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ORIGINAL ARTICLE

Assessment of factors associated with dental caries in rural communities in Rakai District, Uganda

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Abstract To assess factors associated with dental caries in rural communities in Rakai District, Uganda. This was a cross-sectional survey in 18–62 year olds, randomly selected from three sub-counties: Kyalurangira (n=121), Kabira (n=133), and Kacheera (n=67). The participants were clinically examined for caries using Decayed Missing Filled Teeth (DMFT) index and were administered to a structured questionnaire. In the whole material, caries prevalence (DMFT score>0) was 57.3% and the mean DMFT score was 2.3. The M-component contributed 61% of the DMFT scores. Using bivariate analyses, age, consumption of sugared snacks and tobacco smoking were directly and significantly associated with development of dental caries. Tooth cleaning and previous dental visits were indirectly and significantly associated with dental caries. In binary logistic regression analyses, the participants who were older were four times and those who consumed sugared snacks were 11 times more likely to develop dental caries as compared to their counterparts. The participants who cleaned their teeth or who had visited the dentists were less likely to develop dental caries as compared to their counterparts. The odds ratios were 0.6 and 0.5, respectively. Based on stepwise multiple linear regression analyses, age, previous dental treatment, consumption of sugared snacks, tooth cleaning and tobacco smoking explained a total of 46% of the variations in DMFT scores. Caries prevalence and severity were relatively low in this population. Although a number of independent variables were significantly associated with caries they gave a modest overall multivariate model.

Keywords Dental caries · Sugared snacks · Tobacco smoking · Tooth brushing · Uganda

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Introduction

It is common knowledge that oral health has a significant impact on nutrition and overall quality of life [1]. Dental caries is one of the most important oral health problems worldwide. Although by the 1990s, a general decline in the prevalence of dental caries had been observed in Europe [2], there was no definite time trend in some of the developing countries of Africa [3]. In the rural Uganda, low levels of dental caries have been recorded both in children and adults [4-6] with the majority of the affected teeth being untreated [5, 6]. Just as in other parts of Africa [7], some of the reasons for this trend of untreated caries have been suggested to be inadequate resources such as oral health personnel and dental facilities as well as lack of oral health education and awareness about dental services in the majority of the population [8, 9].

Despite a number of studies having been carried out on dental caries in Uganda, only one study [6] assessed factors associated with dental caries, and in children. The aim of the present study was to assess the factors associated with dental caries in adults in rural communities in Rakai District.

Material and methods

Study areas

This was a cross-sectional survey conducted in Rakai District. The district is located in Southwestern Uganda about 190 km from the capital, Kampala. It covers an area of about 4,989 km^2 with a total population of about 480,000 people, 49% being males. About 77% of the population is aged between 12 and 19 years (report on Uganda National Population and Household Survey, 2002). The populace economically survives mainly on small-scale cattle keeping and subsistence crop farming.

Rakai is one of the rural districts in Uganda with the widest coverage of health infrastructure. It has 41 government dispensaries (health centre IIs), 21 health centre IIIs, two health centres IVs and two hospitals with 60 beds each. In addition to government health facilities, it has 37 private/non-governmental organisation dispensaries, 28 clinics and one health centre (Principal Dental Surgeon, MoH, personal communication). However, dental services in the district are only offered in government hospitals and health centre IVs as well as 12 private clinics. The clinical dental services are limited to simple fillings, tooth extractions and scaling. About 40% of the population lives more than 5 km away from health facilities offering dental services.

Rakai District is subdivided into 23 sub-counties, of which, three were randomly selected for the present study using numbers: Kyalurangira, Kabira and Kacheera sub-counties.

Ethical considerations

Permission to carry out the study was sought from Makerere University, College of Health Sciences Review and Ethics Committee, the Rakai District administration and health authorities. The purpose of the study was explained to the participants and they were requested for verbal consent before being recruited into the study. In accordance with Helsinki Declaration [10], the nature of the study and the participants' right to accept or refuse to take part in the study were duly explained to them. All the participants consented to clinical examination and oral interview.

Selection of study participants

With the help of the Local Council I (village) officials in the selected sub-counties, residents aged at least 18 years (based on their village register) were informed and requested to come to their respective parish headquarters for the survey. The study participants were selected using stratified systematic random sampling technique. They were requested to make two lines according to gender and every third person was then selected from the line for the study, totally 321 participants (169 males versus 152 females): Kyalurangira (n=121), Kabira (n=133) and Kacheera (n=67). The age of the participants ranged from 18 to 62 (mean 38.8±15.5)years (Table 1).

