

Predictors of Dental Caries Among Adults Attending Public Oral Health Facilities in Two Districts in KwaZulu-Natal, South Africa: A Cross Sectional study

Jimmy Mthethwa (✉ jmmmthethwa@gmail.com)

University of KwaZulu-Natal College of Health Sciences <https://orcid.org/0000-0002-3586-1930>

Ozayr Mahomed

University of KwaZulu-Natal College of Health Sciences

Research article

Keywords: descriptive study, risk factors, dental caries, eThekweni and uMgungundlovu districts, adults

Posted Date: September 10th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-61069/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Background: Dental caries is the most common chronic oral condition affecting millions of people worldwide. There are several predictors of dental caries that include amongst others water source, fluoride use, smoking status, alcohol use, employment status, level of education, diet and socioeconomic status.

Aim: The aim of this study was to determine the risk factors and or predictors associated with dental caries among adults attending dental clinics at public health facilities in eThekweni and uMgungundlovu districts in the KwaZulu-Natal (KZN) province of South Africa

Setting: The study took place at thirteen dental public health clinics in eThekweni and six from uMgungundlovu districts in KZN province, South Africa

Methods: An observational cross-sectional study was conducted over a 5-month period from November 2018 to the end of March 2019 with a sample of 4716 patients of all adults 18 years and above age groups. A clinical examination as well as a close-ended questionnaire on the diagnosis, basic demographics data, socioeconomic status (SES), as well as lifestyle-related questions such as smoking, alcohol use and dietary choices, was administered to all consenting participants. Bivariate analysis and multivariate analysis using logistical regression were used to measure the association.

Results: Females participants OR 1.4 (95% CI 1.2-1.6) $p < 0.001^{**}$, patients consuming an unhealthy diet OR 1.2 (95% CI 1.2-1.6) $p < 0.001^{**}$ were more likely to develop dental caries. Patients Achieving more than secondary level education were OR 0.8 (95% CI 0.7-0.9) $p = 0.02^{*}$ less likely to develop dental caries. Despite showing a slightly increased odds ratio OR 1.25 (95% CI 0.93-1.67) $p = 0.14$, lack of access to water was not a statistically significant contributor to dental caries.

Conclusion: This study showed that female sex, consumption of an unhealthy diet and lower than a secondary level of education were the predictors of dental caries. It is hoped that these findings will contribute in influencing dental public health policy planning to ensure that planning for dental services takes a more comprehensive approach that includes health promotion, primary prevention, secondary prevention and tertiary prevention at appropriate levels of the health system.

Background

Dental caries is the most common oral condition and remains a major problem in the adult population of both developing and industrialized countries ¹. More than 90% of dental caries remains untreated in third world countries ². A Cross-sectional study in 2000 which examined dental caries and nutritional status showed a predominantly downward trend in the prevalence of caries in South Africa, particularly in the 5–6 year and 35–44 age groups, despite this there is also evidence of increased sugar consumption³. Findings from the 2001 South African Oral Health Survey showed that almost 60% of 6-year-old children had dental caries which was above the 50% target set by the Department of Health (DOH) ⁴. Furthermore,

80% of all dental caries in children in South Africa went untreated⁵. Our unpublished study, which was carried out in two districts in KwaZulu-Natal (KZN), South Africa, reported an overall prevalence of dental caries among the population of health seekers visiting public dental facilities of 63%⁶.

Various demographic and behavioral risk factors such as diet, alcohol, smoking, socioeconomic status, water source, gender and education level that are associated with dental caries among adults have been evaluated by different investigators in different parts of the world. It is well established that demographic variables, diet, use of fluorides, oral hygiene and access to health service are some of the predictors of dental caries^{7,8}.

It is evident from the literature that age is associated with the type of dental caries. For example, a survey in the United States of America (US) found that 94% of adults showed evidence of past or present coronal caries whereas children tend to have more occlusal caries⁹.

There seem to be mixed findings on the association between sex and dental caries. An oral health survey done in 2001 in Germany showed that women had more dental caries than men¹⁰. An oral health survey amongst the adults and the elderly in Hungary, in 2004, did not show any significant differences between men and women¹¹. These findings are consistent in literature.

A cross-sectional study which explored the association between parents' education status and tooth loss among Korean Elders found that a strong relationship between socioeconomic status (SES) and oral health¹². Other authors have found that as SES increases, disease, illness, and their impacts decrease¹³. In a large-scale epidemiological survey among the Southern Chinese, socio-economic factors had a considerable effect on dental caries status. Individuals who were unemployed, or had no income, had higher dental caries scores compared to the those employed and with a higher income¹⁴.

