Research Article

DENTAL HEALTH AND DIET OF THE PEOPLE OF WHITCHER'S CAVE, EASTERN CAPE, SOUTH AFRICA

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ABSTRACT

A recent revision of the Whitcher's Cave skeletal assemblage (~5000 BP to ~1800 BP) yielded a minimum number of 32 individuals. To explore the dental pathology, we assessed the permanent dentition of all the individuals with preserved cranial elements. All dentition sets were analysed for the presence or absence of enamel hypoplasia, caries, abscesses and ante-mortem tooth loss. The incidences of these conditions were compared with reported data from several other archaeological sites and ethnographic studies, representing San hunter-gatherers and more recent pastoralist and agricultural groups. Our results show that the frequency of enamel hypoplasia is low (two of 16 individuals), comparable to other hunter-gatherer groups and much lower compared to more recent groups. Caries levels are low (caries frequency 20.0%; n = 25, 183 teeth), but abscessing (33.3%; n = 30) and ante-mortem tooth loss (AMTL intensity 23.3%; n = 30) are more common. This is ascribed to the generally advanced dental wear observed in many individuals which may possibly be attributed to the presence of older individuals, and also to the nature of their diet which likely caused pulpal exposure followed by abscessing and tooth loss. Low levels of enamel hypoplasia support the previously reported general good health of children in this group.

Keywords: Bioarchaeology, Tsitsikamma caves, Late Stone Age, dental analysis, isotopes.

INTRODUCTION

Human skeletal remains are valuable sources of information on past populations. Of these elements, teeth are the most durable, enabling the reconstruction of aspects of health and diet, especially childhood physiological stress, even in cases where skeletal elements are poorly represented (e.g. Cohen 1989; Lukacs 1992; Morris 1992; Sealy *et al.* 1992; Larsen 2000; Wols & Baker 2004). They also reflect cultural behaviours, for example, through wear patterns or cultural modification (Alt & Pichler 1998; Lukacs 2012; Milner & Larsen 1991), and differences in access to food resources between individuals of different social status groups or genders (e.g. Walker & Hewlett 1990; Russell *et al.* 2013). Teeth provide a powerful window into past health, behaviour and diet.

The investigation of teeth usually includes assessments of disturbances of enamel development (e.g. enamel hypoplasia), dental caries, calculus formation, abscesses, ante-mortem tooth loss and attrition. The development of dental disease depends on many intrinsic and extrinsic factors, including the nature of the diet, crown morphology, enamel defects, oral and food pH, general health, and fluoride levels in the water, amongst other things (Hillson 1998; Larsen 2015). Genetics (Wright 2010) and hormonal changes in women (Lukacs & Largaespada 2006; Lukacs 2008) have also been suggested as possible contributing factors to increased caries risk. Many studies have focused on dental diseases relating to the change from foraging/hunter-gatherer lifeways to those of pastoralists or agriculturalists (e.g. Walker & Hewlett 1990; Lukacs 1992; Crittenden *et al.* 2017; Marklein *et al.* 2019). Most researchers agree that these changes in subsistence were associated with an increase in caries due to higher and/or more frequent intake of carbohydrate-rich foods and less abrasive foods (Turner 1979; Sealy & Van der Merwe 1988; Lukacs 1992; Hillson 1998; Roberts & Cox 2003; Klaus & Tam 2010; Pechenkina *et al.* 2013), although the development of caries is complex. Dental decay is often associated with ante-mortem tooth loss, although many other factors may play a role in ante-mortem tooth loss such as excessive wear (with pulpal exposure), dental modification, trauma and use of teeth for purposes other than chewing.

A general increase in dental decay with the adoption of agriculture, as reflected by caries, has been observed in sub-Saharan Africa (e.g. Carter & Irish 2019), although some exceptions exist, for example at Oakhurst, a Holocene forager site in South Africa, where high levels of caries were found and were attributed to low fluoride levels (Sealy *et al.* 1992). Various other studies have included remains of Khoesan people, ranging from pre-2000 BP San hunter-gatherers (a.k.a. foragers who depended primarily on wild foods for subsistence) to historic Khoesan (some of whom may also have been pastoralists or sedentary) (e.g. Patrick 1989; Sealy 1989; Morris 1992; Sealy *et al.* 1992; Botha & Steyn 2015; Gibbon & Davies 2020). These mostly confirm the expected trends of increased dental decay and decreased dental wear with changes in subsistence patterns.

