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Oral health status and factors associated with oral health of primary school children in Gulu district, northern Uganda

Peter Akera[1,3*], Sean E Kennedy[2], Raghu Lingam[2], Robyn Richmond[1] and Aletta E Schutte[1,4]

Abstract

Background Globally, oral diseases remain a major public health problem. However, there is limited information about the oral health status and factors associated with oral disease among children in Uganda. The aim of this study was to examine the oral health status and factors associated with oral health of primary school children in urban and rural areas of the Gulu district of northern Uganda.

Methods A comparative cross-sectional study was conducted among 356 school children aged 11–13 years attending six schools located in urban and rural areas. The children received a clinical oral examination and participated in a questionnaire survey that collected information on sociodemographic and oral health knowledge, attitude, and practices. All data were entered and analysed using IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp statistical software. Logistic regression analyses examined factors associated with dental caries and gingival bleeding.

Results Of the 356 children (11–13 years) included, the mean age was 12.2 years, 140 (39.3%) were male and 176 (49.4%) were from urban areas. The proportion of school children with dental caries was 33.6% ($n = 119$), with the mean decayed, missing due to caries, and filled teeth (DMFT) index of 0.81 (25th percentile = 0; 75th percentile = 1.00). There was no significant difference in caries prevalence between rural and urban children (31.6% versus 35.6%, $p = 0.33$). Of the children involved in the study, 141(39.8%) had gum bleeding. The mean oral knowledge score was 2.85 ± 1.53 (range, 0–7), while the mean attitude, hygiene practice, frequency of sweets consumption, and oral health related impact scores were 4.25 ± 1.23 (range, 1–6), 5.40 ± 1.81 (range, 0–9), 25.66 ± 4.29 (range 9–54) and 2.1 ± 1.65 (range, 0–6), respectively. Using logistic regression analyses, as oral health knowledge score increased the odds of not having dental caries increased (aOR = 1.19, 95% CI 1.02–1.39).

Conclusion The prevalence of dental caries and gum bleeding of primary school children in Gulu district is high. Children lacked knowledge on causes of oral disease, and behaviour towards oral disease prevention. In addition, oral health knowledge scores were significantly associated with dental caries. Oral health education programs in schools should emphasise providing skills-based education.

Keywords Associated factors, Child, Dental caries, Gingivitis, Oral health, Primary school

*Correspondence:
Peter Akera
peterakera2010@gmail.com
[1]School of Population Health, University of New South Wales, Sydney, Australia
[2]School of Clinical Medicine, University of New South Wales, Sydney, Australia
[3]Department of Public Health, Faculty of Medicine, Gulu University Gulu City, P.O. Box 166, Gulu, Uganda
[4]The George Institute for Global Health, Sydney, Australia

Background

Oral diseases in children have considerable social, physical, and psychological consequences, including pain, difficulty in chewing, and missed days from school [1]. Oral diseases remain a major global burden with the World Health Organization (WHO) estimating 3.5 billion cases of oral conditions, with lower economically developed countries having the higher burden [2]. Most oral disease can be prevented, particularly dental caries which is the most prevalent.

There is a high prevalence of dental caries in many low- and -middle income countries (LMICs) [3–5]. In Uganda, the prevalence of dental caries ranges from 23 to 40% among 12-year-old children [6, 7] compared to Zimbabwe where 59.5% of 12-year-old-children in urban areas have dental caries [3]. Key contributors to the high prevalence of oral disease among children in LMICs are a sugar-rich diet and poor oral hygiene [1]. Other contributors to dental caries in LMICs are lack of parents' involvement, oral health education program and dental services [8, 9].

In Uganda, the school oral health program involves oral health education, screening, and training teachers on oral health education and promotion to prevent oral disease among children [10]. The school oral health program is delivered in alignment with the national oral health policy [10–12]. However, there is insufficient funding, unsatisfactory skills-based education, and a lack of clear policy guidance [12] and little is known about the oral health status and factors associated with oral disease among children in Uganda. Previous studies have focused on oral health status, treatment need, oral hygiene practices, and frequency of consumption of sugared foods and drinks [6, 7, 13] with no attention paid to understanding possible factors associated with oral disease such as oral health knowledge and attitudes to the prevention of oral disease and behaviours such as utilisation of health services. More information and recent data are needed on children's oral health status and possible factors associated with oral diseases.