Calibration of examiners

In order to minimise inter-examiner variability, three trained dentists (CMR, LMM and WB) who carried out oral examination were calibrated in assessment of caries in 25 patients who attended Mulago Dental School clinic, Kampala, a few days to the commencement of the survey. Cohen's kappa values ranged from 0.78 to 0.91 (mean 0.87).

Questionnaire (survey instrument)

A structured questionnaire with closed ended questions was administered to the participants by a recording assistant in form of an oral interview to collect information on demography, oral hygiene practises, dietary habits, health seeking behaviour and tobacco-smoking habits. The questionnaire was written in English and translated into the local language (Luganda) for the respondents who did not understand English.

Clinical examination

Clinical examination was done in a shade under a tree. Indirect sunlight was the source of illumination. The three trained and calibrated dentists with the help of recording assistants carried out intra-oral examination of the participants. The participant was examined while lying supine on a couch with the head resting on the examiner's lap who was seated at 12 o'clock position inclined forward to fully access the participant's oral cavity. Disposable mouth mirror, dental probe and pair of tweezers were used in oral examination. Cotton wool was used to wipe off soft debris from the teeth and to control saliva during recording of dental caries.

Dental caries was assessed using Decayed Missing Filled Teeth (DMFT) index [11] according to criteria described by World Health Organization (WHO) [12] with modifications. Dental caries was recorded as being present when a lesion in a pit/fissure or on a smooth surface had a detectable softened floor, undermined enamel, softened wall or temporary filling. A tooth was considered filled if it had a permanent restoration. It was assumed missing due to caries if there was history of pain and or presence of a cavity prior to extraction.

The examiner dictated the observation to a recording assistant who in turn recorded it on a WHO recommended form [12]. The record forms were counter-checked for errors and completeness after each day's fieldwork.

Table 1 The number (*n*) and percent (%) of participants according to gender, age, tobacco smoking, consumption of sugared snacks, tooth cleaning and previous dental visits (*n*=321)

Variables	Categories	*n* (%)
Age	18–24 year	61 (19.0)
	25–34 year	87 (27.1)
	35–44 year	72 (22.4)
	45–62 year	101 (31.5)
Gender	Males	169 (52.6)
	Females	152 (47.4)
Education level	No formal education	82 (25.6)
	Primary education	218 (67.9)
	Tertiary education	21 (6.5)
Smoking tobacco	Yes	94 (29.9)
	No	225 (70.1)
Frequency of smoking (*n*=96)	Once a day	7 (7.4)
	Twice a day	22 (23.2)
	More than twice a day	67 (69.5)
Consumption of sugared snacks	Yes	130 (40.5)
	No	191 (59.5)
Types of sugared snacks (*n*=130)[a]	Sweets	83 (63.8)
	Cakes	49 (37.7)
	Chocolates	3 (2.3)
	Ice cream	5 (3.8)
Frequency of taking sugared snacks (*n*=130)	Once a day	87 (66.9)
	Twice a day	43 (33.1)
Tooth cleaning	Yes	247 (76.9)
	No	74 (23.1)
Frequency of tooth cleaning (*n*=247)	Once a day	39 (15.8)
	Twice a day	64 (25.9)
	Occasionally	144 (58.3)
Tooth cleaning device (*n*=247)	Toothbrush	81 (32.8)
	Chewing stick	166 (67.2)
Previous dental visits	Yes	208 (64.8)
	No	113 (35.2)

[a] Some respondents reported consumption of more than one type of sugared snacks

Reliability test

During the survey, each of the three dentists did duplicate examination of about 10% of randomly selected participants for a reliability test. The mean Cohen's kappa value was found to be 0.84 (range 0.79–0.86). There was no evidence of systematic error ($p>0.05$, paired *t* test).

Statistical analyses

Data were analysed using the Statistical Package for Social Sciences Inc. (version 15.0 for windows, IL, USA). Frequency distribution was used to describe the material. Student's *t* test for paired observations was used to check for reproducibility in recording dental caries. The independent variables were categorised (Table 1) and Spearman's rank correlation coefficient (r_s) was used to study the bivariate association between the independent variables and the DMFT scores (Table 2). Students' *t* test with n-2 degrees of freedom was used to assess whether r_s was significantly different from zero and to test any significant differences in DMFT scores on the basis of the independent variables. The dependent variable, DMFT score was categorised as zero DMFT=0 and DMFT ≥1=1. Binary logistic regression analyses were used to estimate the magnitude of risk of developing dental caries. The 95% confidence intervals (CI) were generated around all the odds ratios (OR) to determine the significance of the predictor variables. Stepwise multiple linear regression analyses were used to control for any confounding and to assess any factors explaining variation in the severity of dental caries, i.e., DMFT score>0. The F-test was used to evaluate the significance of the fit of the model. The level of significance was set at 5%.

