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Agnes Gatarayiha, Pascal Ubuzima, Ashu Michael Agbor, Patrick Mahoro, Isaac Nsengiyaremye, Gladys Umukundwa, Donat Uwayezu

Corresponding author: Agnes Gatarayiha, Department of Preventive and Community Dentistry, School of Dentistry, College of Medicine and Health Sciences, University of Rwanda, Remera Campus, Kigali, Rwanda. agnesgata31@gmail.com

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Assessment of dental caries prevalence and associated risk factors among primary school children in Gasabo and Kamonyi districts in Rwanda: a cross-sectional study

Agnes Gatarayiha[1,&], Pascal Ubuzima[1], Ashu Michael Agbor[2], Patrick Mahoro[1], Isaac Nsengiyaremye[1], Gladys Umukundwa[1], Donat Uwayezu[1]

[1]Department of Preventive and Community Dentistry, School of Dentistry, College of Medicine and Health Sciences, University of Rwanda, Remera Campus, Kigali, Rwanda, [2]Université des

Montagnes Dental School, Institute of Health Sciences and Biomedical Sciences, Bangangté, Cameroon

[&]Corresponding author

Agnes Gatarayiha, Department of Preventive and Community Dentistry, School of Dentistry, College of Medicine and Health Sciences, University of Rwanda, Remera Campus, Kigali, Rwanda

Abstract

Introduction: *dental caries is a widespread public health concern, affecting 60-90% of children worldwide. It can disrupt eating ability, school performance and overall quality of life. This study aimed to determine the prevalence of dental caries and associated risk factors among school children aged 6-12 years in both Gasabo and Kamonyi districts in Rwanda.* ***Methods:*** *a cross-sectional study was conducted among children in two randomly selected primary schools. Stratified and systematic sampling techniques were used. Data collection included structured interviews and clinical oral examinations. Both Chi-square test and Univariable logistic regression were performed.* ***Results:*** *a total of 384 children were recruited, comprising; 55.2% (n= 212) females and 44.8% (n= 172) males. Majority 56.2% (n= 216) were aged 8-10 years. The overall prevalence of dental caries was 40.6%. The analysis revealed that age was the only factor which showed statistical significance associated with dental caries (P<0.001). Specifically, school children aged 6-7 years were found to have significantly higher odds of developing dental caries (OR= 4.842; CI= 2.093-11.203; P<0.001). Similarly, children aged 8-10 years also demonstrated significantly increase odds of developing dental caries (OR= 3.391; CI= 1.776-6.474, P<0.001). However, other factors such as brushing gender, location, usage of tooth brushing and toothpastes while cleaning teeth, frequency of sugary intake were not significantly associated with dental caries.* ***Conclusion:*** *dental caries was prevalent among school children, especially in younger age groups, underscoring the essential preventive oral health interventions targeting children in the initial years of schooling to effectively reduce the burden of dental caries.*

Introduction

Dental caries, also as tooth decay, is one of the most prevalent chronic diseases, and is the oldest and most common infection affecting the human race [1]. After the Second World War, there has been an exponential increase in dental caries in both industrialized and developing countries as a result of increased production of refined sugar as well as increased consumption of sugar-based diets. That is why dental caries is known as a disease of civilization. Dental caries is a multifactorial microbial infectious disease caused by bacterial deposits in dental plaque, characterized by demineralization of the inorganic hard tissues of the teeth. The World Health Organization (WHO) defines dental caries as a localized, post-eruptive, pathological process of external origin involving softening of the hard tooth tissue and proceeding to the formation of a cavity [2]. The disease is the result of a complex interaction between acid producing tooth-adherent bacteria and fermentable carbohydrates. Over time, the acids in the dental plaque may demineralize enamel and dentin in the fissures and on the smooth surfaces of the tooth [3].