The aim of this study was to examine the oral health status and factors associated with the oral health of primary school children (11–13 years) in urban and rural areas of the Gulu district of northern Uganda.

Methods

Study design

A cross-sectional school-based study was conducted from February 2022 to April 2022 including a clinical assessment of children's teeth and an interviewer-administered questionnaire (see Additional file 1). The study design and methodology were aligned with the World Health Organisation's (WHO) guidelines: the "Oral Health Surveys; Basic Methods" [14].

Study setting

The study was conducted in six primary schools, three in Gulu city and three in Gulu district. Uganda is divided into 146 districts with a population projection of 45.5 million in 2023, with 63% of the population living in rural areas [15]. Gulu district is in the northern part of Uganda, approximately 330 km north of Kampala, the capital city of Uganda. The district is administratively divided into Aswa county and 6 sub counties. Gulu city is the commercial and administrative centre of Gulu district and is administratively divided into 2 counties (Gulu East and Gulu West) and 4 divisions. For this study, we considered participants from Gulu city as urban and those from Gulu district as rural populations. Gulu district and Gulu city in northern Uganda were chosen because the region has emerged from a civil war that lasted over 20 years (1986–2006) and there was limited information on oral health status of children in the region and for comparison between rural and urban areas.

Sample size calculation

The sample size was calculated based Kish Leslie's formula for cross sectional studies [16]. The prevalence of dental caries of 27.1% among 11-13-year-old children reported in a study in Gulu district conducted in 2015 was used [6], with a degree of precision of 5% and a 95% confidence interval. Allowing for 15% non-response, the estimated sample size was 346.

Sampling technique

A multistage sampling technique was used. Firstly, six schools in rural (3) and urban (3) areas were randomly selected from a list of 131 schools provided by Gulu city and district education offices using the fishbowl draw method. Each of the six schools should have at least 58 participants who met the selection criteria. Then, using random numbers 356 eligible children were selected from lists provided by the schools' administration. Boys and girls aged 11 to 13 years old residing in Gulu city and Gulu district and attending school at the time of the study were eligible to participate in the study. Informed assent was sought from the participants and informed consent to participate was obtained from the parents or legal guardians of any participant under the age of 16.

Study measures

In this study, oral health status refers to dental caries and periodontal status. The teeth and gums of participating children were examined in classrooms or in the school compound under adequate natural light using mouth mirrors and periodontal probes while seated in a classroom chair with a backrest by a trained and calibrated examiner (PA). The Cohen's kappa values about dental caries for inter-rater reliability was 0.62. Dental caries was recorded using the DMFT index and periodontal health status using community periodontal index (CPI) modified [14]. The DMFT index was obtained as follows: The D component included all decayed teeth and filled teeth with caries. Caries was recorded as present when a lesion in a pit or fissure, or on a smooth tooth surface, has an unmistakable cavity, undermined enamel, or a detectably softened floor or wall. The M component comprised teeth missing due to caries and the F component includes teeth with fillings. A tooth was considered missing if there was history of pain or cavity prior to extraction and considered filled if it had a permanent restoration. Dentition status was scored as 0=sound, 1=carious, 2=filled with caries, 3=filled no caries, 4=missing due to caries, 5=missing for any other reason, 6=fissure sealant, 7=fixed dental prosthesis, 8=unerupted tooth, 9=not recorded [14]. A sum of the DMFs for all individuals was divided by the number of participants to derive the DMFT index. Cases of dental caries were identified as individuals with a DMFT≥1. Periodontal health status was assessed using CPI metallic probe and scored as 0=absence of gingival bleeding, 1=presence of gingival bleeding, 9=tooth excluded, and X=tooth not present [14]. Twenty-five children were re-examined once after 2 weeks to assess intra-rater reliability. The Cohen's kappa value about dental caries for intra-rater reliability was 0.73.