Whitcher's Cave is a Stone Age site in the Cape Fold mountains which was excavated in the 1920s (Morris 2022). It was inhabited over a long period, and from the currently available dates, it seems that this happened in two phases, with older (circa 4000–5000 BP) and more recent (*c*.1000–2000 BP; recalibrated dates) occupation phases (Steyn *et al.* 2024, this volume). The skeletal material from this site is currently curated in the Raymond A. Dart Archaeological Human Remains Collection at the University of the Witwatersrand and comprises a commingled assemblage of skeletons representing at least 32 individuals. The findings from our recent study (Steyn *et al.* 2024) suggest that the assemblage includes individuals of all ages but with a predominance of older individuals. Few indicators of chronic stress or disease were found.

Wells and Gear (1931) thought that the occupants lived mostly on shellfish, but reported that there were also bush pig, duiker, steenbok and bird bones in the Whitcher's Cave faunal assemblage. In more recent studies, Sealy and Pfeiffer (2000), and Pfeiffer and Sealy (2006) reported on the dietary isotope values of Holocene samples in the southern Cape, in which a few dated individuals from Whitcher's Cave were included. They reflected on the small body size and found that this was already present in the Holocene pre-2000 BP. They also suggested that pre-2000 BP, the shortest people were more dependent on terrestrial (as opposed to marine) foods, while the pattern changed as the diet overall shifted to more terrestrial food after 2000 BP. They did, however, find some very short people (mainly females) between 4000 and 2000 BP. Much variability was introduced after 4000 BP, for which a variety of factors could be responsible, amongst them a known increase in population density in the area. As very few signs of disease are present in most pre-2000 BP skeletons, Pfeiffer and Sealy (2006) ascribed the short stature to genetic or nutritional rather than infectious stressors. They argued that there was a slight increase in stature from 3000 BP onwards, even before the advent of pastoralism around 2000 BP. In their study of Holocene foragers housed at the University of Cape Town, Gibbon and Davies (2020) found an increase in stress markers in skeletons dating after 2000 BP, which was higher in coastal than in inland communities. They attributed this to an influx of more people around this time, putting more pressure on people in the area.

In general, dental caries rates have been shown to increase with the advent of agriculture (Turner 1979; Cohen & Armelagos 1984; Larsen 1995, 2015), however, it should be kept in mind that this may represent an oversimplification of the dietary challenges associated with the hunter-gatherer/forager and agricultural subsistence strategies. It has been argued that a more holistic approach, focusing on climatic changes, consumed cultigens and their respective cariogenic levels, should be followed when interpreting caries rates amongst different subsistence strategies (Marklein *et al.* 2019; Gibbon & Davies 2020).

This study aimed to assess the dentition of the individuals from Whitcher's Cave to gain information on their diet, general dental health, and overall well-being (through evaluation of dental enamel hypoplasia).

MATERIALS AND METHODS

The skeletal assemblage of Whitcher's Cave comprises a minimum of 32 individuals, mainly represented by cranial material. There are at least ten subadults, seven of whom were under the age of 12 years (Steyn *et al.* 2024). However, the count of 32 is based on the most frequent skeletal element, and the assemblage most probably represents more individuals. There are 25 crania in various states of preservation. The maxillae associated with skulls as well as isolated (not specifically associated with any of the partial skulls) maxillae number 18, whereas 29 mandibles are present. These 29 mandibles could not always be associated with a skull, and they were treated as separate individuals where appropriate. For this study, all maxillae and mandibles containing permanent teeth were assessed macroscopically. All dentition sets (permanent teeth only) were scored for the presence or absence of teeth, ante-mortem tooth loss, abscessing, the presence of caries, and enamel hypoplasia. A detailed analysis of dental wear fell beyond the scope of this article, but all teeth were observed for general levels of dental wear, as advanced dental wear precludes the scoring of caries and enamel hypoplasia and may contribute to tooth loss. Due to the incomplete and commingled nature of the collection, estimations of sex and age are tentative at best.

Although there are many discussions as to its exact causes, enamel hypoplasia is commonly interpreted as representing episodes of disease and malnutrition during the formation of the enamel (e.g. Goodman & Rose 1992; Hillson & Bond 1997; Towle & Irish 2020), leaving long-lasting evidence of stress during childhood as the enamel of teeth does not remodel. It is more commonly recorded for anterior teeth. Enamel hypoplasia was macroscopically scored as present or absent in all individuals with permanent teeth (including a juvenile of 7–10 years old). Similarly, carious lesions were scored as present or absent in all individuals with permanent teeth, including four adolescents, but excluding the 7–10-year-old. Teeth with advanced wear were considered non-scorable for caries and enamel hypoplasia, and these individuals were completely left out of the subsequent analyses. Ante-mortem tooth loss was scored relative to the number of dental positions available.