Elamin *et al.* reported that dental caries affects primary teeth more than permanent teeth. Since the deterioration of the permanent teeth is high among children, more attention on preventive dental caries measures in children is crucial [4]. Children between the ages of 6 and 12 are at high risk [5]. In a study done in a rural area of Mexico, dental caries were experienced in the range from 94.7% to 100% among 2 to 18 years old children [6]. In the USA, children presenting with five or more carious teeth for both primary and permanent teeth were higher in Boston than in Maine. Also, in Georgia (USA), an association was established between sugar-sweetened beverages and dental caries among 3rd grade students (8 to 9

years old), where 52% experienced dental caries [7]. The prevalence of tooth decay was at 41% among preschool children in Abu Dhabi, United Arab Emirates [4]. However, in Africa, the prevalence of dental caries among children aged 6 to 12 years in semi-urban Nigeria was greater (71.2%) compared to those aged 1 to 5 years (28.8%) [8]. Additionally, among children aged between 6 to 10 years in Ethiopia, 33.3% experienced dental caries, and 45% among school children in Mozambique [9,10].

In East Africa, the prevalence of dental caries is high with 58% in Tanzania, and 47% in Uganda (47%) [6,9]. In Addition, results from Rwandan national oral health survey reported that almost 2/3 (64.9%) of participants had experienced dental caries, with 54.3% having untreated caries [11]. Furthermore, a study done in Kigali showed a high prevalence (42.4%) of dental caries among children aged 6-12 years [12]. Dental caries remains a global oral health burden, especially in African communities, affecting their quality of life as a result of dental pain, tooth loss and difficulties in eating and speaking [13]. There is paucity of literature on the risk factors of dental caries among school children in Rwanda. Therefore, this study aimed to assess the prevalence of dental caries and related risk factors among school children.

Methods

Study design and setting

A cross-sectional study was carried out among primary school children at Groupe Scolaire Saint Dominique Savio Remera in urban area of Remera sector, located in Gasabo district, Kigali City and Groupe Scolaire Saint Dominique Gihara in rural area of Runda sector, located in Kamonyi District, Southern province, in Rwanda.

Study population

The study population were primary school children aged 6-12 years old attending St. Dominique Savio Remera and at St Dominique Gihara in Rwanda.

Inclusion criteria: inclusion criteria were: 1) children aged 6-12 years enrolled from the selected schools; 2) children who were present in the class at the day of data collection and had informed consent from parents or guardians.

Exclusion criteria: exclusion criteria were: 1) children with systemic conditions affecting oral health; 2) children who were absent or whose parents declined consent. The sample size for this study was determined by using Cochran formula [14]:

$n = Z^2pq/e^2$

A sample size of 384 school children were included in the study based on Z^2: abscissa of the normal curve that cuts off an area a at the tails (desired confidence level is 95%), p: the estimated proportion of an attribute that is present in the population. This study considered the proportion of 50% due to the lack of study done at which we may obtain the value of proportion, q: 1-p and e: the desired level of precision of 0.05.

The study sites were selected purposively, Groupe Scolaire St Dominique Gihara located at Runda Sector, Kamonyi district, Southern province was considered due to its rural area location whereas Groupe Scolaire St Dominique Savio Remera is located at Remera Sector in Kigali city, was selected as an urban area. The participants were selected using non proportional stratified random sampling. Each school grade from Primary 1 to Primary 6 (P1-P6) was treated as a separate stratum. From each stratum, a fixed number of students were randomly selected regardless of the actual number of students per grade, hence the method is non-proportional. A list of students from each class was obtained, and a simple

random sampling technique was used to select participants within each grade.

Data collection

A semi-structured questionnaire was used to collect data and it was adopted from another study done by Elamin *et al.* [4]. This questionnaire was administered by dental practitioners and final year dental students under supervision via interviewer-administered format to ensure clarity and consistency among respondents. In addition, it was used in collecting data on socio-demographic characteristics and other factors including eating habits and oral hygiene behaviors. After responding to the questions, the participants were screened for dental caries using the recommended WHO dental caries assessment tool [15]. Caries was assessed using visual-tactile inspection under natural daylight, with each tooth scored according to the WHO decayed (D), missing (M), and filled (F) index for primary and permanent teeth. Intraoral examination was performed by an experienced dental practitioner using dental mirrors, dental probes and tongue depressors.