All children were interviewed face-to-face in school by four trained interviewers (SO, EO, ET, and HA) using a paper-based questionnaire in English. The pretested questionnaire adapted from previous studies collected information about the participants' demographic background (e.g. gender, age, and tribe), knowledge of factors associated with oral disease [17–19] e.g. tooth decay is a disease that. (1 = "destroys your teeth", or 0=other responses; destroys your teeth, makes gums bleed causes bad breath, makes your teeth white, and don't know; eight questions related to knowledge), attitudes [17, 20] e.g. regular dental check-up prevents dental problem (1=Agree, or 0=Disagree); six questions related to attitudes, oral hygiene practices towards the prevention of oral disease [14, 17, 19] e.g. how often do you clean your teeth (1=never, 2=several times a month (2–3 times), 3=once a week, 4=several times a week (2–6 times), 5=once a day, 6=2 or more times a day; 10 questions related to behaviours), consumption of sugared food and drinks [14] e.g. How often do you eat biscuits, cakes, or buns (6=several times a day, 5=every day, 4=several times a week, 3=once a week, 2=several times a month, 1=never, .and oral health related impacts on quality of life [14] e.g. I often avoid smiling or laughing because of my teeth. (1=yes, 2=no, 3=don't know; six questions related to quality of life).

An "oral health knowledge score" was calculated by adding the total number of items answered correctly, Oral health knowledge scores ranged from 0 to 8, with higher scores indicating better dental knowledge. Oral health attitude scores were calculated by counting the total number of statements that participants had a positive attitude. This score ranged from 0 to 6, with a higher score indicating a more positive attitude. Oral hygiene practices were calculated by counting the total number of statements that participants answered correctly. The score ranged from 0 to 10, with a higher score indicating a better hygiene practice. Consumption of foods and drinks high in sugar was scored based on frequency of consumption of fresh fruit, biscuits, carbonated beverages, chewing gum, sweets, jam, and sweetened milk, tea, and coffee. Each type of food and drink were rated: 1 point=never, 2 points=several times a month, 3 points=once a week, 4=several times a week, 5=every day, 6=several times a day. Scores ranged from 9 to 54, with higher scores indicating more frequent consumption of sweets. Lastly, an "oral impact score" was calculated by counting the total number of statements that participants rated as negative (0=No, 1=yes). The score ranged from 0 to 6, with a higher score indicating a more negative impact on quality of life.

Data analysis

Test-retest reliability was used to assess consistency of participants' responses to the questions on 23 randomly selected questionnaires. All data were entered and analysed using IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp). First, we described both clinical oral health status and self-reported questionnaire. The t-test for continuous variables such as DMFT, oral health knowledge scores and $\chi 2$ for categorical variables such as prevalence of dental caries and gingival bleeding were used to compare urban and rural participants. Logistic regression analyses using odds ratios with 95% confidence interval (CI) were used to assess the association between possible factors associated with oral disease and oral health status. An adjusted odds ratio (aOR), namely an odds ratio (OR) that has been adjusted to account for other predictor variables, is provided.

Results

Demographic characteristics of participants

There were 356 children (11–13 years) in six primary schools in urban and rural areas of Gulu districts who participated in the study. Of these, 140 (39.3%) were male and 176 (49.4%) lived in urban areas (Table 1).

Oral health status of primary school children

The prevalence of dental caries among children was 33.6% (119 from n=354) and their mean DMFT was

Table 1 Sociodemographic characteristics showing variables and numbers with percentages for each category *n* = 356

Variable	Category	Number (%)
Primary school / Location	Akonyibedo / Rural	59 (16.6%)
	Gulu Baptist / Urban	55 (15.4%)
	Kulu Keno / Rural	59 (16.6%)
	Obiya West / Urban	63 (17.7%)
	Omoti Hill / Rural	62 (17.4%)
	Pece Prison / Urban	58 (16.3%)
Gender	Male	140 (39.3%)
	Female	216 (60.7%)
Age	11 years	92 (25.9%)
	12 years	93 (26.1%)
	13 years	171 (48.0%)
Class	Primary 3	49 (13.8%)
	Primary 4	91 (25.6%)
	Primary 5	110 (30.9%)
	Primary 6	98 (27.5%)
	Primary 7	8 (2.2%)

Table 2 Coding for presence of carious, missing and filled teeth and prevalence of dental caries and gingival bleeding of school children