Various calculations (Lukacs 1989; Botha & Steyn 2015; Gibbon & Davies 2020) were done to assess the prevalence of dental disease, and the results were compared to other reported results using chi-squared (for larger samples) and Fisher's exact (for smaller samples) analyses. The following parameters were calculated in line with previously published results in South African studies (see for example Tables 1 & 2) in order to make comparisons and consequently no caries corrections were applied for calculations of ATML (Lukacs 1995):

Enamel hypoplasia (EH)

Frequency = *100 × total number of individuals with EH/total number of individuals assessed*

Teeth affected = *100 × total number of teeth with EH/total number of teeth assessed*

Anterior teeth affected = *100 × total number of anterior teeth with EH total number of anterior teeth assessed.*

Caries

Caries frequency = *100 × total number of individuals affected with caries/total number of individuals in the sample*

Caries intensity = *100 × total number of teeth affected with caries/total number of teeth in the sample*

Carious teeth per mouth = *100 × total number of teeth affected with dental caries/total number of individuals in the sample*

Ante-mortem tooth loss (AMTL)

AMTL frequency = *100 × total number of individuals affected by ante-mortem tooth loss/total number of individuals investigated*

AMTL per individual = *total number of teeth lost ante-mortem/total number of individuals affected by ante-mortem tooth loss*

AMTL intensity = *100 × total number of teeth lost ante-mortem/total number of tooth places present*

For purposes of comparison, a sample of forager (hunter-gatherer) and sedentary (living on European-run farms) San individuals (Van Reenen 1966), as well as various other Khoesan groups, were included. These included the sample from Oakhurst (Patrick 1989; Sealy *et al.* 1992), various coastal and interior sites in the Western Cape (Gibbon & Davies 2020), historic Griqua, Riet River and Kakamas (Morris 1992) groups, and skeletal remains of historic individuals housed in institutions outside of South Africa (Botha & Steyn 2015). Gibbon and Davies (2020) divided their group into pre- and post-2000 BP individuals, and we maintained their division for comparative purposes.

FIG. 1. *Advanced dental wear of especially anterior teeth in individual A1192 PEM 325S nr 1.*

FIG. 2. *Unusual wear pattern of individual A1192 PEM 325S nr 1. Note the oblique wear of the left second premolar (white arrow).*

In addition, skeletal samples representing Bantu-speaking farming communities, specifically from K2 and Mapungubwe (Steyn 1994), as well as those representing modern pre-industrialised Venda (L'Abbé 2005), and post-industrialised mine workers from Gladstone, Kimberley (Van der Merwe 2006) and Koffiefontein (L'Abbé *et al.* 2003) were included as reflecting individuals with a different mode of life. Finally, individuals recovered from Cobern Street, Marina Residence and Polyoak, representing various historic communities around Cape Town (Manyaapelo 2007), were also included for comparison.

RESULTS

The analysis of dentition and dental disease was difficult due to the extensive dental wear and many post-mortem tooth losses. In some individuals, the wear was such that especially the anterior teeth were worn down to stumps, so that they had a rounded appearance and most of the crown was lost (Fig. 1). We did not score very worn teeth for enamel hypoplasia or the presence of caries but included their tooth positions in the analysis of abscessing and AMTL. We noted some unusual wear patterns, for example in A1192 PEM 325S nr 1 (same individual as shown in Fig. 1), where the maxillary left second premolar was obliquely worn, suggesting uses other than mastication (Fig. 2), such as gripping something between the teeth. Unfortunately, this individual did not have a matching mandible and the first premolar was missing, most probably lost as a result of an abscess, so we were unable to draw firm conclusions about the oblique wear.

Assessment for the presence of enamel hypoplasia in permanent teeth could be done for only 16 individuals because the teeth were often too worn, and in some instances obscured through varnished-on cave deposits (older practices saw fragile skeletal elements being varnished in an attempt to retain the integrity of skeletal material). None of the individuals had a complete set of teeth. Of the 16 individuals, two (12.5%) have enamel hypoplasia (both on a single anterior tooth). This

TABLE 1. *Enamel hypoplasia frequency comparisons between Whitcher's Cave and other South African samples.*