In another cross-sectional study in 2017 which sought to determine the association between SES and dental caries in elderly people in Sichuan Province, China, the burden associated with dental caries remained high in disadvantaged, poor and older populations¹⁵. In addition, a systematic review and meta-analysis study in 2015 which explored socioeconomic inequality and dental caries found that those with lower educational level or lower income, were most likely to have a higher risk of caries lesions¹⁶.

A 2019 systematic review and meta-analysis study reported a positive association between tobacco smoking and dental caries¹⁷. This finding was further reinforced in a Swedish prospective study which explored tobacco use and caries increment in young adults which reported that smoking had a relative risk of 1.5 of increasing dental caries over 3 years. This study further concluded that habitual smoking is a risk factor for caries in young adults¹⁸.

There seems to be mixed evidence regarding the association between alcohol use and dental caries. A cross sectional study conducted in India on alcohol dependency and oral health, reported that alcohol-dependent subjects had slightly lower mean plaque and salivary pH, and a higher prevalence of dental

caries, periodontitis and mucosal lesions, compared with nonalcoholic subjects ¹⁹. Another study on the prevalence of dental caries in chronic alcoholics conducted in Eastern Europe reported no major differences in the prevalence of caries in alcoholics compared to the non-alcoholics group ²⁰. A 2015 study which explored smoking, alcohol use, socioeconomic background and oral health among young Finnish adults found that the consumption of alcohol was not associated with dental caries and periodontal disease ²¹.

There is a plethora of evidence in the literature that points to an association between dental caries and type of diet. A cross-sectional study among young adults in 2004 in Turkey, found a strong association of dental caries with sugar consumption ²². The 2014, National Health and Nutrition Examination Survey in the US reported a lower prevalence of dental caries among individuals following a Healthy Eating Index. This finding supports the notion of a healthy diet contributing to lower dental caries ²³. This is supported by another study in the US which reported that dietary patterns were associated with the prevalence of dental caries. It further concluded that while food groups high in sugar were associated with the prevalence and severity of caries, associations were more apparent in the context of overall diet ²⁴.

Oral health services and public health facilities in KZN constantly experience huge challenges such as poor prioritization, under-funding, limited resource allocation, overcrowding and often patients presenting late to seek help with advanced disease. On the other hand, there are various patient factors known in public health literature such as genetic, environmental exposure and social that will impact irrespective of the patients acquiring a particular disease. It is thought that an understanding of some of the risk factors that patients are exposed to even before they seek help from public health facilities may assist in educating and mitigating these factors and improve patient's oral health condition.

In addition, the association of dental caries and risk factors has been widely reported in the literature, however, there is a paucity of data in KZN and South Africa. It is therefore imperative to identify the risk factors associated with dental caries among adults attending public oral health facilities in KZN, South Africa in order to contribute to knowledge about these risk factors and educate the public.

The present study aimed to determine the risk factors/predictors associated with dental caries among adults attending dental clinics at public health facilities in eThekweni and uMgungundlovu districts in KZN province over a 5-month period. The adults were chosen as the results of our previous study on the prevalence of common oral conditions demonstrated that the adults had a higher prevalence of dental caries compared to the other groups.

Methods

A cross-sectional study was conducted over a 5-month period from November 2018 to the end of March 2019 with a sample of 4716 adult patients of 18 years and above age groups who attended seven dental public health clinics in eThekweni and six in uMgungundlovu districts. These two districts were selected as when combined, they served more than 40% of the entire population of the province. These 2 districts

also represented both urban and semi-urban parts of the province and the dental clinics themselves were a combination of five primary health care facilities, one district hospital, three regional hospitals, two tertiary hospitals and one central hospital.

Sampling and sample size

The estimated combined population size for the two districts was approximately 4 million²⁵. The aim was to recruit at least 10% (4000 participants) for this study, noting that almost 90% of the population use public dental facilities for their oral health needs. Adult patients of 18 years and older who attended the out-patient dental and maxillofacial department (between 7am-4pm) in the two districts as well as those who attend the inpatient dental and maxillofacial department in the facilities after hours, were included in the study. All patients had to sign informed consent in order to participate in the study. Patients who did not provide informed consent and those attending outside the study period were excluded from the study.

Data collection

Every participant was requested to participate in an interviewer-administered questionnaire. Illiterate participants were assisted by qualified dental assistants. The clinician, a qualified dentist or dental therapist consulting the patients, completed a standardized questionnaire following an oral health assessment. The dental caries status was examined with a dental mirror and a probe in a dental chair. The structured questionnaire contained sociodemographic characteristics, health-related behaviours and key sociodemographic variables.