Clinical Assessment (*n* = 354)					
Dental caries	**Mean**	**SD**	**Sum**	**Minimum**	**Maximum**
Number of teeth with caries	0.79	1.5	280	0	9
Number of filled teeth with caries	0	0	0	0	0
Number of teeth with caries and filled teeth with caries (D component)	0.79	1.5	280	0	9
Number of filled teeth with no caries (F component)	0	0	0	0	0
Number of missing teeth (M component)	0.2	0.18	8	0	2
DMF = D + M + F	0.81	1.55	288	0	9
Number of teeth with gingival bleeding	1.44	2.62	508	0	15
Dental caries prevalence	119 (33.6%, *n* = 354)				
Gingival bleeding	141 (39.8%, *n* = 354)				

0.81 (25th percentile = 0; 75th percentile = 1.00). Of the children, 96.3% with dental disease had untreated caries (D-component), 24.4% had missing teeth (M-component), and none of them had filled teeth (F-component) (Table 2).

Additionally, 39.8% (141 from *n* = 354) of participants had gingival bleeding (Table 3). There was no significant difference in the prevalence of dental caries and giving bleeding between urban and rural participants, (31.6% vs. 35.6%, $p = 0.33$) and (38.5% vs. 41.1%, $p = 0.48$), respectively (Table 3).

Table 3 Descriptive statistics for key study variables

Variable	Total *N* = 356	Urban *n* = 176	Rural *n* = 180	*p*-value *
Dental caries prevalence (number, %)	119 (33.6%)	55 (31.6%)	64 (35.6%)	0.33
DMFT (Mean SD)	0.81 ± 1.55	0.81 ± 1.55	0.82 ± 1.57	0.94
Gingival bleeding (number, %)	141 (39.8%)	67 (38.5%)	74 (41.1%)	0.48
Number of teeth with gingival bleeding (mean, SD)	1.44 ± 2.62	1.16 ± 2.17	1.70 ± 2.97	0.05
Oral health knowledge score (mean, SD)	2.85 ± 1.53	2.91 ± 1.66	2.78 ± 1.40	0.42
Oral health attitudes score (mean, SD)	4.25 ± 1.23	4.15 ± 1.34	4.34 ± 1.11	0.13
Oral hygiene practices score (mean, SD)	5.40 ± 1.81	5.37 ± 1.59	5.44 ± 2.01	0.72
Consumption of food and drinks score (mean, SD)	25.66 ± 4.29	26.33 ± 4.42	25.00 ± 4.09	0.0034
Oral health related impact (mean, SD)	2.1 ± 1.65	2.12 ± 1.64	2.09 ± 1.66	0.86

*T-test for continuous and χ^2 for categorical data, testing difference between urban and rural children

Factors associated with oral health of primary school children

The mean oral knowledge score was low 2.85±1.53 (range, 0–7), while the mean attitude, hygiene practice, frequency of sweets consumption, and oral health related impact scores were high 4.25±1.23 (range, 1–6), 5.40±1.81 (range, 0–9), 25.66±4.29 (range 9–54) and 2.1±1.65 (range, 0–6), respectively. The mean oral health knowledge score for children in urban areas was 2.91±1.66, like the mean of 2.78±1.40 in rural areas ($p = 0.42$). There were significant differences in the sugar consumption scores between urban and rural areas (26.33±4.42 vs. 25, ± 4.09, ($p < 0.05$), respectively (Table 3).

A logistic regression analysis examined factors associated with dental caries for all participants. Hosmer-Lemeshow tests for our regression models were non-significant ($p = 0.33$), indicating a good model fit. In the logistic regression analyses (Table 4). Only oral health knowledge score was a predictor in the model, as an increase in oral health knowledge score by unit the odds of children categorised as dental caries absent increased, adjusted odds ratio (aOR) = 1.19, 95% CI 1.02–1.39). As the sugar consumption score increased by 1 unit the odds of children categorised as dental caries absent decreased (aOR = 0.98, 95% CI 0.93–1.03). Children in urban areas were 16% less likely to have dental caries compared to those in rural areas (aOR = 0.84, 95% CI 0.53–1.33), however the difference was not statistically significant.

