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Dental caries and oral health: an ignored health barrier to learning in Nigerian slums (a cross sectional survey)

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Abstract

Introduction: *in sub-Saharan Africa, 62% of the urban population reside in slums but there is paucity of data on the prevalence of dental caries in underprivileged children residing in urban slums in diverse regions of Nigeria. The purpose of our study was to determine the caries experience, risk factors, indicators and their association with anthropometric indices among children in a Nigerian slum.* ***Methods:*** *this was a cross sectional survey that utilised cluster sampling technique for recruiting the study participants. The participants included children from the four cluster areas of Makoko; Makoko North, Makoko Central area, on Water residents and South-East Makoko in Lagos, Nigeria; 684 children were enlisted for the study. Caries was recorded based on the WHO criteria while the weight for age (WAZ), height for age (HAZ), and weight for height (WHZ) measures were used to assess each child´s nutritional state. The chi-square test was used to test bivariate associations. Statistical significance was set at 0.05.* ***Results:*** *out of the 684 children seen, 64 (9.9%) had dmft ≥1 with range of 1-12; (127 primary teeth were decayed; 6 missing due to caries; 0 filled); while 45 (7.1%) had Decayed Missing Filled Teeth (DMFT) ≥1 with range of 1-6; (79 permanent teeth were decayed; 14 missing due to caries; 0 filled). Maternal and Paternal educational level, child´s age, consumption of cariogenic meals, and history of dental visits were all significantly associated with caries experience (p<0.05). For children with dental caries, the mean weight for height, height-for-age, weight for age- and BMI-for-age z-scores were 0.33±2.6; -1.49±1.8 and -0.79±1.90.58, -0.16), respectively, and these z-score values were lower than those in the caries-free children. The BMI-for-age z-scores were significantly lower in children with dental caries than in caries free children (p=0.005).* ***Conclusion:*** *dental caries, which was mainly untreated was moderately prevalent among the children surveyed in the urban slum. There was also a significant association between the presence of caries in this population and low BMI. Specifically designed and well-targeted oral health interventions that takes status into consideration is required.*

Introduction

A slum is a human habitation with poor sanitation, defective buildings and weak infrastructure, reduced access to safe water, overpopulation and a constant threat of homelessness [1]. There has been a massive population explosion in the urban areas of low-income and middle-income countries (LMICs) over the past 50 years which has led to the development of large slums, thereby overstraining the inadequate accommodations and amenities, due to inadequate governmental investment in environmental and health infrastructures [1,2]. The United Nations recently estimated that about a billion people live in slums or squatter settlements [3] while the UN-HABITAT estimates that 828 million people, representing about a third of the urban populace in developing countries live in slums [4]. However, this problem is more pronounced in sub-Saharan Africa, where three out of every five people residing in urban regions stay in slums [5]. The huge scope of this problem has worried policy makers, necessitating its inclusion in the Sustainable Development Goals (SDGs) targets by the United Nations [6].

Inadequate consideration has however been paid to the health of people living in slums in developing countries. Residents in slums tend to have poorer health outcomes than those in urban or non-slum areas, because they are exposed to environmental risks from poor sanitation. Children living in slums are especially susceptible to communicable diseases, poor nutrition, chronic and excessive loose stooling, wasting and stunting as well as impaired intellectual faculties [7,8]. Research data shows that children residing in slums have poorer health outcomes than those living in urban or even poor rural regions in the same nation [8,9]. Furthermore, extensive research exists that link child health outcomes and school performance [10]. Health conditions such

as visual and hearing impairment, poor mental status, poorly controlled asthma, lead exposure and dental caries, that negatively affect school aged children´s academic performance are known as "Health Barriers to Learning" (HBLs). When these HBls are not addressed, they result in cognitive impairment, reduced attention span, reduced motivation, absenteeism in school and even withdrawal from the academic program [11].