Table 2 Spearman's rank correlation coefficients between age, gender, education level, tobacco smoking, consumption of sugared snacks, tooth cleaning, previous dental visits and DMFT scores (n=321)

Independent variables	Correlation coefficient
Age[a]	0.36
Gender	0.09
Education level	0.06
Smoking tobacco[a]	0.28
Frequency of smoking (n=96)	0.12
Consumption of sugared snacks[a]	0.41
Types of sugared snacks (n=130)	0.15
Frequency of taking snacks (n=130)	0.19
Tooth cleaning (n=247)[a]	−0.24
Tooth cleaning device (n=247)	0.07
Frequency of tooth cleaning (n=247)	0.04
Previous dental visits[a]	−0.27

[a] Statistically significant

Results

There was no significant difference in either caries prevalence or severity in the three sub-counties studied hence data were pooled. In the whole material, dental caries prevalence (DMFT score>0) was 57.3% and the mean DMFT score was 2.3, ±3.7. D- and M-components of the DMFT scores contributed 39% and 61%, respectively. No filled tooth was recorded. The prevalence of tobacco smoking was 29.9% (Table 1). Those participants who smoked tobacco did so at least eight cigarettes a day. About 64.9% of the participants reported having previously visited a dentist (Table 1) and almost exclusively for emergency treatment. Twenty one percent of the respondents were aware that decayed teeth can be restored in health facilities. In the bivariate analyses, increase in age, consumption of sugared snacks and tobacco smoking were positively and significantly associated with DMFT scores (p<0.05, t test, Table 2). Tooth cleaning and previous dental visits were indirectly and significantly associated with DMFT scores (p<0.05, t test), but the type of tooth cleaning device (plastic tooth brush or chewing stick) did not show any significant difference (p>0.05, t test, Table 2). Gender had no significant influence on dental caries prevalence and severity (p>0.05, t test). In binary logistic regression analyses, the participants who were older or who consumed sugared snacks were significantly at higher risk of developing dental caries as compared to their counterparts (Table 3). On the other hand, the participants who cleaned their teeth or who previously visited a dentist were significantly at a lower risk of developing dental caries as compared to their counterparts (Table 3). In stepwise multiple linear regression analyses, age, previous dental visits, consumption of sugared snacks, tooth cleaning and tobacco smoking explained a total (r^2 adjusted) of 46% of the variations in DMFT scores (Table 4). The consumption of sugared snacks was the main contributor with 25% points of the variation in DMFT scores (Table 4).

Discussion

The present survey was conducted in a rural setting with inadequate oral healthcare system typical of most of African countries [8]. Dental caries was assessed using the diagnostic criteria described by WHO [12], which record any carious lesions with frank cavitation that have reached the stage of clinical intervention. Although the criteria have been recommended for field surveys using limited facilities [12], they underestimate the level of the disease since they exclude the pre-cavitated lesions and the inaccessible cavities on the inter-proximal surfaces. They may themselves alone be inadequate when assessing the treatment needs in the population [13].

Different examiners may give different caries recordings due to inter- and intra-examiner variability. However, in the present study, the three trained dentists were calibrated before the survey in order to minimise the variability. Furthermore, during the survey, blind duplicate examination was done by each examiner in order to check on intra-examiner variability, which revealed that the recordings were almost perfect, without evidence of systematic error.

In the present study, a dental caries prevalence of 57% and a mean DMFT score of 2.3 were recorded, which are much lower than 63% and 3.4, respectively, observed by Muwazi et al. [5] in an epidemiological survey involving 35–44 year olds drawn from urban and peri-urban settings in different districts in Uganda. The lower values recorded in the present study may partly be attributed to the area of residence and the reported high prevalence of tooth cleaning. Urbanisation is associated with an increase in the occurrence of dental caries [14], particularly with increased access to dietary sugar products [15]. The

Table 3 Binary logistic regression analyses showing odds ratio (OR) and 95% confidence interval for dental caries (zero DMFT= 0, DMFT ≥1=1) with significantly associated independent variables: age (0=18–24, 1=25–34, 2=35–44, 3=45–62 years), consumption of sugared snacks (0=no, 1 = yes), tooth cleaning (0=no, 1 = yes) and previous dental visits (0=no, 1 = yes)

