Dietary Intake and Prevalence of Dental Caries among Five-Year-Old Children in Urban and Rural Areas of Uasin-Gishu County, Kenya

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***Abstract* — Dental caries is a major public health problem associated with diet and nutrition affecting 60-90% of children globally with the burden in both industrialized and less industrialized countries undergoing nutrition transition. The aim of this study was to assess the relation between the dietary intake and nutritional status on dental caries prevalence of 5-year-old school children in urban and rural areas of Uasin-Gishu County. In this study, 382 five year old children and their parents/caregivers were sampled from urban and rural schools in Uasin-Gishu County to participate in the study. Dental caries status was assessed based on the criteria proposed by WHO for oral health surveys. Structured questionnaires was used to gather information on demographic and socio-economic status. A quantitative food frequency questionnaire was used to collect data on dietary intake. Dietary intake data was analyzed using ENA for SMART computer programmes and the rest of the data was analyzed using the Statistical Package for Social Sciences (SPSS) Version 21 (2007). The prevalence of dental caries stood at 39.3% with a mean dft of 1.55 and 60.7% being dental caries free. Children met their nutrient requirements for protein, vitamin C, calcium, and phosphorus, but did not meet the requirements for energy, folate, vitamin A, and iron. Many children from urban than rural areas consumed sweets/candies at 33.5% and 15.3% respectively. Children from urban areas (288) had the highest mean dft of 1.83±1.37 while those from rural areas (154) had a mean dft score of 1.16±1.13. This was significantly different ($p<0.05$). Overweight was higher in the urban population compared to the rural population at 13.64% and 8.96% respectively. The prevalence of underweight was higher in rural areas at 10.7%, stunting at 14.6% and wasting at 6.8%. There is inadequate intake of Energy, Vitamin A and Iron in the diet consumed by the 5-year-old which might be contributing to dental caries prevalence both in the urban and rural areas of Uasin – Gishu County, Kenya. Children should be fed on nutrient rich foods and cariogenic foods should be consumed occasionally.**

***Index Terms* — Cariogenic Foods, Dietary Intake, Dental Caries, Nutritional Status.**

I. Introduction

Dental caries is one of the common dental diseases that affect millions of children globally. One of the leading cause of dental caries is the diet, which play an important role in its etiology in dental caries. The prevalence of dental caries seems to be increasing, thanks to the nutrition in transition that is being experienced in developing nations due to globalization [1]. Globally, 60-90% of children are afflicted by dental caries with majority of them coming from developing countries.

Diet plays a critical role in the development and progression of dental caries. Research has shown that intake of diets deficient in fluoride, calcium and iron leads to the improper enamel formation that is a risk to the development of caries [2]. On the other hand, intake of refined carbohydrates, especially sucrose have been established in the etiology of dental caries [3]. Intake of foods rich in Vitamins A, D, K, B6, calcium, phosphorous, amino acids lysine and fats have been shown to have inhibitory effect on the development and progression of dental caries. Equally, adequate intake of fruits and vegetables rich in Vitamin C may also reduce the incidences of dental caries [4].

Studies that have been done in Kenya reveal that dental caries prevalence, especially in preschool children are on the rise. The first Kenya National Oral Health Survey showed that 5-year-old children have the highest prevalence of 46.3% and a dmft of 1.87 [5]. In Uasin-Gishu County, Kibosia [6] found higher dmft's of 1.97 and 3.30 for rural and urban children respectively, with over 90% of these dental caries remaining untreated. In these studies, oral hygiene practices of the children and their caregivers was suggested as the main reason for the increase in dental caries. However, studies have suggested that dental caries is caused by a host of factors one of them being the diet [7], [8]. Apart from affecting the social interaction of the children, the pain caused by dental caries results in difficulty in chewing food and thus children do not eat a variety of diet. This leads to poor growth and development [5]. The current study aimed to assess the dietary intake and prevalence of dental caries among 5-year-old children in urban and rural areas of Uasin-Gishu County, Kenya.

II. Methodology

A. Study design and sampling procedures

The present cross-sectional study was carried out to assess the relationship between dental caries and dietary intake of 5-year-old children in Uasin-Gishu County. Multi-stage systematic and random sampling techniques were used in this study to select three hundred and eighty-two (382) five-year-old children and their parents/caregivers from urban and rural

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schools in Uasin-Gishu County to participate in the study.