Oral diseases are public health problems of global significance, and they are characterised by inequity, whereby poor and deprived populations in all societies bear the greatest burden. Dental caries, the most prevalent of these childhood diseases, is about five times as common as common as asthma [12], has about 2.4 billion people afflicted with globally [13]. When untreated, dental caries can negatively affect the child´s growth, development, systemic health and quality of life. While not life threatening, untreated dental caries result in substantial acute and chronic health disorders such as abscesses and cellulitis, premature tooth loss, hospitalisation and exposure to general anaesthesia, deranged occlusion, high expenditure on health care and psychosocial disorders [14]. Like other lifestyle diseases, the poor and deprived are disproportionately afflicted with oral diseases, including dental caries. Thus, socioeconomic status is a critical contributing factor for oral health. Children from indigent background have been observed to have cariogenic bacterial colonisation at a younger age and higher counts of step mutans and lactobacillus species [15]. These children also tend to consume cheap food items that are nutrient deficient and cariogenic rather than healthier alternatives which are costly [16].

Cities in the developing countries had a population of 2 billion people in the year 2000 and this is expected to rise to about 4 billion by 2030 [17]. This rapid and haphazard urbanization in many sub-Saharan African countries, have caused a vast majority of people in urban areas to live in slum conditions. Presently, about 800 million people live in urban slums globally, and this is projected to increase twofold over the next 30 years [18]. In Africa alone, close to 70 million live in slums; 6 of every 10 urban dwellers [19]. These slums have poor residents living in crowded defective building with poor access to clean water and sanitary facilities [20]. All these factors result in worse health outcomes for them than those in adjoining urban regions, and even rural areas. Till date, no baseline data is available on the prevalence of dental caries of these deprived children living in urban slum areas in different parts of Nigeria. While several studies [21-24] have been conducted to determine dental caries prevalence and oral health status of Nigerian children both in urban and rural settings, there is no study to the best of our knowledge among children living in slums. The purpose of our study is to determine the caries experience, caries risk factors and indicators and its association to anthropometric indices among children in a Nigerian slum.

Methods

Ethical consideration: ethical approval for this research was obtained from the Health Research and Ethics Committee of the Lagos University Teaching Hospital (LUTH), Idi-Araba, Lagos, Nigeria. (Protocol Number: ADM/DCST/HREC/APP/2343). Prior to the commencement of the study, the objectives and protocol of the study were explained to the mothers/caregivers underscoring the fact that their involvement was voluntary, and that withdrawal was permissible. The parents gave their informed consent by signing or thumb printing the forms.

Study area: this was a cross-sectional study carried out among children resident in Makoko, a massive urban slum in Lagos, Nigeria. Makoko is a riverside settlement located in the Mainland Local Government Area in Lagos State, Nigeria. It is situated within latitude 6.28´ and 6.29´ and longitude 3.12´ and 3.13´, and it has about 100,000 residents [25]. This swampy region which is partly on land and partly on the lagoon with

buildings on stilts serving as marine piles is populated with Akoko trees, an array of animals and marshland vegetation. It is a polyethnic fishing and trading community, primarily controlled by the Ilajes and Eguns, but with an assortment of people from other tribes including Yoruba, Ibo, Niger delta natives and migrants from other West African countries such as Benin republic, Togo and Ghana [26]. The inhabitants of Makoko are indigent and poor, and they lack basic amenities and infrastructure such as hospitals, schools, decent housing, accessible roads and sanitary facilities.

Study population and sampling: a cluster sampling methodology was used for the selection of the study population. The participants included children from the four cluster areas of Makoko; Makoko North, Makoko Central area, on water residents and South-East Makoko. The children and their mothers were invited to one day free medical and dental outreach in a town hall through the community leaders of the four Makoko areas. The participants congregated in their respective clusters and were randomly selected by systematic random sampling: after selecting a random starting point, the third child consecutively on the list registered for the mission in each cluster was invited to participate. If the child´s mother was not available or refused to participate, the next child on the list was selected. Four dentists, four dental assistants and seventeen students who had previous experiences in epidemiological studies were trained and calibrated to participate in the survey.