Independent variables	OR (95% CI)
Age	4.3 (3.7–6.9)
Consumption of sugared snacks	11.2 (8.1–18.3)
Tooth cleaning	0.6 (0.3–0.9)
Previous dental visits	0.5 (0.2–0.7)

Table 4 Stepwise multiple linear regression analysis showing r^2 change and r^2 adjusted for age, gender, tobacco smoking, consumption of sugared snacks, tooth cleaning and previous dental visits on DMFT scores (n=321)

Independent variables	r^2 change
Age	0.064
Tobacco smoking	0.025
Consumption of sugared snacks	0.252
Tooth cleaning	0.073
Previous dental visits	0.052
r^2 adjusted	0.456

communities in the present study were in a rural setting and it could be assumed to have had limited exposure to sugar diet compared to those residing in urban centres. Indeed the 40% of the respondents in the present study who positively reported consumption of sugared snacks had a significantly higher level of dental caries as compared to their counterparts (Tables 2–4).

Review of literature generally shows there is some evidence, though weak, that tooth brushing prevents dental decay [16]. This preventive action is particularly enhanced by regular use of fluoride toothpaste because fluoride is considered the most significant therapeutic form of prevention and protection against dental caries [17]. In the present study, it was not possible to assess other sources of fluoride exposure to the communities. It was noted that a total of about 77% (n=247) of the participants who reportedly cleaned their teeth used a toothbrush with fluoride toothpaste (33%) and chewing stick (67%; Table 1), which was much higher than what was previously observed in the Ugandan rural adolescents (n=481) where 7% of the subjects used a toothbrush with fluoride toothpaste, while 25% cleaned their teeth with a chewing stick [6]. In Burkina Faso, 57% of 35–44 year olds (n=493) reportedly cleaned their teeth on a daily basis and mainly using a chewing stick [18].

In the present study, the D-component contributed 39% of the DMFT scores and the rest of the scores were due to the M-component while Muwazi and co-workers [15] found the D-component contributing 81% of the DMFT scores in a Ugandan urban and peri-urban population. The F-component was hardly recorded in the present study as compared to 1.8% of the DMFT scores reported in the previous Ugandan survey [5]. This state of affair confirms the poor awareness of restorative dental services in some of health facilities by the local population where only one out of five respondents (n=68) in the present study gave a positive response. It could be assumed that due to lack of awareness about restorative care, dental services are sought when the decayed teeth are beyond the conventional restorative care, thus being extracted leading to a high M-component recorded in this population. Characteristic of African developing countries including Uganda, there is poor funding in government health facilities resulting in failure of equipment and inadequate material supplies [19] limiting dental care to extractions.

There is a general perception among a substantial proportion of different populations that dental visits are largely to have some problem fixed, rather than as an opportunity for prevention and early detection [20]. It is important to note that oral health promotion efforts through dental visits may benefit prevention and early detection of oral diseases in populations. Two-thirds of the participants (n=208) in the present study gave a history of having visited a dental facility for emergency treatment at least once in their lifetime (Table 1). The health-seeking behaviour in this Ugandan population had a significant indirect association with the severity of dental caries as compared to those who had not visited the dental facilities (Tables 2–4).

Dental caries increased with age (Tables 2–4), which may seem natural since caries is a cumulative disease. The same trend has previously been observed in other studies in Uganda [5, 6, 21, 22]. Gender had no significant influence on dental caries (Table 2), which corroborates previous findings in Uganda [5], but in contrast to those from a Kenyan rural community (n=141) where about 72% of the participants with caries were females [23].

In the present study, about 30% of the respondents reported smoking tobacco (Table 1). Based on bivariate and stepwise multiple linear regression analyses, tobacco smoking was found to be significantly associated with dental caries (Tables 2 and 4). This finding was in agreement with other previous studies [13, 24-26]. However, when using binary logistic regression analyses, tobacco smoking did not appear to be a significant risk indicator in the development of dental caries. Overall, review of published studies does not converge towards a single factor through which tobacco usage can have direct relationship to dental caries [27]. With this background, there is need for prospective studies to elucidate on the relationship between tobacco smoking and dental caries.

Conclusions

Caries prevalence and severity were relatively low in this population and the M-component was the major contributor of the DMFT scores. Although a number of independent variables were significantly associated with dental caries they gave a modest overall multivariate model.

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Conflict of interest The authors declare that they there is no conflict of interest. We have no financial relationship with Sida/SAREC that sponsored the research.

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