Variables

The independent variable was dental caries. Dependent variables included socio-demographic factors such as age, gender, education level, employment status and the location of the facility. The following health-related behavioural variables were recorded for each participant: access to fluoridated water supply; smoking habits, alcohol use and dietary status (healthy or unhealthy).

Data analysis

The collected data were captured and analyzed using descriptive statistics presented as means, graphs and proportions. This was conducted on Stata Statistical Program version 15 with the assistance of a biostatistician. Firstly, the statistics used included the median, interquartile range (IQR) and the Pearson Chi-Square Test to determine associations. Univariate association between the participants' characteristics and the outcome measure of dental caries were performed in order to assess the extent of the association. Finally, multivariate logistic regression analysis was used to estimate the associations

between the presence of dental caries and the dependent variables as well as to adjust for the confounder variables. The adjusted Odds Ratios (AORs), p-value and Confidence intervals (CI) were calculated. A 95% confidence level was adhered to for all statistical tests. A p-value of less than 0.05 was considered statistically significant.

Results

Study population

At the end of the 5 months study period 4716 participants had been recruited, which was greater than the 4000 calculated number of recruits needed (**Table 1**). The participants' age ranged from 18-98 years. The mean age was 37.1 years (SD 14.3). Of the participants, 2516 (53%) were males compared to 2200 (47%) females. Most of the participants 3625 (76.9%) had achieved higher than secondary level of education and 1090 (23.1%) had achieved less than a secondary level of education. Most of the participants 3063 (65%) were unemployed compared to 1651 (35%) who were employed. Nearly all, 95% participants had access to clean water compared to 5% who had no access to water at home. On the self-reporting questionnaire provided, 3301 (70%) of the participants reported themselves as consuming a healthy diet. A large percentage, 3483 (73.8%) reported that they did not consume alcohol and 3697 (78%) reported that they did not smoke.

Outcome of dental caries results

Descriptive epidemiology of patients with dental caries

Sixty nine percent (3273) (Figure 1) of the sampled patients presented with dental caries whilst (1443) 31% presented with all other oral conditions which includes periodontal disease, trauma and tooth loss. Dental caries was slightly higher among the adult population of 18-32 age group at (1670) 70% compared to the greater than 33 years age groups at (1603) 69.0 %, however this marginal difference was not statistically significant. Males (1832; 72.8%) compared to females (1441; 65.5%) and participants who achieved less than secondary level of education (787; 72.2%) compared to those that achieved higher than secondary education (2486; 68.6 %), had a statistically significantly higher dental caries rates (Table 1).

Unemployed participant's (2158; 70.5%), participants who that had access to water (3092; 69.1%), participants that do not consume alcohol (2431; 70.0%) and those that consumed healthy diet (2258; 68.4%) showed higher but not statistically significant rates of dental caries. However, participants that did not smoke (2595; 70.0%) showed statistically significant higher dental caries than those that smoked (678; 66.5%) (Table 1)

Table 1
Frequency table of the study population

Variable	N	%	Dental caries Yes N (%)	Dental caries No N (%)	P- value Chi Square
Participants (Total 5600)	4716*	100			
Mean age/ (SD)	37.1 years /14.3				
Median /IQR	33 / 26- 46	50 / 25- 75			
Age categories					
18-32	2384	50.5	1670 (70.0)	714 (30.0)	
>33	2332	49.5	1603 (69.0)	729 (31.0)	0.322
Gender					
Male	2516	53	1832 (72.8)	684 (27.2)	< 0.001**
Female	2200	47	1441 (65.5)	759 (34.5)	
Education					
> Secondary	3625	76.9	2486 (68.6)	1139 (31.4)	0.021*
< Secondary	1090	23.1	787(72.2)	303(27.8)	
Employment status					
Employed	1651	35	1114 (67.5)	437 (32.5)	0.032*
Unemployed	3063	65	2158 (70.5)	905 (29.5)	
Access to water					
Has access	4472	95	3092 (69.1)	1380 (30.9)	0.091
Do not have access	244	5	181 (74.2)	63 (25.8)	

Diet use					
Healthy	3301	70	2258 (68.4)	1043 (31.6)	0.072
Unhealthy	1411	30	1012 (71.7)	399 (28.3)	
Alcohol consumption					
Yes	1233	26.2	842 (68.3)	391 (31.7)	0.321
No	3483	73.8	2431 (70.0)	1052 (30.0)	
Smoking					
Smokes	1019	22	678 (66.5)	341 (33.4)	0.022*
Does not Smoke	3697	78	2595 (70.0)	1102 (30.0)	
** p <0.001 and * p <0.05					

Socio-demographic factors associated with dental caries.