Inclusion criteria: children residing in the urban slum areas of Makoko. children in the age group of 5 to 16 years. children whose parents agreed to participate in the study and who gave informed consent and assent where appropriate.

Exclusion criteria: children with physical or mental disability, who are more prone to dental caries. Those with any developmental dental anomaly.

Sample size calculation: the sample size was determined with a formula for descriptive cross-sectional studies [27].

$$n = \frac{Z^2 pq}{e^2}$$

where Z = 1.96, p = with 21.2% prevalence of dental caries from a previous study in Urban Lagos [21], q=1-p, e set at 5% margin of error. The minimum calculated sample size was 256.

Data collection: a questionnaire which was adapted from previously validated questionnaires was utilized for the study [28,29]. The questionnaire was pretested for face and content validity by two experts in pediatric dentistry and dental public health, who assessed its relevance and tested the content validity. Questions with low reliability and validity were removed, and the questionnaire was back translated by two bilingual experts in English and Yoruba. Questionnaire reliability coefficient obtained by calculating Cronbach´s alpha (α) was found to be adequate (0.84). The interviewer-administered questionnaire had three main parts. The first part included socio-demographic characteristics: mother´s age, child´s age and mother´s level of education. The second part assessed oral health practices of the children, questions asked included frequency of mouth cleaning, use of fluoride and consumption of sugar-containing diet, while the third part determined the utilization of dental services.

Clinical examination: the children were examined for dental caries using the WHO dental caries diagnostic criteria. The children were examined seated in a well-lit area, with the plane dental mirror, parents held very young children in knee-to-knee position for examination when necessary. Teeth were cleaned with wet gauze pads before examination. Teeth were recorded as carious, where there is visual evidence of demineralization of cavitation. Dental caries was assessed using a visual-tactile method, and the criteria for caries was a visually detectable cavity

on smooth surfaces and a catch of the blunt probe under slight pressure for pits and fissures. For each participant the DMFT index was calculated according to the number of decayed (D), missing (M), filled (F) teeth early stages of dental caries and questionable lesions considered as sound were excluded. The examiners were previously calibrated by double examination of 20 children; kappa statistics were used to determine intra and inter-examiner reliability, yielding a kappa values of 0.9 and above.

Anthropometric measures: the children´s height was measured while they were standing upright with their feet unshod using a transportable stadiometer (Seca 216 Height Rod; Seca GmbH ang Co. KG, Hamburg, Germany) and the reading was rounded up to the closest 0.5 cm. Their weight was measured while they were lightly dressed utilizing a digital scale (Soehnle Gala XL; Leifheit AG, Nassau, Germany) and the reading was rounded up to the closest 0.5 cm The equipment were recalibrated every day and all measurements were done by a well-trained nurse following standardized guidelines.

Data analysis: the Statistical Package for Social Sciences IBM SPSS version 23.0 (IBM, Armonk, New York, USA) was utilized for data analysis. Continuous variables were displayed as means with standard deviation, while categorical variables were displayed as frequencies with accompanying percentages. Descriptive analysis was conducted to determine the prevalence of caries in the study population for age, sex, and socioeconomic stratum. The chi-square test was used to test associations between the presence/absence of caries and (i) the child´s age (ii) gender (iii) mother´s educational level (v) oral health practices (frequency of toothbrushing, use of fluoride, consumption of sugar and utilization of dental services. The level of significance was set at 0.05.