Sample	N	Na	(%)	Chi^{2*}	p-value	Source
Whitcher's Cave	16	2	12.5	–	–	–
Oakhurst	22	11	50	5.7877	0.0161	Patrick (1989)
Pre-2000 BP San	49	6	12.3	0.0007	0.9785	Gibbon & Davies (2020)
Post-2000 BP Khoesan	43	6	14	0.021	0.8847	Gibbon & Davies (2020)
Historic Khoesan	55	17	30.9	2.1431	0.1432	Botha & Steyn (2015)
K2/Mapungubwe	60	38	63.3	13.0924	0.0003	Steyn (1994)
Venda	90	12	13.3	0.0082	0.9277	L'Abbé (2005)
Gladstone	92	14	15.2	0.0797	0.7776	Van der Merwe (2006)
Koffiefontein	37	22	59.5	9.9411	0.0016	L'Abbé *et al.* (2003)
Cobern street	14	7	50	5	0.0253	Manyaapelo (2007)
Marina Residence	22	17	77.3	15.5455	0.0001	Manyaapelo (2007)
Polyoak	9	8	88.9	14.0046	0.0002	Manyaapelo (2007)

N = total number of individuals
Na = total number of individuals affected
*degrees of freedom = 1
Alpha set to 0.05
Significant p-values indicated in bold

TABLE 2. *Carious lesions in the current sample and other South African samples.*

Sample	N	Na	Nt	Nta	Caries frequency (%)	Caries intensity (%)	Carious teeth/ mouth	Source
Whitcher's Cave	25	5	183	14	20.0	7.7	0.56	-
Historic Khoesan	116	33	1 722	111	28.4	6.5	0.95	Botha & Steyn (2015)
Gladstone	92	51	2 694	116	55.4	4.3	1.26	Van der Merwe (2006)
Griqua	26	–	575	30	42.3	5.2	1.15	Morris (1992)
Oakhurst	13	11	192	34	84.6	17.7	2.62	Sealy *et al.* (1992)
Khoesan (foraging)	104	–	3 335	17	7.7	0.5	0.16	Van Reenen (1966)
Khoesan (sedentary)	221	–	7 052	56	12.2	0.8	0.25	Van Reenen (1966)
Venda	97	59	2 016	157	60.8	7.8	1.62	L'Abbé (2005)
K2/Mapungubwe	–	–	306	56	54.5	18.3	1.40	Steyn (1994)
Cobern Street	28	21	734	118	75.0	16.1	4.21	Manyaapelo (2007)
Marina Residence	32	27	759	120	84.4	15.8	3.75	Manyaapelo (2007)
Polyoak	9	7	210	57	77.8	27.1	6.33	Manyaapelo (2007)

N = number of individuals investigated
Na = number of individuals affected
Nt = total number of teeth investigated
Nta = number of teeth affected by caries
Caries frequency = total number of individuals affected with caries/total number of individuals in the sample
Caries intensity = total number of teeth affected with caries /total number of teeth in the sample
Carious teeth per mouth = total number of teeth affected with dental caries/total number of individuals in the sample

represents two teeth out of a total number of 136 scorable teeth (1.5%), and two (4.9%) out of a total number of 41 anterior teeth (incisors and canines) where enamel hypoplasia is more likely to be reported. We present a comparison between Whitcher's Cave enamel hypoplasia frequency and other South African samples in Table 1. The frequency of enamel hypoplasia observed in the Whitcher's Cave material is significantly less than those observed in the Oakhurst, K2/Mapungubwe, Koffiefontein and three historic Western Cape samples (Cobern Street, Marina Residence and Polyoak), but similar to groups such as the pre-2000 BP San, and the post-2000 BP and historic Khoesan (Gibbon & Davies 2020).

The results of assessments of dental disease (permanent teeth only), namely, the frequency of caries, abscessing and ante-mortem tooth loss, are shown in Tables 2–6. A total number of 25 isolated mandibles, isolated maxillae, or combined mandibles/maxillae could be scored for dental caries. Caution is advised when comparing these data to the MNI because some of the isolated upper and lower elements may or may not have been associated with one another. Due to the fragmentary nature of the remains sex estimation was not possible for many individuals. Consequently, we did not attempt to separate the results according to male or female. Only eight of the individuals had both upper and lower teeth, whereas five had only maxillary teeth and 12 only mandibular teeth.