Females OR 1.41(95% CI 1.24-1.61 and those consuming an unhealthy diet OR 1.2 (95%CI 1.0- 1.3) showed significant increased odds of developing dental caries after bivariate analysis and multivariate analysis. Those participants who had achieved more than secondary level of education showed a significant OR 0.8 (95% CI 0.7-1.0) after both bivariate and multivariate analysis.

Access to water showed a significant increased odd of developing dental caries OR 1.2 (95%CI 0.9-1.7) on bivariate analysis but was non-significant after multivariate analysis.

Bivariate and multivariate analysis showed a non-significant decreased odd of developing dental caries amongst the 18-21 age group OR 0.9 (95% CI 0.8-1.0) and those consuming alcohol OR 0.9 (95% CI 0.8-1.0).

Table 2

Bivariate and multivariate analysis of the predictors of dental caries among the adult population of eThekweni and uMgungundlovu districts

Variables	Bivariate analysis (Unadjusted Odds Ratio) UOR			Multivariate analysis (Adjusted Odds Ratio) (AOR)		
	OR	95%CI	p-value	AOR	95% CI	P-value
Gender						
Females vs males	1.41	1.24-1.61	0.001**	1.4	1.2-1.6	< 0.001**
Age category						
18-32 vs 33 and above	0.9	0.8-1.0	0.32			
Employment						
Unemployed vs employed	0.8	0.7-1.0	0.03	0.9	0.8-1.0	0.241
Education						
> Secondary vs <Sec	0.8	0.7-1.0	0.02*	0.8	0.7-1.0	0.021*
Water access						
No access vs access	1.2	0.9-1.7	0.09	1.2	0.9-1.7	0.142
Diet						
Unhealthy diet vs healthy	1.2	1.0- 1.3	0.02	1.2	1.0-1.4	< 0.001**
Alcohol consumption						
Alcohol consumption vs no alcohol	0.9	0.8-1.0	0.32	1.0	0.9-1.3	0.432
Smoking						
Smoking vs no smoking	0.8	0.7-0.9	0.02	0.9	0.8-1.2	0.822
** p <0.001 and * p <0.05						

To control for confounders, variables with unequivocal odds ratios as well as p value greater than 0.1 on bivariate analysis were removed. The following factors remained significant: gender OR 1.4 (95% CI 1.2-1.6) p < 0.001**, diet OR 1.2 (95% CI 1.2-1.6) p < 0.001** and education OR 0.8 (95% CI 0.7-0.9) p = 0.02*. However, despite showing a slightly increased odds ratio 1.25 (95% CI 0.93-1.67) p = 0.14, access to water was not statistically significant.

Table 3
Stepwise logistic regression

Variables	OR	95%CI	p-value	AOR	95% CI	P-value
Gender						
Females vs males	1.41	1.24-1.61	0.001**	1.4	1.25-1.62	< 0.001**
Education						
>Secondary vs < Sec	0.8	0.7-1.0	0.02*	0.8	0.7-0.9	0.021*
Diet						
Unhealthy diet vs healthy	1.2	1.0-1.3	0.02	1.2	1.2-1.6	< 0.001**
** p < 0.001 and * p < 0.05						

Discussion

This study provided a profile of some of the socio-demographic predictors of dental caries among adults attending public oral health facilities in the eThekweni and uMgungundlovu districts in KwaZulu-Natal, South Africa, over a 5-month period. It is worth noting that there was enormous co-operation from both staff and patients involved in this study. This resulted in a high response rate of 4716 (which is 760 more patients than our minimum calculated sample size) patient's visits in 5 months. This will strengthen our study findings and enable it to be generalizable.

After adjusting for confounders this study showed that, out of the eight initial risk factors associated with dental caries, only three risk factors i.e. an unhealthy diet, female and achieving less than secondary education emerged as the predictors of dental caries in this study. This is also supported by a myriad of studies undertaken in both developed and developing countries which showed a varying association between diet, alcohol use, gender differences and access to clean water and dental caries among adults.

Diet and dental caries

This study found that adults who consumed an unhealthy diet were OR 1.2 (95% CI 1.2-1.6) times more likely to have dental caries than those who consumed a healthy diet. There seems to be mixed evidence in the literature on this association. A cross-sectional study conducted in 2018 in Brazil to evaluate the

association of the consumption of healthy and cariogenic foods with the prevalence of untreated dental caries showed that consumption of cariogenic foods as well as other factors such as brushing habits were strongly associated with dental caries ²⁹.

Another study in 2019, which examined the association of dental caries with dietary sugars in Australian adults also found that there was a strong positive association between dental caries and unhealthy diet³⁰. However, when controlled for confounders where sugar consumption was identified as a key determinant, the statistical significance between dental caries and unhealthy diet disappeared³⁰. It concluded that any analysis of the relationship between dental caries and diet must include detailed data about sugar and carbohydrate consumption ³⁰. The results of our study may need to be explored further in future studies as our study did not differentiate the details of a cariogenic diet. Our study interest was broadly on diet behaviour, and as such participants were asked to indicate whether they followed healthy or unhealthy diet practices in general.