Results

Out of the 684 children seen, 322 (46.8%) were female, the highest proportion (276; 40.1%) were aged between 6-11 years and the mean age was 7.32 ±4.14 yrs. Only 68 (9.6%) of mothers had ≥12 years of formal education while 88 (12.7%) of fathers had ≥12 years of formal education. Sixty-four (9.9%) of the children had dmft≥1 with range of 1-12; (127 primary teeth were decayed; 6 were missing due to caries; none was filled); while 45 (7.1%) had DMFT≥1 with range of 1-6; (79 permanent teeth were decayed; 14 were missing due to caries; none was filled). For caries risk factors and indicators, the children consumed biscuits or sweets an average of 1.43 ±0.53 times per week; 251 (37.1%) of the children did not use fluoridated toothpaste while 662 (96.5%) had no dental home or previous dental visits. Maternal and paternal educational level, child´s age, consumption of cariogenic meals, and history of dental visits were all significantly associated with caries experience ($p<0.05$) (Table 1). Of the 684 respondents with complete data, females 66 (20.5%) had a higher prevalence of carious lesions than males while respondents aged 6-11 years had significantly more carious lesions 72 (26.5) than those older than 11 years 29 (20.1) and those aged 1-5 year 21 (7.8%); similarly, those from the Hausa tribe 10 (33.3), and those whose mothers 101 (18.3) and fathers 102 (18.5) had <12 years of formal education also had a higher prevalence of carious lesions. The mean dmft values 0.33±1.13 were significantly higher among respondents aged 6-11 years while the mean DMFT values were significantly higher than those whose fathers had ≥12 years of formal education (Table 2). For children with dental caries, the mean weight for height, height-for-age, weight for age- and BMI-for-age z-scores were 0.33±2.6; -1.49±1.8 and -0.79±1.90.58, -0.16), respectively, and these z-score values were lower than those in the caries-free children. The BMI-for-age z-scores were significantly lower in children with dental caries than in caries free children ($p=0.005$) (Table 3).

Discussion

This study aimed to determine the caries experience, caries risk factors and indicators and its association to anthropometric indices among children in a Nigerian slum. Out of the 684 children we screened, 46.8% were female and the highest proportion (40.1%) were aged between 6-11 years with mean age of 7.32 ±4.14 years. Only 9.6% of mothers and 12.7% of the fathers had ≥12 years of formal education. In Kenya, illiterate women in the slums constituted 5.1% of the populace compared with 1.2% in the rest of the city. Furthermore, in the non-slum areas, 54% of women had a high school education, compared with only 32% in slum areas [30]. This slum/non-slum education gap is persistent across generations and world region while maternal education is strongly correlated with the educational achievement of a child. Many oral diseases are linked with socioeconomic status, including variables such as parental education, occupational status, family income, quality of housing and access to healthcare. Thus, children living in slums and deprived neighborhoods have poorer systemic and oral health outcomes than those from wealthier regions [31]. In addition, maternal education can equip subjects with self-efficacy to provide care, and to understand the relationship between diet, oral hygiene and dental clinic and the development of dental caries [32].

Dental caries was moderately prevalent among these children in the slum with 9.9% of them having dmft≥1 (range of 1-12) while 7.1% had DMFT≥1 (range: 1-6). This may be reflective of the fact that the children infrequently consumed biscuits or sweets only on an average of 1.43 ± 0.53 times per week. However, of those that had dental caries, none of them had any form of restorative care in the form of dental filling. Furthermore, 37.1% of them do not use fluoridated toothpaste while 96.5% had no dental home or previous dental visits. While the prevalence of dental caries that we observed was not necessarily higher than regional or national values, possibly due to the modifying influence of diet, there are issues of concern because most carious lesions were untreated and there was little or no access to care. Untreated early childhood caries can be accompanied with severe pain, difficulty in chewing and it often results in sleep disturbance [33,34]. Other indirect consequences include parental distress, the financial cost of treatment, parental loss of income due to time taken off from work [35]. We also observed that maternal and paternal educational level, child´s age, frequency of consumption of cariogenic meals, and history of dental visits were all significantly associated with caries experience. A systematic review of 41 studies by Costa *et al*. [36] aiming to correlate socioeconomic status with dental caries, found higher rates of dental caries among poorly educated people who worked in unkilled and semi-skilled professions. These findings were corroborated by Bernabé and Hobdell [37]. Children from low with low socio-economic status are at risk of having dental caries and other oral disease. Folayan *et al*. [38] in their study furthermore showed that the odds of having caries in preschool children increased by 23% as the socioeconomic status decreased, and that children from indigent backgrounds were less likely to utilize dental services. These children tend to have poorer dietary choices, barriers to access for general and dental healthcare facilities and limited professional advice [39].