B. Data collection methods and procedures

Structured questionnaires was used to obtain data on socio-demographic characteristics of the children who participated in the study. Parents/caregiver of the children were interviewed by the research assistant. Those who were 5± 6 moths at the time of the study, and those whose parents gave consent were included in the study. School children who cooperated were examined for dental caries by trained dental assistants using the criteria proposed by WHO for oral health surveys. The examinations were performed in the school-room with children in a seated position on a school chair; the examiner sat in front of them. Cotton wool was used for drying the teeth, and natural day light was used for proper visibility. A CPI ball-ended probe and a lighted mouth mirror were used as examination tools to score caries. A quantitative food frequency questionnaire (QFFQ) was used to collect data on dietary intake. The QFFQ which was categorized into eleven food groups namely; starchy staples, beverages, legumes, dairy, fruits, vegetables, sugar/sweets, meats, eggs, additives and spreads from which the population source its nutrient intake. The respondents (parents or caregivers of the children) were asked to indicate how many times a day, week, month or year that the children consumed the selected foods in order to estimate the usual diet. Standard portion sizes (cups, plates, spoons, bowls, and rulers) commonly used locally by the respondents were used to help the respondents estimate the correct portion sizes consumed. The respondents were then required to describe the size, of each of his or her child's usual serving as small, medium or large relative to these standard servings.

C. Ethical review

The proposal was submitted for approval and research permit obtained from the Institutional Research and Ethics Committee (IREC) Moi University (Approval number: 0001888). Prior to the study, consent was obtained from the various school heads and parents to include their children in the study. A pilot study was carried out before the main study to check for the viability and validity of the study.

D. Data analysis

To determine the nutrient intake per day, food portions was multiplied by the number of portions consumed per week and divided by 7 or per month and divided by 30. An estimated daily nutrient intake was arrived at after analysis of the portion sizes per food consumed and then compare it to the RDA.

III. Results

A. Socio-economic characteristics of the parents/caregivers

Approximately 43.9% of the parents/caregivers had attained University and college education with 11.5% and 18.6% having attained primary and secondary education, respectively. Only 1.8% had no education. On the monthly income, 32.2% of the parents/caregivers had Ksh. 21,000-50,000 (approximately $210-$500) with 6% of them reporting a monthly income of <Ksh. 5000 ($50) per month. This translates to a daily income of about Ksh. 166 ($1.67) for 6% of the parents/caregivers (Table I).

TABLE I: Socio-demographic characteristics of parents/caregivers of selected 5 year old school children

Variable	Description	Sample	Percentage (%)
Level of education	Incomplete primary	12	3.1
	Complete primary	44	11.5
	Incomplete secondary	80	20.9
	Complete secondary	71	18.6
	University& college	168	43.9
	None	7	1.8
Occupation	Farmer	63	16.6
	Civil servant	125	32.8
	Casual laborer	74	19.3
	Self-employed	104	27.1
	Other	16	4.2
Household income	<Ksh. 5000	23	6.0
	Ksh. 6,000-10,000	66	17.2
	Ksh. 11,000-20,000	75	19.6
	Ksh. 21,000-50,000	123	32.2

B. Characteristics of the children

In the study, 228 children (59.6%) were from urban areas whereas rural areas had 154 (40.36%), with 192 male (50.3%) and 190 female (49.7 %) (Table II).

TABLE II: Characteristics of 5-year old children in urban and rural areas of Uasin-Gishu County, Kenya

Variable	Description	Sample	Percentage (%)
location	Urban	228	59.6
	Rural	154	40.4
Gender	Male	192	50.3
	Female	190	49.7

C. Prevalence of dental caries

Among the 382 children, 150 (39.2%) had dental caries with a mean dft of 1.55±1.34 while 232 children (60.8%) had no dental caries (Fig. 1)

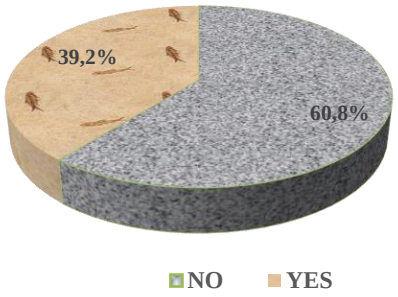

Fig.1: Prevalence of dental caries among 5-year-old children in rural and urban areas of Uasin-Gishu County, Kenya.

D. Nutrient intake of 5-year-old children

Data on nutrient intake was collected using QFFQ and analyzed by Nutri-Survey for Windows (2007) revealed that Children in both urban and rural areas met and surpassed the nutrient intake requirements for protein, vitamin C, calcium, and phosphorus, but were unable to meet the daily requirements for energy, folate, vitamin A, and iron (Table III; A and B).