Gender and dental caries

There is a plethora of evidence in the literature on the association between gender and dental caries. There seems to be consensus that females are more likely to develop dental caries than males. The present study found that females were OR 1.4 (95% CI 1.25-1.62) times more likely to have dental caries than males. In support of this finding, a Canary Islands study in 2006 which sought to explain gender differences in the prevalence of dental caries among the sexes found that females tend to typically exhibit higher prevalence rates than males. The explanation provided in the study was that the biochemical composition of saliva and overall saliva flow rate are modified in several important ways by hormonal fluctuations during events such as puberty menstruation, and pregnancy, making the oral environment significantly more cariogenic for women than for men ³¹.

A study in 2019, which examined the association between dental caries and dietary sugars in Australian adults, found that gender was one of the demographic factors that were positively associated with dental caries ³⁰. This finding is consistent with our study which also found a strong association between females and dental caries after adjusting for confounders in a multivariate analysis.

Another study which explored the sex differences in dental caries: clinical evidence, complex etiology also supported the studies above in that the etiology of dental caries is complex and impacts understanding of the sex difference in oral health. Both biological (genetics, hormones, and reproductive history) and anthropological (behavioural) factors such as culture-based division of labor and gender-based dietary preferences play a role. It also concluded that females had a higher risk of dental caries than males ³². This study concurred with our findings that females were more likely to have dental caries than males.

Education level and dental caries

There seems to be consensus in the literature on the association between education levels and dental caries. This study found that education levels were significantly associated with dental caries. Those who achieved higher than secondary education level at school were less likely to have dental caries OR 0.8 (95% CI 0.7-0.9) compared to those who had achieved less than secondary level of education. A 2005 cross-sectional study which explored international perspectives on socio-behavioural risk factors in dental caries, found that the effect of educational background on measures of dental caries was observed for all countries but was found to be particularly strong when the disease prevalence was high. This study further found that individuals from a high education background as well as other favorable socioeconomic circumstances were less likely to have dental caries³³.

A systematic review in 2012 which explored socioeconomic indicators and dental caries in adults in Brazil also concluded that educational level was significantly associated with a greater occurrence of dental caries³⁴. It found that schooling of the subject was the most frequently used socioeconomic indicator. Lower schooling was statistically associated with greater severity of dental caries in six out of nine multivariate analyses³⁴. One study found that lower schooling was associated with lower severity of dental caries, two did not find significant association and one did not find association between schooling of the father and dental caries³⁴. There may be various hypothesis to explaining the difference in education levels and dental caries. Our study did not explore these further however, one can assume that participants with higher levels of education are more likely to be aware and exercise a choice and affordability of the type of diet they consume thus decreasing the chances of consuming high calories diet exposing them to developing dental caries. The other possible theory is that a higher level of education enables access to general awareness and preventive measures against dental caries thus less likely to develop dental caries compared to the less educated. Our study finding is therefore consistent with the literature, however further studies are needed to explore the differences in educational levels and dental caries.

Access to water and dental caries

This study showed that despite showing a slightly increased odds ratio OR 1.25(95% CI 0.93-1.67) access to water was not statistically significant after both analysis. The results of the present study show that having no access to clean water had a negative effect on dental caries. The participants who had no access to clean water were 1.25 times more likely to have dental caries compared to those that do have access to clean water. There is a myriad of studies to support the link between quality of drinking water and dental caries. A public health report as far back as 1942, pointed to an inverse relationship between the fluoride content of the public water supply and dental caries in continuously using such water throughout life³⁵.

This finding is further supported by other studies that areas where the potable water supplies contain the fluoride ion at optimum concentration of 0.17 mg/L at the source, the dental caries experience of those who ingest these water fluorides, especially during the years of tooth development, is about 60% less than

among areas with fluoride-deficient water supplies³⁶. Adults who have used such water supplies continuously enjoy the dental benefits obtained during childhood³⁶. Controlled water fluoridation for the prevention of dental caries, involving the addition of fluoride compounds in optimum concentration to fluoride-deficient supplies, has been studied since 1940 in different areas³⁷. These studies have demonstrated that dental caries can be effectively reduced through controlled water fluoridation to the same extent as observed in areas where water contains the fluoride at the source³⁷.