The results for the analysis of caries are shown in Table 2, where they are also compared to those of human remains recovered from several other southern African sites. Twenty percent of the Whitcher's Cave individuals were affected by caries, which is the lowest of all groups shown here, with the exception of the San described by Van Reenen (1966). It should be kept in mind that the number of individuals with caries is affected by the completeness of the dentition sets. The caries intensity for Whitcher's Cave is 7.7%, which is comparable to that of the historic Khoesan described by Botha and Steyn (2015). The carious teeth per mouth (0.56) from Whitcher's Cave is the lowest of all listed samples, except for the Van Reenen (1966) San. The caries intensity of the anterior teeth (incisors and canines) versus those of the posterior teeth (premolars and molars) was also calculated. The intensity in the posterior teeth (9.7%) is much higher than that of the anterior teeth (2%), as expected because posterior teeth are more likely to be affected by caries. Overall, this group of individuals seems to have had a low caries prevalence, as would be expected from individuals with a hunter-gatherer/forager type of diet.

TABLE 3. *Caries frequency comparisons between Whitcher's Cave and other South African samples.*

Sample/Site	Chi-squared value (χ^2)	p-value	Source
Khoesan (foraging)	3.3691	0.06643	Van Reenen (1966)
Khoesan (sedentary)	–	0.3409*	Van Reenen (1966)
Oakhurst	14.6486	0.0001	Sealy *et al.* (1992)
Pre-2000 BP San	0.1419	0.7064	Gibbon & Davies (2020)
Post-2000 BP Khoesan	–	0.776*	Gibbon & Davies (2020)
Riet River[a]	3.6623	0.0557	Morris (1992)
Kakamas[b]	–	1*	Morris (1992)
Historic Khoesan	0.7456	0.3879	Botha & Steyn (2015)
Griqua	0.0817	0.7750	Morris (1992)
K2/Mapungubwe	5.7497	0.0165	Steyn (1994)
Venda	13.283	0.0002	L'Abbé (2005)
Gladstone	9.8913	0.0017	Van der Merwe (2006)
Cobern Street	15.9869	0.0001	Manyaapelo (2007)
Marina Residence	23.6216	<0.00001	Manyaapelo (2007)
Polyoak	–	0.0037*	Manyaapelo (2007)

Alpha set to 0.05
*For expected frequencies less than five, Fisher's exact test was used
Significant p-values indicated in bold
[a] N = 47 although Morris (1992) noted 46.5 to account for one missing mandible/maxilla
[b] N = 43 although Morris (1992) noted 42.5 to account for one missing mandible/maxilla

Caries frequency (Table 3) and caries intensity (Table 4) were compared between the Whitcher's Cave and other South

TABLE 4. *Caries intensity comparisons between Whitcher's Cave and other South African samples.*

Sample/Site	Chi-squared value (χ^2)	p-value	Sources
San (foraging)	–	<0.00001	Van Reenen (1966)
San (sedentary)	–	<0.00001	Van Reenen (1966)
Oakhurst	8.4923	0.0036	Sealy *et al.* (1992)
Riet River	3.7358	0.0533	Morris (1992)
Kakamas	–	<0.00001	Morris (1992)
Historic Khoesan	0.3913	0.5316	Botha & Steyn (2015)
Griqua	1.5027	0.2203	Morris (1992)
K2/Mapungubwe	10.5901	0.0011	Steyn (1994)
Venda	0.0044	0.9470	L'Abbé (2005)
Gladstone	4.4425	0.0351	Van der Merwe (2006)
Cobern Street	8.4395	0.0037	Manyaapelo (2007)
Marina Residence	8.0465	0.0046	Manyaapelo (2007)
Polyoak	25.1008	<0.00001	Manyaapelo (2007)

Alpha set to 0.05
Significant p-values indicated in bold
*For expected frequencies less than five, Fisher's exact test was used

African samples with available data. The Whitcher's Cave individuals show a significantly lower caries frequency compared to the Oakhurst, Venda, Gladstone and three historic Western Cape samples (Cobern Street, Marina Residence and Polyoak). Caries intensity comparisons reveal a significantly higher caries intensity for the Whitcher's Cave individuals when compared to the Van Reenen (1966), Kakamas and Gladstone individuals. Significantly lower caries intensities were, however, seen for Whitcher's Cave when compared to Oakhurst, K2/Mapungubwe and the three Western Cape samples (Cobern Street, Marina Residence and Polyoak).