Definitions

Independent variables were age, gender, location of schools, frequency of cleaning teeth, use of toothpaste and toothbrush and frequency of taking sugary food and drinks.

Dependent variables: presence of dental caries, missing teeth (due to decay) and filled teeth.

Statistical analysis

The Statistical Package for Social Sciences (SPSS) version 25 was used to analyze data. Descriptive statistics were used to summarize socio-demographic characteristics and the frequency distribution of dental caries among study participants. Chi-square tests were applied to determine difference in statistical significance between categorical independent variables and dental caries status. Univariable logistic regression was further performed to examine on how predictor was associated with dental caries. Odds ratios (OR) with 95% confidence intervals (CIs) were reported. The statistical significance was set at $p < 0.05$.

Ethical considerations

Ethical clearance with reference number: CMHS/IRB/631/2023 was obtained from Institutional Review Board of University of Rwanda, College of Medicine and Health Sciences. Informed consent was signed by parents or guardians of children. The participants signed their assent before they were included in the study. The collected information was stored safely on a computer and only available to the authorized authors.

Results

General characteristics of the study population

In this study, the total sample size recruited were 384 participants, comprising of 200 (52.1%) participants from G.S. St Dominique Savio Remera which is located in urban and 184 (47.9%) from G.S. St. Dominique Gihara located in rural area. More than half 216 (56.2%) of the participants at both schools were aged between 8-10 years compared to other age groups. In our study 212 (55.2%) were female whereas males were 172 (44.8%) (Table 1).

Prevalence of dental caries among study participants

The overall prevalence of dental caries among all children examined was 40.6%. The prevalence was higher in the 8-10 years old age group with a prevalence of 25.3%. Dental caries was less prevalent in the males (19.3%) than females (21.47%). The participants in G.S. Dominique Gihara had a higher prevalence (21.6%) than G.S St. Dominique Savio Remera (19.0%). Dental caries was higher in frequency of cleaning teeth once or several times per day (33.1%) than cleaning sometimes (7.6%). Dental caries was higher

(34.1%) among those who brush with toothbrush and toothpaste compared to those who don't brush using toothbrush and toothpaste (6.5%). Dental caries was higher in taking sugary food and drinks more frequent (22.1%) was taking them sometimes (18.5%) (Table 2).

Factors associated with dental caries among children at both schools

In this study, age was the merely factor which is statistically significant associated with dental caries (P<0.001). School children aged 6-7 years had significantly higher odds of developing dental caries (OR= 4.842; 95% CI= 2.093-11.203; P< 0.001), did those aged 8-10 years (OR= 3.391, 95% CI= 1.776-6.474, P<0.001), compared to the 11-12 age group. However, other variables such as gender (P= 0.389), location of schools (P= 0.086), frequency of cleaning teeth (P= 0.862), use of toothpaste and toothbrush (P= 0.432) and frequency of taking sugary food and drinks (P= 0.458) were not significantly associated with dental caries, respectively (Table 3).

Discussion

This study aimed to assess the prevalence of dental caries and associated risk factors among children aged 6 to 12 years attending schools in Gasabo and Kamonyi districts in Rwanda. The study found a high prevalence of dental caries among school children in the two selected schools in Rwanda. Children aged 6-7 and 8-10 years were particularly at greater risk of developing caries, indicating age as significant contributing factor. The prevalence of dental caries identified in this study (40.6%) is comparatively lower compared to 64.9% caries prevalence reported in Rwanda National Oral Health Survey done in 2018 [11] and other sub-Saharan countries such as Nigeria 71.2% [8], Tanzania 58%, Uganda (47%) and Mozambique (45%) [6,9]. In addition, the prevalence of tooth decay in developed countries is higher compared to the one in the current study. For example, WHO reported 79.8% in Britain, 60-65% in India, 52% in United States in the state of Georgia, and 94.7% in Mexico [6,16,17].

