UCT 545	30-40	-	-	-
UCT 546	>40	45.1	38.2+/-11	45-49
UCT 547	40		36.8+/-9.6	40-44
UCT 548	35-50	-	-	-
UCT 549	35-40	37.2	36.8+/-9.6	35-39
UCT 550	25-35	-	-	-
UCT 551	35-40	-	-	-
UCT 552	30-35	32.8	29+/-5.9	30-34
UCT 554	35	-	-	-
UCT 555	20-30	24.4	25+/-4.9	20-29
UCT 556	35-40	-	-	-
UCT 557	>40	-	-	-
UCT 558	30	-	-	-
UCT 559.1	20-25	-	-	-
UCT 559.2	>40	-	-	-
UCT 560	5-6	-	-	-
UCT 561	1	-	-	-
UCT 562	35-40	37.1	36.8+/-9.6	35-39

Burial #	Standard Visual Age	Igarashi et al. Method	Suchey-Brooks Method	Meindl & Lovejoy Method
UCT 563	22-25	22.7	25+/-4.9	20-24
UCT 572.1	18-24	21.3	19.4+/-2.6	20-24
UCT 572.3	7	-	-	-