Table 4 Adjusted odds ratios with 95% confidence intervals (CI) for factors associated with dental caries for all participants

Variable	aOR	95% CI	*p*-value
Oral health knowledge score	1.19	1.02–1.39	0.03
Oral health attitude score	0.98	0.82–1.18	0.86
Oral hygiene practice score	1.00	0.89–1.13	0.95
Sugar consumption score	0.98	0.93–1.03	0.36
Age in years	1.02	0.78–1.33	0.91
Gender (Male/Female)	1.43	0.90–2.26	0.13
Location (Urban/Rural)	0.84	0.53–1.33	0.45

Note. aOR=adjusted odds ratio (Adjusted for all variables in table.) The reference point is the first category for gender and location

Additionally, children who reported never eating sweets had a lower likelihood of having gingival bleeding (aOR=0.38, 95% CI 0.18–0.81). Those reporting distance as a reason for not visiting a dentist had a 2-fold gingival bleeding (aOR=2,18, 95% CI 0.94, 5.09), though the difference was not statistically significant.

A logistic regression analysis examined factors associated with dental caries for urban and rural participants. Oral health attitude score was the only factor that had a statistically significant association with dental caries among children in rural areas with aOR of 0.71 (95% CI [0.53–0.97], indicating as the oral hygiene attitude score increased by a unit the odds of dental caries being absent decreased by 0.71. (Table 5).

The aORs for oral hygiene practices scores with dental were different for urban and rural participants (1.10; 95%CI [0.89–1.37] vs. 0.95: 95% CI [0.81–1.12]), indicating as the oral hygiene practice scores by a unit the odds of dental caries being absent increased by 1.10 among urban participants and decreased by 0.85 among rural participants.

Discussion

Poor oral health has an acute and lifelong impact on children [1], yet most dental and oral disease is preventable. In Uganda, there is dearth of information on oral diseases among primary school children. This study identified that one third of children aged 11–13 years had untreated dental caries and the average oral health related impact scores were high with overall low oral health knowledge scores. The factors associated with dental caries were low oral health knowledge scores. Children in urban areas were less likely to have dental caries.

The prevalence of dental caries reported in the present study was like previous reports on the oral health status of children in urban and rural areas of 7 districts (Gulu, Hoima, Jinja, Kabale, Kabarole, Soroti, and Masaka) in Uganda [6] and in a rural sub county in central Uganda [13]. Approximately half of the children had bleeding gums, however, this was somewhat lower than a report from a 2002 study in 12-year-old children in other districts in Uganda [7]. The difference might be due to variable access to and improvements in oral health promotion.

This study and others across Uganda and many other LMICs have reported high prevalence for both caries and gum bleeding in children [3–5], therefore, a key question is whether children are equipped with sufficient health knowledge to prevent oral disease? Other factors, environmental or behavioural, that may contribute to this challenge should also be carefully considered, such as access to dental care. In-person surveys with children found the mean oral health knowledge scores were low. There were no previous studies in Uganda that assessed knowledge of oral health for comparison. This finding is similar reports from a study in China where the mean oral health knowledge scores were low [20]. Poor oral health knowledge among school children in the Gulu district might be because of limited oral health education and promotion in primary schools. Children's poor oral health knowledge may have contributed to irregular tooth brushing and their high intake of sugar as reported in our study.

In this study, there was a high sugar consumption score. There were no previous studies in Uganda that assessed sugar consumption score for comparison. It is well known that a high intake of sugar and poor oral hygiene are associated with dental caries and the WHO strongly recommends reducing the intake of sugar and tooth brushing twice a day with fluoride toothpaste [1, 21]. Cognizant of the multifactorial causes of oral

Table 5 Adjusted odds ratios with 95% confidence intervals (CI) for factors associated with dental caries for urban and rural participants

Variable	Urban			Rural		
	aOR	95% CI	*p*- value	aOR	95% CI	*p*-value
Oral health knowledge score	1.18	0.95–1.46	0.13	1.17	0.93–1.48	0.18
Oral health attitude score	1.21	0.94–1.55	0.14	0.71	0.53–0.97	0.03
Oral hygiene practice score	1.10	0.89–1.37	0.37	0.95	0.81–1.12	0.57
Sugar consumption score	0.99	0.92–1.07	0.82	0.95	0.88–1.03	0.21
Age in years	0.89	0.59–1.33	0.57	1.14	0.78–1.65	0.50
Gender (Male/Female)	1.66	0.84–3.29	0.14	1.16	0.60–2.24	0.65

Note. aOR=adjusted odds ratio (Adjusted for all variables in table.) The reference point is the first category for gender diseases, the association between possible associated factors and oral health status were assessed.