In this study, age showed a statistically significant association with dental caries. Early aged school children were more exposed to dental caries. Dental caries remains public health problem in early age [18]. This may be due to lack of oral health care dependence on oral hygiene practices and inadequate parental supervision of the children during teeth brushing [19,20]. Agarwal *et al.* highlighted that oral hygiene practice awareness increases with age [19]. This is because with age the learning capacity and dexterity of children increases with age.

In the current study, dental caries was more prevalent with the high frequent use of cariogenic food but not significantly associated with dental caries. This might be related to the fact that those children had oral hygiene practices. This finding is similar to a study in the UK indicated no relationship between prevalence of caries and the frequency of cariogenic foods consumption [17]. This contradicts the study carried out by Agarwal *et al.* (2015) who reported that eating habits was one of the important factors that cause dental caries in children [19]. Another study carried out in Belgium, showed that foods like snacks and sugary drinks intake are considered as an essential cause for caries experience [21].

Oral hygiene practice using toothbrush and toothpaste and its frequency showed more prevalence of dental caries but not significantly associated. Some school children might do oral hygiene practices unfortunately, parental or guardian supervision, and self-awareness in their practices might affect the outcome. In contrast, Mulu *et al.* (2014) reported that poor oral hygiene were significantly associated with dental caries [9]. Consequently, this may be related to the lack of proper guidance and directives regarding oral hygiene practices as revealed in a study done in Saudi Arabia [22].

The current study revealed that children from G.S. St Dominique Gihara (a rural area) were affected by dental caries (21.6%) compared to those in urban area at G.S. St. Dominique Savio Remera (19.0%), but location of the school was not significantly associated with dental caries. This might be the fact that children in rural communities are less aware of oral hygiene practices and good dietary habits, have poor accessibility to oral health services and lack oral health education. However, some studies reported a high prevalence in urban than rural areas [5,22,23].

This predominance in different areas might be due to the unmet treatment needs, financial burden, increased frequency consumption of sugary dietary foods and drinks, altered oral hygiene practices, lack of parental or guardian supervision, cultural differences and insufficient to oral health promotion programs targeting and emphasizing certain groups. This makes one group of individuals or areas with certain lifestyles experience dental caries more than the others. Consequently, tooth decay can progress to tooth loss if left untreated. In children, its consequences extend beyond oral health, contributing to poor academic performance, frequent absenteeism, social stigma through bullying, and a reduced oral health-related quality of life (OHRQoL).

Therefore, the findings of this study highlight the urgent need for early, school-based oral health interventions, particularly targeting younger children who are most vulnerable to dental caries. Effective strategies should encompass age-specific oral health education, enhanced parental involvement, and improved access to preventive dental care. Such targeted interventions could help reduce the burden of dental caries and its negative impacts on children's overall well-being. Future research should explore longitudinal designs to better understand the causal pathways and long-term impacts of dental caries in diverse populations. Studies assessing the effectiveness of tailored oral health promotion programs and interventions at different community levels would also provide valuable evidence to inform public health policies and practice.

Despite its contributions, this study has some limitations. The use of a cross-sectional design limits causal inferences, and the findings may not be generalizable to all Rwandan school children, as data were drawn from only two schools within two districts. Additionally, reliance on self-reported practices may introduce reporting bias. However, the study's strengths lie in its focus on an under-researched population, use of clinical oral examination to assess dental caries, and its contribution to the limited data on pediatric oral health in Rwanda, providing a foundation for future oral health interventions and policy planning.