Another Cochrane based systematic review in 2015, of data analyzed in studies conducted prior to 1975 to 2014 indicated that water fluoridation is effective in reducing caries levels in both deciduous and permanent dentition³⁸. It further found that the initiation of water fluoridation results in a 35% reduction of caries in children and a 26% reduction in adults³⁸. Although many studies acknowledge the beneficial effect of fluoride in preventing dental caries, there is caution also on the effects of over fluoridation, which was not of interest to this study.

Study Limitations

Although meticulousness and diligence were maintained to ensure the integrity and veracity of the study, the study has several limitations. The most critical of these is information bias. The questionnaire did not quantify any unit of measure in the alcohol consumption as a result, bias could have an impact in our results as most papers have reported alcohol consumed in some unit of measure rather than a generalized question irrespective of alcohol consumption. In addition, we did not conduct a detailed analysis of the participants' dietary history, detailed dietary type, as such our results were based on self-reported perception of diet as healthy or unhealthy. Both these limitations could mean underreporting or over reporting by the participants on their responses. Finally having access to municipal water supply was considered safe, clean drinking water that was fluoridated.

Conclusions And Recommendations

This study showed that female sex, consumption of an unhealthy diet and lower than a secondary level of education were the predictors of dental caries. It is hoped that these findings will contribute in influencing dental public health policy planning to ensure that planning for dental services takes a more comprehensive approach that includes health promotion, primary prevention, secondary prevention and tertiary prevention at appropriate levels of the health system.

Policy makers need to consider the emphasis on issuing dietary guidelines about sugar consumption and oral health as part of education awareness drives. It is hoped that this study has contributed to providing knowledge in the province about the dental caries among adults attending public oral health facilities in the eThekweni and uMgungundlovu districts in KZN, South Africa.

List Of Abbreviations

AOR	Adjusted Odds Ratios
BREC	Bioethics Research and Ethics Committee
CI	Confidence intervals
DoH	Department of Health
IQR	Interquartile Range
KZN	KwaZulu-Natal
OR	Odds Ratios
SSA	Statistics South Africa
SD	Standard Deviation
SES	Socioeconomic status
SPSS	Statistical Program for Social Sciences
UKZN	University of KwaZulu-Natal
US	United States of America
UOR	Unadjusted Odds ratio

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Biomedical Research and Ethics Committee of the University of KwaZulu-Natal (UKZN), reference number (BREC 423/13). Written permission, consent and access to the health facilities to conduct the study was obtained from the KZN provincial DoH.

Consent for publication

Written informed consent for publication of their clinical details and/or clinical images was obtained from the patient. A copy of the consent form is available for review by the Editor of this journal

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request

Competing interests

The authors have declared that no competing interests exist.

Funding

This was a self-funded study. This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Authors' contributions

J Mthethwa was responsible for conceptualization, data collection, formal analysis, investigation, methodology, resources, validation and writing of the original draft.

O Mahomed was responsible for conceptualization, supervision, data analysis, writing review and editing

Acknowledgements

The authors wish to acknowledge the KZN DoH for giving permission to use its platform to conduct this study as well as the KZN DoH staff at all participating facilities. We wish to also acknowledge the KZN DoH Head office staff for active participation in the data collection. We are grateful for the valuable inputs from some staff from the University of Witwatersrand.

References

1. Treasure E, Kelly M, Nuttall N, Nunn J, et al. Factors associated with oral health: a multivariate analysis of results from the 1998 Adult Dental Health survey. *Br Dent J.* 2001 Jan;190(2):60–8.
2. Kathmandu RY. The burden of restorative dental treatment for children in Third World countries. *International dental journal.* 2002 Feb;52(1):1–9.
3. Cleaton-Jones P, Richardson BD, Granath L, et al. Nutritional status and dental caries in a large sample of 4-and 5-year-old South African children. *South African Medical Journal.* 2000;90(6):631–5.
4. KwaZulu-Natal Department of Health. Annual report 2018 [Available from: <http://www.kznhealth.gov.za/2017-2018-Annual-Report.pdf>.
5. Van Wyk PJ, Van Wyk C. Oral health in South Africa. *Int Dent J.* 2004 Dec;54(S6):373-.
6. Mthethwa J, Yengopal V, Mahomed O. Epidemiological profile of patients utilizing public oral health services in uMgungundlovu and eThekweni districts KZN province, South Africa. 2019 (Unpublished article).
7. Cornejo-Ovalle M, Paraje G, Vásquez-Lavín F. Changes in socioeconomic inequalities in the use of dental care following major healthcare reform in Chile, 2004–2009. *Int J Environ Res Public Health.* 2015 Mar;12(3):2823–36.