The results of our study furthermore show high levels of under nutrition among children living in urban slums, and this finding corresponds with other previous studies [40,41]. The mean Height for age, weight for age and BMI for age Z score for the study population was -1.82 ± 2.8-0.64 ± 2.1 and 0.62±3.4 respectively. Malnutrition, particularly stunting, is still a severe public health problem in sub-Saharan Africa [42]. For children with dental caries present, the mean weight for height, height-for-age, weight for age- and BMI-for-age z-scores were 0.33±2.6; -1.49±1.8 and -0.79±1.90.58,

-0.16), respectively, and these z score values were lower than those in the caries-free children. The BMI-for-age z-scores were significantly lower in children with dental caries than in caries free children. Oral diseases share the same determinants and risk factors with many non-Communicable diseases (NCDs) including heart disease, cancer, chronic obstructive pulmonary disease, diabetes, dementia, and malnutrition. Indigent children from poor families are less likely to have access to balanced meals and more likely to be malnourished [43].

Furthermore, there is a complex interplay of many variables that can produce divergent and bi-directional outcomes depending on the population studied. Overweight or obese children also have relatively high levels of dental caries due to the consumption of high levels of soda and other energy-dense foods, which are cariogenic and obesogenic [44]. Protein-energy malnutrition in children in indigent populations can also result in reduced salivary flow and a high count of lactobacilli and Streptococcus mutans, as well as altered saliva composition and impaired secretion, predisposing to dental caries [45]. Conversely, reduced chewing ability due to caries can negatively affect nutritional intake, which further exacerbates susceptibility to dental caries [46]. Slums are not often acknowledged and considered by politicians and administrators as an integral part of the city and therefore people there often have the most deplorable living and environmental conditions, characterized by physical and social decadence, crime, psychological distress and subhuman experiences. Little attention has also been given to the oral health of the vulnerable children living in these slums. The main limitation of this study was its cross-sectional study design, hence limiting our ability to establish temporal relationships. A longitudinal study design is thus still required to further validate these findings.

Conclusion

Dental caries, which was mainly untreated, was moderately prevalent among the children surveyed in this urban slum in Nigeria. There was also a significant association between the presence of caries in this population and low BMI. The situation calls for specifically designed and well-targeted oral health interventions that takes into consideration that many of the mothers are deprived and poorly educated, which affects their ability to care for their children.

What is known about this topic

- *In Africa alone, close to 70 million live in slums; 6 of every 10 urban dwellers. These slums have poor residents living in crowded, defective building with poor access to clean water and sanitary facilities. Like other lifestyle diseases, the poor and deprived are disproportionately afflicted with oral diseases, including dental caries. Thus, socioeconomic status is thus a critical contributing factor for oral health;*
- *Children living in slums and deprived neighbourhoods have poorer systemic and oral health outcomes than those from wealthier regions. There is however a data paucity on the oral health of slum dwelling children in Nigeria.*

What this study adds

- *To our knowledge, our study is the first community survey conducted in Nigeria among children living in Nigerian slums to determine their caries experience, caries risk factors and indicators and its association to anthropometric indices;*
- *We observed that though the children infrequently consumed cariogenic meals, over a third of the children do not use fluoridated toothpaste while 96.5% had no Dental Home or previous dental vi sits;*

- *For children with dental caries, the mean weight for height, height-for-age, weight for age- and BMI-for-age z-scores were lower than those in the caries-free children. The BMI-for-age z-scores were significantly lower in children with dental caries than in caries free children. Targeting oral health interventions at children in these slums can have a positive impact on their anthropometric indices.*

Competing interests

The authors declare no competing interests.

Authors' contributions

All the authors have read and agreed to the final manuscript.