Table 5 summarises the ante-mortem tooth loss (AMTL) of the Whitcher's Cave individuals and historic Khoesan (Botha & Steyn 2015) groups, while Table 6 shows the AMTL intensity of several southern African samples. While the per-individual and per-mouth counts are similar to those of the historic Khoesan, the intensity of tooth loss is relatively high (number of teeth lost out of the total number of tooth positions present) – the highest of all groups observed. Chi-squared tests confirmed that the Whitcher's Cave individuals present with a significantly higher AMTL intensity compared to all the other South African samples (Table 6). There were thus many AMTL observed in the Whitcher's Cave community, where the heavy wear observed in many individuals probably resulted in pulp exposure and subsequent tooth loss. This is also reflected in the fact that as many as one-third of

TABLE 5. *Summary of ante-mortem tooth loss (AMTL).*

Sex	Per individual[1]			Per mouth[2]			Intensity[3]		
	N	Nai	%	Nai	Na	C/M	Nt	Na	%
Whitcher's Cave	30	12	40.4	12	88	7.3	377	88	23.3
Historic Khoesan	116	44	37.9	44	441	10.0	3712	441	11.9

[1] total number of individuals affected by ante-mortem tooth loss/total number of individuals investigated
[2] total number of teeth lost ante-mortem/total number of individuals affected by antemortem tooth loss
[3] total number of teeth lost ante-mortem/total number of tooth places present
N = total number of individuals investigated
Nai = number of individuals affected by ante-mortem tooth loss
Na = number of teeth lost ante-mortem
C/M = average number of teeth lost ante-mortem per mouth
Nt = total number of tooth places present in the sample

TABLE 6. *Comparison with ante-mortem tooth loss intensity in various other South African samples.*

Sample	N	Na	AMTL intensity (%)	Chi^{2*}	p-value	Source
Whitcher's Cave	377	88	23.3	–	–	-
Riet River	1557	95	6.1	105.3074	<0.00001	Morris (1992)
Kakamas	1317	54	4.1	141.6053	<0.00001	Morris (1992)
Historic Khoesan	3712	441	11.9	39.9177	<0.00001	Botha & Steyn (2015)
Griqua	894	152	17.0	6.9586	0.0083	Morris (1992)
K2/Mapungubwe	306	7	2.3	62.5282	<0.00001	Steyn (1994)
Venda	2016	347	17.2	8.0237	0.0046	L'Abbé (2005)
Gladstone	2694	63	2.3	312.0673	<0.00001	Van der Merwe (2006)
Koffiefontein	1016	63	6.2	83.5949	<0.00001	L'Abbé *et al.* (2003)
Cobern Street	849	61	7.2	63.837	<0.00001	Manyaapelo (2007)
Marina Residence	885	104	11.8	27.5349	<0.00001	Manyaapelo (2007)
Polyoak	263	27	10.3	17.9709	0.00002	Manyaapelo (2007)

N = total number of tooth places present
Na = total number of teeth lost ante-mortem
*degrees of freedom = 1
Alpha set to 0.05
Significant p-values indicated in bold

TABLE 7. *Comparison of abscess frequency in various other South African samples.*

Sample	N	Na	%	Chi^{2*}	p-value	Source
Whitcher's Cave	30	10	33.3	-	-	-
Historic Khoesan	116	34	29.3	0.1832	0.6687	Botha & Steyn 2015
Venda	97	7	7.2	13.4802	0.0002	L'Abbé (2005)
Gladstone	89	13	14.6	5.0463	0.0246	Van der Merwe 2006
Cobern street	28	9	32.1	0.0093	0.9231	Manyaapelo (2007)
Marina Residence	36	12	33.3	0.0688	0.7832	Manyaapelo (2007)
Polyoak	9	4	44.4	0.3714	0.5422	Manyaapelo (2007)

Alpha set to 0.05
Significant p-values indicated in bold
N = total number of individuals investigated
Na = number of individuals affected by the condition
% = abscess frequency
***degrees of freedom = 1**

the individuals from Whitcher's Cave were affected by dental abscessing (Table 7). Chi-squared analysis indicates that significantly more Whitcher's Cave individuals suffered from abscesses compared to, for example, the Venda individuals and the Gladstone miners. No significant differences in the number of individuals presenting with abscesses are, however, observed between the Whitcher's Cave community and any of the other comparative groups. The AMTL per type of tooth (anterior versus posterior) is 0.112 versus 0.300, indicating that even though the anterior teeth were heavily worn in many cases, the posterior teeth were still more likely to be lost – most probably due to the combined impact of caries and tooth wear. There were many older-aged individuals in the sample, which would also have played a role in the relatively high observed AMTL.