8. Pitts N, Amaechi B, Niederman R, et al. Global oral health inequalities: dental caries task group—research agenda. *Advances in dental research*. 2011 May;23(2):211–20.
9. Winn DM, Brunelle JA, Selwitz RH, et al. Coronal and root caries in the dentition of adults in the United States, 1988–1991. *Journal of dental research*. 1996 Feb;75(2_suppl):642–51.
10. Splieth CH, Schwahn CH, Bernhardt O, et al. Caries prevalence in an adult population: results of the Study of Health in Pomerania, Germany (SHIP). *Oral health & preventive dentistry*. 2003 Apr 1;1(2).
11. Szoke J, Petersen PE. State of oral health of adults and the elderly in Hungary. *Fogorvosi szemle*. 2004 Dec;97(6):219–29.
12. Han DH, Khang YH, Choi HJ. Association of parental education with tooth loss among Korean Elders. *Community dentistry and oral epidemiology*. 2015 Dec;43(6):489–99.
13. Marmot M. Explanations for social inequalities in health. *Society and health*. 1995.
14. Lin HC, Wong MC, Zhang HG, Lo EC, Schwarz E. Coronal and root caries in Southern Chinese adults. *Journal of dental research*. 2001 May;80(5):1475–9.
15. Wang L, Cheng L, Yuan B, Hong X, Hu T. Association between socio-economic status and dental caries in elderly people in Sichuan Province, China: a cross-sectional study. *BMJ open*. 2017 Sep 1;7(9):e016557.
16. Schwendicke F, Dörfer CE, Schlattmann P, et al. Socioeconomic inequality and caries: a systematic review and meta-analysis. *Journal of dental research*. 2015 Jan;94(1):10–8.
17. Jiang X, Jiang X, Wang Y, Huang R. Correlation between tobacco smoking and dental caries: A systematic review and meta-analysis. *Tobacco induced diseases*. 2019;17.
18. Petersson GH, Twetman S. Tobacco use and caries increment in young adults: a prospective observational study. *BMC research notes*. 2019 Dec 1;12(1):218.
19. Priyanka K, Sudhir KM, Reddy VC, Kumar RK, Srinivasulu G. Impact of alcohol dependency on oral health—a cross-sectional comparative study. *Journal of clinical diagnostic research: JCDR*. 2017 Jun;11(6):ZC43.
20. Dukić W, Trivanović Dobrijević T, Katunarić M, Lešić S. Caries prevalence in chronic alcoholics and the relationship to salivary flow rate and pH. *Central European journal of public health*. 2013 Mar 1;21(1):43 – 7.
21. Tanner T, Päckilä J, Karjalainen K, et al. Smoking, alcohol use, socioeconomic background and oral health among young Finnish adults. *Community dentistry and oral epidemiology*. 2015 Oct;43(5):406-14.21.
22. Ceylan S, Açıkel CH, Okçu KM, et al. Evaluation of the dental health of the young adult male population in Turkey. *Military medicine*. 2004 Nov 1;169(11):885-9.
23. Kaye EA, Sohn W, Garcia RI. The Healthy Eating Index and coronal dental caries in US adults: National Health and Nutrition Examination Survey 2011–2014. *The Journal of the American Dental Association*. 2020 Feb 1;151(2):78–86.

24. Blostein FA, Jansen EC, Jones AD, Marshall TA, Foxman B. Dietary patterns associated with dental caries in adults in the United States. *Community Dentistry and Oral Epidemiology*. 2020 Apr;48(2):119–29.
25. Statistics South Africa. (2017,July). Statistics by place / Metropolitan Municipality. Retrieved from http://www.statssa.gov.za/?page_id=1021&id=ethekwini-municipality.
26. Marcenes W, Kassebaum.JN, Bernabé. E, et al. Global burden of oral conditions in 1990–2010: a systematic analysis. *J Dent Res*. 2013;92(7):592–7.
27. Kathmandu RY. The burden of restorative dental treatment for children in Third World countries. *Int Dent J*. 2002;52(1):1–9.
28. Thema LK, Singh S. Epidemiological profile of patients utilising public oral health services in Limpopo province, South Africa. *African journal of primary health care family medicine*. 2017;9(1):1–5.
29. Morikava FS, Fraiz FC, Gil GS, de Abreu MH, Ferreira FM. Healthy and cariogenic foods consumption and dental caries: A preschool-based cross-sectional study. *Oral Dis*. 2018 Oct;24(7):1310–7.
30. Barrington G, Khan S, Kent K, et al. Obesity, dietary sugar and dental caries in Australian adults. *International dental journal*. 2019 Oct;69(5):383–91.
31. Lukacs JR, Largaespada LL. Explaining sex differences in dental caries prevalence: Saliva, hormones, and “life-history” etiologies. *American Journal of Human Biology: The Official Journal of the Human Biology Association*. 2006 Jul;18(4):540–55.
32. Lukacs JR. Sex differences in dental caries experience: clinical evidence, complex etiology. *Clinical oral investigations*. 2011 Oct 1;15(5):649 – 56.
33. Petersen PE. Sociobehavioural risk factors in dental caries–international perspectives. *Community dentistry and oral epidemiology*. 2005 Aug;33(4):274–9.
34. Costa SM, Martins CC, Bonfim MD, et al. A systematic review of socioeconomic indicators and dental caries in adults. *Int J Environ Res Public Health*. 2012 Oct;9(10):3540–74.
35. Dean HT, Arnold FA, Elvove E. Public Health Weekly Reports for AUGUST 7, 1942. *Public health reports*. 1942;57(32):1155-94.
36. Russell AL, Elvove E. Domestic water and dental caries: VII. A study of the fluoride-dental caries relationship in an adult population. *Public Health Rep*. 1951 Oct;26:1896–970. 1389 – 401.
37. Ast DB, Schlesinger ER. The conclusion of a ten-year study of water fluoridation. *American Journal of Public Health the Nations Health*. 1956 Mar;46(3):265–71.
38. Iheozor-Ejiofor Z, Worthington HV, Walsh T, et al. Water fluoridation for the prevention of dental caries. *Cochrane Database of Systematic Reviews*. 2015(6).