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Tables and figures

Table 1: demographic characteristics, caries risk indicators and caries status of the sample

Table 2: association between socio-demographic profile, caries occurrence and mean DMFT/dmft (n=592)

Table 3: mean comparison of anthropometric parameters of participants according to dental caries status

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Table 1: demographic characteristics, caries risk indicators and caries status of the sample

Category	**Mean ±SD or No. (%)**	**Dental caries present; χ2; p-value**
Children's demographics n=684		
Male	362 (52.6)	17.61; 0.062
Female	322 (46.8)	
Age, y	7.32 ±4.14	29.65; 0.020
1.0-5.0	268 (39.2)	
6.0-11.0	272 (40.3)	
>11.0	144 (20.5)	
Maternal education		
<12 years of formal education	616(90.4)	7.29; 0.028**
≥12 years of formal education	68 (9.6)	
Paternal education		
<12 years of formal education	596 (87.2)	4.10; 0.013**
≥12 years of formal education	88 (12.7)	
Caries prevalence	122 (17.8%)	
dmft		
(range 1-12; d=127; m=6; f=0))		
DMFT		
(range 1-6; D=79; M=14; F=0)		
Caries risk factors and indicators		
Cookies, biscuits or sweets times/wk	1.43 ±0.53	
Never or rarely	7 (1.0)	13.39; 0.014**
Weekly or more frequently	672 (97.7)	
Daily or more frequently	9 (1.3)	
Use of fluoridated toothpaste (No)	251 (37.1)	19.72; 0.018
Daily tooth brushing (No)	61(8.6)	31.50; 0.043**
No dental home or previous dental visits	662(96.5)	50.81; 0.015**

Table 2: association between socio-demographic profile, caries occurrence and mean DMFT/dmft (n=592)				
Variable	**Caries**		**dmft**	**DMFT**
	No (n=562)	Yes (n=122)	Mean+SD	Mean+SD
Overall mean			0.21±0.91	0.13±0.54
Gender				
Male	306(84.5)	56(15.5)	0.17±0.75	0.11±0.49
Female	256(79.5)	66(20.5)	0.26±1.07	0.16±0.57
			t=1.083, p=0.339	t=1.108, p=0.331
Age(years)				
1-5	247 (92.2)	21(7.8)	0.06±0.45	-
6-11	200(73.5)	72(26.5)	0.33±1.13	0.11±0.47
>11	115(79.9)	29(20.1)	0.02±0.21	0.33±0.85
			t =8.136, p= 0.004*	
Ethnicity				
Yoruba	258 (79.6)	66 (20.4)	0.23±0.88	0.14±0.53
Igbo	38 (80.9)	9 (19.1)	0.17±0.56	0.15±0.55
Others	246 (82.9)	37 (13.1)	0.17±0.89	0.14±0.57
Hausa	20 (66.7)	10 (33.3)	0.07±0.25	0.00±0.00
			t=0.374, p=0.886	t=0.631, p=0.676
Maternal education				
<12 years of formal education	451(81.7)	101(18.3)	0.29±1.02	0.23±0.63
≥12 years of formal education	111(84.1)	21 (15.9)	0.20±0.89	0.12±0.52
			t=0.513, p=0.474	t=2.358, p=0.125
Paternal education				
<12 years of formal education	450 (81.5)	102 (18.5)	0.22±0.89	0.24±0.66
≥12 years of formal education	112 (84.5)	20(15.2)	0.21±0.91	0.12±0.51
			t=0.002, p=0.960	t=4.128 p=0.043*

Table 3: mean comparison of anthropometric parameters of participants according to dental caries status					
	Overall	**Dental caries present**	**No-dental caries**	**t-value**	**p-value**
Weight for height Z score	1.09±2.5	0.33±2.6	1.15±2.5	-1.257	0.210
Height for age Z score	-1.82±2.8	-1.49±1.8	-1.88±2.9	1.192	0.234
Weight for age Z score	-0.64±2.1	-0.79±1.9	-0.62±2.1	-0646	0.518
BMI for age Z score	0.62±3.4	-0.29±1.9	0.79±3.6	-2.823	0.005*