Conclusion

In the present study, the prevalence of dental caries was notably higher in the school children in Rwanda. Age was significantly associated with dental caries, with younger children more likely to be affected. These findings indicate that dental caries remains a public health concern among younger school-aged children in Rwanda. The study highlights the need for strengthened oral health promotion programs in primary schools, particularly focusing on younger children through targeted oral health education and dietary counseling. Such interventions can help reduce the burden of dental caries and improve overall oral health outcomes. Future studies with larger sample sizes and broader geographic representation are recommended to validate and generalize these findings across the country.

What is known about this topic

- *Dental caries is a public health concern generally;*
- *The school children are at high risk of developing dental caries compared to adults in Rwanda;*

- *Risk factors include poor oral hygiene and frequent consumption of sugary foods and drinks.*

What this study adds

- *The study highlights the high prevalence of dental caries among school children in both rural and urban settings in Rwanda;*
- *Additionally, age was significantly associated with dental caries, with younger children more likely to be affected;*
- *Moreover, oral health promotion should improve oral health education and dietary counselling at primary schools especially in rural settings.*

Competing interests

The authors declare no competing interests.

Authors' contributions

Conception, study design and data analysis and interpretation: Agnes Gatarayiha, Pascal Ubuzima, Donat Uwayezu. Data collection: Pascal Ubuzima, Patrick Mahoro, Isaac Nsengiyaremye, Gladys Umukundwa. Manuscript drafting: Agnes Gatarayiha, Pascal Ubuzima. Manuscript revision: Donat Uwayezu, Ashu Michael Agbor, Pascal Ubuzima, Agnes Gatarayiha. All authors approved the final version of the manuscript.

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Tables

Table 1: distribution of participants according to the socio-demographic characteristics

Table 2: prevalence of dental caries among study participants

Table 3: factors associated with dental caries among study participants

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Table 1: distribution of participants according to the socio-demographic characteristics

Variables	**Frequency (n)**	**Percentages (%)**
Age		
6-7years	70	18.2
8-10 years	216	56.3
11-12 years	98	25.5
Gender		
Male	172	44.8
Female	212	55.2
Schools		
G. S. St. Dominique Gihara	184	47.9
G. S. St.Dominique Savio Remera	200	52.1
Total sample size	384	100

Table 2: prevalence of dental caries among study participants			
	Dental caries		
	Yes	**No**	
Variables	**Frequency**	**Frequency**	**P-Value**
Age			0.000
6-7years	40 (10.4%)	30 (7.8%)	
8-10years	97 (25.3%)	119 (31.0%)	
11-12years	19 (4.9%)	79 (20.6%)	
Gender			0.391
Male	74 (19.3%)	98 (25.5%)	
Female	82 (21.4%)	130 (33.9%)	
School of the participants			0.087
G.S.St. Dominique Gihara (Rural)	83 (21.6%)	101 (26.3%)	
G.S.St. Dominique Savio Remera (Urban)	73 (19.0%)	127 (33.1%)	
Frequency of cleaning teeth			0.862
Once or severe times per day	127 (33.1%)	184 (47.9%)	
Sometimes	29 (7.6%)	44 (11.5%)	
Use of toothpaste and toothbrush			0.432
Yes	131 (34.1%)	198 (51.6%)	
No	25 (6.5%)	30 (7.8%)	
Frequency of taking sugary food and drinks			0.458
Every day, several times per day and week	85 (22.1%)	112 (29.2%)	
Sometimes	71 (18.5%)	116 (30.2%)	
Total Prevalence	156 (40.6%)	228 (59.4%)	
Abbreviation: %= Percentage			

Table 3: factors associated with dental caries among study participants				
Variables	**P-Value**	**OR**	**Confidence interval (95%)**	
Age			**Lower bound**	**Upper bound**
6 - 7 years	0.000	4.842	2.093	11.203
8 – 10 years	0.000	3.391	1.776	6.474
11-12 years		1		
Abbreviation: OR= Odd Ratio				