Figures

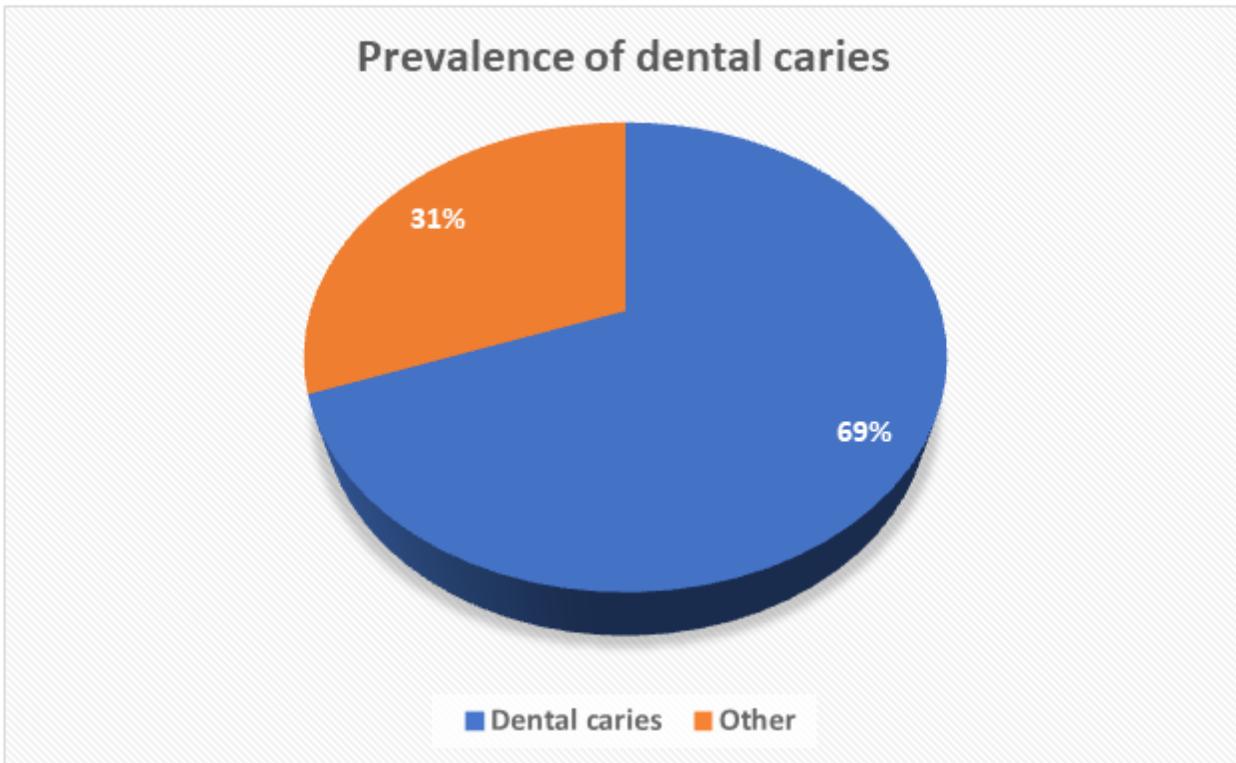


Figure 1

Combined prevalence of dental caries in the eThekweni and uMgungundlovu districts of KwaZulu-Natal, South Africa