TABLE III (A): NUTRIENT INTAKE AMONG 5-YEAR-OLD CHILDREN IN URBAN AND RURAL AREAS OF UASIN-GISHU COUNTY, KENYA

Nutrients	Mean intake	RDA [a] /EER [b]	Adequacy of Intake
Energy	1321.87±348.85[b]	1600 Kcal	Lower by 45%
Protein	29.21±5.94[a]	19 g	Higher by 53.74%
Vitamin A	382.30±189.85[a]	400 µg	Lower by 4.43%
Folate	135.82±22.56[a]	400 µg	Lower by 66.05%
Vitamin C	49.82±22.56[a]	25 mg	Higher by 99.28%

a Based on nutrient requirements for children 4-5 years old as recommended by IOM (2000)

b The Estimated Energy Requirement (EER) represents the average dietary energy intake that will maintain energy balance in a healthy person of a given gender, age, weight, height, and physical activity level

TABLE III (B): NUTRIENT INTAKE AMONG 5-YEAR-OLD CHILDREN IN URBAN AND RURAL AREAS OF UASIN-GISHU COUNTY, KENYA

Calcium	**470.67±113.64[a]**	**1000 mg**	**Higher by 53%**
Phosphorus	949.32±291.52[a]	500 mg	Higher by 89.86%
Iron	9.29±6.81[a]	10 mg	Lower by 7.4%
Zinc	8.92±2.57[a]	5 mg	Higher by 78.4%

E. Consumption frequency of cariogenic foods among the 5-year-old children

In this study, consumption of refined sugar snacks was investigated using a Quantitative Food Frequency Questionnaire (QFFQ). As shown in Table 4, children from urban primary schools ate sweets/candies everyday (33.5%), several times a day (28.4%), tea with sugar everyday (58.5%), pastries several times a week (54.6%) and carbonated soft drinks several times a week (44.5%). Children from rural primary schools ate sweets once a week (27.9%), several times a week (43.3%), tea with sugar every day (46.5%), biscuits or queen cakes once a week (43.7%), and carbonated soft drinks once a week (40.6%).

TABLE IV: CONSUMPTION FREQUENCY OF SELECTED FOODS AMONG 5-YEAR-OLD CHILDREN IN RURAL AND URBAN SCHOOLS IN UASIN GISHU COUNTY

Foods	Area	Never (%)	Once a week (%)	Several times a week (%)	Everyday (%)	Several times a day (%)
Sweets/Candy	Urban	0.9	23.1	14.1	33.5	28.4
	Rural	11.7	27.9	43.3	15.3	4.0
Tea with sugar	Urban	0.1	2.41	23.2	58.5	15.9
	Rural	6.5	29.6	10.5	46.5	7.0
Pastry	Urban	0.0	17.5	54.6	17.9	10.0
	Rural	26.4	43.7	15.8	10.4	3.8
Carbonated drinks	Urban	0.5	24.6	44.5	18.3	12.1
	Rural	24.5	40.6	25.2	6.3	3.5

IV. DISCUSSION

The intake of nutrients plays a crucial role in the eruption, growth, development, and protection of teeth from decay [9], with sufficient intake having significant protective roles while insufficient intake accelerates dental erosion leading to dental caries [3]. Therefore, this study sought to assess the intake of recommended minerals such as calcium, phosphorus, fluoride, iron, and zinc; vitamins A, C, folate as well as protein and energy which play a very important role in dental health in children [10].

A. Vitamin C

The mean intake of vitamin C among 5-year-old children in this study was met (49.82 mg). The recommended daily allowance (RDA) is 25 mg for this age group. The adequate intake of vitamin C might be attributed to the consumption of a variety of fruits such as mangoes and oranges as Uasin - Gishu County has a good supply of fruits all-round the year (Uasin Gishu County Integrated Development Plan 2013-2018).Vitamin C is crucial in the synthesis of collagen, which almost exclusively constitutes the protein portion of teeth and serves as the structural support over which mineralization of teeth occurs [11]. Collagen is necessary for the creation of dentine, pulp, cementum and blood vessels [9]. Based on these functions, vitamin C plays a critical role in reduction of caries development and progression.