DISCUSSION

Whitcher's Cave is one of many Stone Age cave sites in the broader Tsitsikamma region. The haphazard excavation of most of these sites (Morris 2020), in combination with subsequent curatorial issues (Steyn *et al.* 2024), resulted in the loss of information and collections of skeletons that are commingled and poorly provenanced – such as that of Whitcher's Cave. This article forms part of our aim to sort, describe and publish the current status of the collections (e.g. Steyn *et al.* 2024). Even though we were unable to fully explore the effects of age and sex on patterns of dental disease based on the condition of the assemblage, we could add new knowledge about the condition of teeth that can be used in future studies aimed at assessing subsistence patterns and health in the region.

Previous studies of San hunter-gatherers, with the exception of Patrick's (1989) study of Oakhurst, reported low levels of enamel hypoplasia. The frequency of 12.5% reported here is very similar to that reported from other comparable LSA sites by Gibbon and Davies (2020). In an analysis of the Whitcher's Cave skeletal remains, we (Steyn *et al.* 2024) also reported few signs of chronic disease, suggesting low levels of infectious disease and stress.

Here, we demonstrate that carious lesions were not frequent, indicating a diet that was most probably low in refined carbohydrates, as expected from hunter-gatherers. This was also seen in most of the comparable hunter-gatherer groups, except for Oakhurst where high levels of tooth decay were attributed to low fluoride levels. It is, however, imperative to not oversimplify the meaning of various dental indicators as there is considerable variation in and between groups, and the aetiology of dental decay is complex (Marklein *et al.* 2019). Marklein *et al.* demonstrated that there is a large overlap between hunter-gatherers and agriculturalists as far as dental caries is concerned, and that any interpretations should be made taking the regional context into account. Caries was, and still is, a common disease which also occurred in fossil hominids (Towle *et al.* 2021).

Heavy occlusal wear was observed in many individuals, with a fair number of abscesses and high levels of ante-mortem tooth losses. This points to abrasive diets and possible use of teeth for non-masticatory purposes, as is shown by the individual with the very oblique wear (Fig. 3). Dietary differences between hunter-gatherers and agriculturalists have been reported to result in differences in masticatory loads (Holly Smith 1984). These differences may be observable as differences in the angle of the occlusal wear. Individuals with an agricultural subsistence were reported as tending to present with the dental wear planes positioned towards the buccal surfaces, whereas in hunter-gatherer communities occlusal wear results in a more uniform horizontal flattening of the crowns (Holly Smith 1984; Larsen 2015). The dental wear observed in A1192 PEM 325S nr 1, for example, is therefore interesting as it may point towards a mixed diet that would have included both more abrasive and tougher foods associated with a hunter-gatherer subsistence and softer, less abrasive foods more consistent with an agricultural diet. Oblique wear patterns observed in this female may of course also point to para-masticatory use (Molnar 2011).

It can be surmised that the heavy tooth wear led to tooth pulp exposure, resulting in abscessing and tooth loss. The tooth loss is thus most likely not related to caries, but rather to extensive wear causing pulp exposure (Lukacs 2007; Molnar 2011). The high abscess frequencies in Whitcher's Cave individuals are comparable to the historic Khoesan and historic Western Cape samples. Abscesses can be the result of tooth decay (caries) or extensive wear. It is therefore likely that the high abscess frequencies in the historic Western Cape samples such as observed in the Cobern Street, Marina Residence and Polyoak samples can be attributed to caries (Manyaapelo 2007) but are here more likely related to wear. Incidences of abscesses and AMTL in groups with different subsistence strategies overlap to a large degree (Marklein *et al.* 2019) and are difficult to interpret. In their mega-data study, Marklein *et al.* (2019) found no clear association between AMTL and caries, and the effect of age at death particularly in the Whitcher's sample should probably not be underestimated when it comes to AMTL.

Of the excavations at Whitcher's Cave FitzSimons (1926: 815) wrote: "The midden floor material … on being carefully sieved and examined, showed that, although the inhabitants lived so far from the coast, and, notwithstanding the long and rough journey to and fro, they subsisted chiefly on shell fish. Animal bones were considerably fewer than in the rock shelters in the cliffs on the coast." Sealy and Pfeiffer (2000) reported on the isotope measurements of five of the dated Whitcher's individuals. In contrast to FitzSimons' inference that the people from Whitcher's Cave had a very heavy reliance on marine foods, their analysis shows that human bone material from the site contains relatively low $\delta^{15}N$ values, with three out of five below 10‰, and the highest only 11.5‰. They concluded that these individuals ate little marine food and that they had mainly terrestrial diets obtained from hunting and foraging for food in the area around the cave. It is interesting to note that the oldest of the dated individuals shows the relatively highest meat intake – tentatively suggesting a decline in game availability in more recent times when human population density increased in the area (Deacon 1976; Gibbon & Davies 2020). The region does not support large antelope (Deacon 1976), and therefore hunting opportunities would have been limited, with a high reliance on plant foods.