Both dental caries and gingival disease are associated with oral health knowledge and consumption of foods that were high in sugar. Studies in China [20] and India [22] reported an association between oral health knowledge and oral health status, an association confirmed among children in our study. Adequate oral health knowledge is essential to instil appropriate oral health behaviour to prevent oral diseases in children. Knowledge is a prerequisite for behaviour change.

Other key factors associated with oral disease include the poor socio-economic status of parents, a lack of an oral health program, and lack of fluoridated tap water [8, 9, 23]. However, findings of structural challenges like residing in rural areas have not been noted or emphasised before. These findings highlight the strong need for Gulu district to improve access to oral health services as it affords opportunity for treatment, screening, and health education that may contribute to prevention of oral disease. There are several child, family, and community-level influences on the oral health of children [24]. If their oral health is to be improved, influences on oral health such as poverty, and the cultural, social, and physical environment should also be addressed.

Based on this study, the Gulu district should provide better oral health promotion that includes providing adequate oral health education and improving access to oral health services to improve oral health of children. The WHO provides an approach for health promotion in schools that can be adopted by Gulu district [25–27]. In Gulu district, teachers are implementing key principles of the WHO's health-promoting school framework such as raising awareness and skills demonstration on proper hygiene using a school curriculum, access to health services, and engaging parents in oral health promotion [11]. There is need to harness teachers' contributions in delivering oral health promotion. Moreover, providing skills-based education, access to health services and a safe and healthy environment have reported clear positive oral health outcomes, such as reduced dental caries in LMICs [12]. Additionally, information from this study should draw attention of policy makers on the current burden of oral diseases among children and provide information that can be used for advocacy, development of oral health policy and appropriation of resources to improve oral health among children.

This study provides baseline information on oral health status and factors associated with oral disease. Similar studies should be conducted across the country over the years to provide information on trends of oral disease and factors associated with oral health. The studies should have a larger population and conduct interviews with parents to clarify the associations between oral health with oral health practices. Further, a survey of none-school going children from different urban and rural areas is recommended to compare their oral health status with that of children attending schools as per our study.

Limitations and strengths of our study

This study should be interpreted in the context of its strengths and limitations. Firstly, the findings of the study are not representative of the entire population of Uganda. However, it provides insights into the oral health status and oral health knowledge, attitudes, and behaviour among urban and rural children in northern Uganda. The design and methodology were aligned to WHO standard clinical criteria [15]. A limitation is that the use of questionnaires to collect data may have elicited socially desirable responses to questions, leading to inflated positive responses.

Conclusion

Over one third of primary school children in this study had dental caries and gum bleeding. An association was found between oral health knowledge and consumption of foods high in sugar and the presence of dental caries among children. In Uganda, a school-based intervention that provides oral health education and access to oral health services is needed for prevention and control of oral diseases. Uganda can adopt the WHO's health promoting school's framework to prevent large-scale oral disease in children that are likely to affect long-term oral health and disease in the adult population.

Abbreviations

aOR	Adjusted odds ratio
CI	Confidence interval
CPI	Community periodontal index
DMFT	Decayed missing filled teeth
LMICs	Low-and middle-income countries
NCD	Non communicable disease
OR	Odds ratio
WHO	World Health Organisation

Supplementary Information

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Supplementary Material 1

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Author contributions

PA designed the study and collected, analysed, and interpreted data and drafted the manuscript. SEK, RL, and RR designed the study, interpreted data, and participated in writing the manuscript. AES interpreted data and participated in writing the manuscript. All authors read and approved the final manuscript.

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Data availability
The data that support the findings of this study are available from the corresponding author upon reasonable request and with permission of UNSW.

Declarations

Ethics approval and consent to participate
This study was approved by the Human Research Ethics Committee of the University of New South Wales, (Australia), reference number HC200028 and Gulu University Research Ethics Committee (Uganda), approval number GUREC-051-20. All methods were performed in accordance with the relevant guidelines and regulations. Written informed assent was obtained from all student participants. Informed consent to participate was obtained from the parents or legal guardians of any participant under the age of 16.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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