B. Vitamin A

Mean vitamin A intake among 5-year-old children in this study was 382.30 µg against the RDA of 400 µg of this age group. This means that the children did not meet their requirements for this nutrient by a small percent (4%). This could have been due to low consumption of Vitamin A rich foods such as yellow-fleshed sweet potatoes, carrots and pumpkins as well as dark green vegetables. This is a pointer that a section of the children were at risk of Vitamin A Deficiency (VAD). According to a study by Oyunga, Omondi and Grant [12], VAD among young children in Western Kenya was attributed to low intake of vitamin A rich foods.

Apart from its role in healthy vision, vitamin A is required for the maintenance of the mucosal membranes, salivary glands, teeth and cell integrity [13]. Vitamin A plays a role in the maintenance of the mucosal membranes and salivary glands ensuring a healthy oral cavity free from acidic bacteria that are implicated for dental caries progression in children [7]. The implication of this finding is that a section of the children are at risk of developing and/or faster progression of dental caries due to low intake of vitamin A.

C. Protein

Protein supply the Essential Amino Acids (EAAs) is needed for the construction of all body tissues and is essential in protein collagen formation which is involved in the formation of dentin, cementum, periodontal ligaments, and bones [8]. A deficiency in the protein intake is linked to protein-energy malnutrition, enamel hypoplasia, caries of the primary dentition and delayed exfoliation of the primary teeth [14]. The mean protein intake among the five (5) year old children in this study was 29.21 g. Therefore the children met their daily protein requirement. This could be due to the abundance and consumption of legume**s** that provide a good amount of protein in the diet [15].

D. Energy

From the results of the current study, mean energy intake

of the 5-year-old children was 1321.87 Kcal, which was lower than the EER recommendation of 1600 Kcal [16]. This may be attributed to the low intake of oil/fat in the diet which has the highest output of energy (9 calories per gram) compared to carbohydrate and protein which provide the body with 4 calories per gram each [17]. A study in Western Kenya among pre-school children also found that children did not meet their energy requirement due to insufficient intake of carbohydrate, fats, and proteins that are the main source of energy in the diet [18]. Optimum energy, especially from carbohydrates, consumed at the right proportions benefit an individual by providing the necessary fuel to support daily activities as well as protein sparing mechanism that allow the protein consumed to be used for dental structure formation and protection. A study by Okemwa *et al.,* [19] on consumption of cariogenic foods among school children in Uasin-Gishu, Kenya observed that excessive energy from consumption of sugar-sweetened beverages, candy, and cookies provides excessive calories which tilts the balance towards the bacterial uses of energy production. This occurrence support the growth of microorganisms that metabolize carbohydrates to produce acidic metabolites causing demineralization of teeth. The implication of the unmet energy consumption in these children is that prolonged energy deficiency will lead to utilization of protein for energy production, leaving little protein for dental development and repair and thus increase the chances of dental caries.

E. Folate

Mean folate intake of 135.82 µg among the preschool children in this study was less than the required RDA of 400 µg for this age group by 66%. This may be attributed to the low consumption of dark green vegetables such as spinach and unsuitable food preparation methods such as boiling. Allen [20] reported that folate deficiency among preschool children is prevalent among children who have a low consumption of green leafy vegetables. Folate plays a major role in the prevention of dental decay by reducing gums inflammation thus making the gums more resilient to dental caries and anaerobic bacteria that causes dental demineralization [21]. A study by Esaki *et al.,* [22] on the relation of folate intake and dental diseases in Japan reported that low serum folate level as a result of insufficient nutrition is associated with the deterioration of dental health and thus the development of dental caries. The inadequate folate intake in this study could be a pointer that children are at risk of dental demineralization.

F. Calcium and phosphorus

In the present study, the mean calcium intake of children was 470.67 mg which was according to the RDA less by 53% for five (5) years old children. Low calcium consumption might have been due to milk commercialization by most of the households in Uasin-Gishu instead of feeding it to the children. Kirui and Nguka [23] in a survey on the influence of milk consumption among children 1 – 5 years in Uasin-Gishu County established that a smaller percentage of the households (32%) fed their children with a mean quantity of 250 ml of milk per week. Tanaka *et al.,* [24] established that daily milk consumption was significantly associated with a lower risk of dental caries in children.

The RDA for Phosphorus among 5-year-old children is 500mg, thus the children in this study met their daily intake. This may be attributed to presence of phosphorus in a variety of foods of both animal and plant sources. Phosphorus is a mineral that helps in building strong bones and teeth enamel thus protecting the teeth against dental caries [25]. Similarly, a study by Lin *et al* [26] among school children reported phosphorus intake of 1135.96 to 1035.05 mg. Phosphorus plays a critical role in the balance between demineralization and remineralization of enamel thus protecting the teeth from dental caries [15].