The work of Botha *et al.* (2020), using a human behavioural ecology or optimal foraging approach in the same bioregion just east of FitzSimon's exploration area, demonstrates how the region's flora provides a rich harvesting ground for at least 90 different edible species including numerous geophytes (plants with specialised underground storage organs or USOs – colloquially known as *uintjies*). They found that apart from the Renosterveld, which yielded higher winter returns compared to those of summer, all other vegetation types showed no seasonal difference in return rates. Their results suggest that food plants provided reliable staple foods along the Cape south coast and immediate hinterland.

Whitcher's Cave is just 20 km north of the coastline, and ~50 km west-north-west of the Klasies River cultural landscape with its well-known cave complex (Deacon & Geleijnse 1988; Wurz 2002; Brenner & Wurz 2019). Here, Van Wijk *et al.* (2017) initially listed 268 plant species in its immediate vicinity of which >70 were deemed edible. A more recent study revealed that 161 indigenous/endemic foodplant species currently grow within ~12.5 km of the Klasies River Main Site and, if foragers extended their range to ~35 km, they had access to 281 known foodplant species. Of these 82 (29.2%) have edible USOs including geophytes or *uintjies* such as *Agapanthus praecox* (bloulelie), *Babiana sambucina* (bobbejaantjie), *Chasmanthe aethiopica* (suurkanolpypie), *Chlorophytum comosum* (hen-met-kuikens), *Cyperus rotundus* (rooiuintjie), *Cyphia undulata* (veldbaroe), *Cyphia volubilis* (bosbaroe), *Disa hians* (akkedisdisa), *Eulophia hians*, *Eulophia speciosa*, *Gladiolus permeabilis* (kleinaandblom), *Gyaxis puniceus* (rooikwas), *Habenaria falcicornis*, *Hypoxis angustifolia* (sterretjie/Afrika-patat), *Hypoxis villosa* (inkbol), *Moraea spathulate* (bergmoraea), *Moraea tricuspidate* (rietuintjie), *Ornithogalum tenuifolium* (bosui), *Oxalis polyphylla* (suring), *Oxalis smithiana* (klawersuring), *Pelargonium sidoides* (kalwerbossie), *Sansevieria hyacinthoides* (skoonma-se-tong), *Trachyandra divaricate* (kus-waaibossie), *Trachyandra revoluta* (waterknolle), *Tulbaghia capensis* (wildeknoffel), *Watsonia knysnana* (Knysna suurkanol) and *Zantedeschia aethiopica* (varkoor) (Lombard & Van Aardt 2023). These studies indicate that within a relatively easy foraging distance from Whitcher's Cave people would have been able to find ample plant foods. It has been suggested that plant carbohydrates obtained in the form of USOs were predictable and reliable forager resources (De Vynck *et al.* 2016; Singels *et al.* 2016; Botha *et al.* 2020), some of which (such as *Cyperus rotundus)* are also rich in proteins and oils (Lombard 2022). If such foods were also a staple of the people who lived at Whitcher's Cave, it may explain the excessive tooth wear observed during our analysis because invariably sand would be chewed with the *uintjies* and other plant foods.

CONCLUSION

In this article, we reported on the dental characteristics of the people from Whitcher's Cave. This sample is of particular interest because it originates from one of the few sites from the Eastern Cape that are not directly at the coast. Other such inland sites, for example Melkhoutboom (Deacon 1976), have been more extensively studied but yielded few human remains. In general, it seems that the people who lived at Whitcher's Cave were healthy and lived to a good age. They had non-cariogenic but highly abrasive diets, leading to much wear and ante-mortem tooth losses. Overall high levels of wear of anterior teeth and unusual wear patterns may also suggest the use of teeth for purposes other than mastication, but this can only be confirmed with a more focused study on dental wear.

Gibbon and Davies (2020) showed a possible increase in stressors after 2000 BP, with lower stress levels before 2000 BP. It is not possible to contribute to this debate at this stage, because the dates of most of the Whitcher's Cave individuals are unknown. The most recent of the individuals date to post-2000 BP and the oldest dated individual lived at ~5000 BP (Steyn *et al.* 2024), showing that Whitcher's Cave was used for at least 3000 years. In the later phases of occupation, its occupants may have been in contact with incoming pastoralists. However, until more (or most) of the remains are dated, it will not be possible to examine variation in the health of the Whitcher's Cave community before and after the advent of pastoralism.

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