Calcium and phosphorus are essential in the mineralization of the protein matrix (deposition of hydroxyapatite), therefore giving the bones and teeth their comprehensive strength [27]. A study on the relationship between diet and dental caries in Japan demonstrated that relatively high calcium and Phosphorus intake results in lower dental caries experience in children [25]. Inadequate intake of calcium and phosphorus-rich diet not only leads to premature tooth loss but is also associated with severe dental caries [28]. The implication of low intake of calcium and high intake of phosphorus is that it may tilt the synergistic balance of calcium and phosphorus thus placing a section of the children in danger of dental caries.

G. Iron and Zinc

The RDA for 5-year-olds is 10 mg of Iron and 5 mg of Zinc. Children in Uasin-Gishu had a mean iron and zinc intake of 9.29 mg and 8.92 mg, respectively. Therefore, the children met the Zinc requirements but failed to meet the Iron requirements. This could have been caused by low intake of animal source food such as meat, and dark green vegetables such as spinach that is high in Iron. This suggests that some children in this study may have suffered from iron deficiency anemia. The role of iron in the prevention of dental caries has been suggested in studies. Buzafal *et al.,* [29] in a study to determine the effects of iron on inhibition of acid demineralization found out that iron plays a critical role of inhibiting acid demineralization of the enamel by directly affecting mineral dissolution. Therefore, iron deficiency directly leads to dental caries by exposing the teeth to acid demineralization. A study by Tang, Huang and Huang [30] in a study on the relationship of dental caries and anemia among children in China reported a strong association of iron deficiency anemia with dental caries. In another study in Canada, Schroth *et al.,* [2] found that children with dental caries were six times more likely to have iron deficiency anemia than caries-free.

Zinc plays a crucial role in inhibiting the growth of bacteria proliferation in the mouth which in turn leads to reduction in dental caries in children [30]. A study by Sejdini *et al.,* [32] on the role of zinc on dental caries found that zinc concentration is significantly associated with a reduction in caries in children and it is also found to play a critical role in mineralization and maturation of hard tooth tissue that protect the teeth against decay. Were *et al.,* [33] in a study on zinc status in children in Suba District recommended that significant improvement in zinc status of the children and nutrition education can improve zinc status of malnourished children. Therefore, adequate supply of zinc and iron in the diet can go a long way in supporting other measures

employed in lowering and even eradicating dental caries in children.

H. Consumption frequency of cariogenic foods

Dietary factors directly associated with the occurrence and severity of dental caries is related to the consumption of high amounts of sugary foods [34]. In the present study, tea with sugar was the most commonly consumed food item on a daily basis at 59% in urban and 47% in rural areas. These findings corroborate those reported by the MoH [5] where the majority of preschool children (61%) drunk tea with sugar every day. Results of the current study also indicated that 28% of the children living in urban areas ate sweets and biscuits several times a day. The sucrose added to candies and processed foods might have led to high dental caries in the urban sample.

In a similar study by Elidrissi & Naidoo [34] among 5 year old children in Khartoum Sudan, the most consumed food items among 5-year-old in the urban settlements included sweets, candies, chocolate, cakes, biscuits and carbonated soft drinks. In contrast, a study by Wigen & Wang [36] reported a low likelihood of dental caries in children who had frequent sugar intake. The implication of this finding is children in urban area that have higher consumption of cariogenic foods are at a higher risk of dental caries.

V. Conclusion and Recommendations

Based on the results of this study, there is inadequate intake of Energy, Vitamin A and Iron in the diet consumed by the 5-year-old both in the urban and rural areas of Uasin – Gishu County, Kenya. The underlying factor may include insufficient consumption, poor selection of foods as well as cooking methods. Urban population have the highest frequency of intake of cariogenic foods compared to the rural children. To reduce the prevalence of dental caries among 5-year-old children in Uasin-Gishu County, this study recommends that children should be fed on nutrient rich foods and cariogenic foods should be consumed occasionally. The county health department should promote awareness programs on alternative rich sources of Vitamin A, such as yellow fleshed sweet potatoes, pumpkin and carrots, and Iron rich sources including dark green vegetables such as spinach, use of fortified cereals and red meat.

Conflict of Interest

The author declare that there is no conflict of interest.

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