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Sugar consumption and dental caries experience in Kenya

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Introduction: There have been claims that dental caries experience and prevalence in Kenya has been increasing as a result of increased sugar consumption. A review of the literature in 1986 failed to link dental caries experience with an increase in gross national sugar consumption. Subsequently, a number of studies were conducted, necessitating further review to examine trends in dental caries experience and to relate this to changes in per capita sugar consumption. **Methods:** Studies conducted since 1980 for children 3–15 years of age were examined. Dental caries prevalence and experience for 3–5 years' (deciduous teeth) and 12 years' (permanent teeth) age groups were analysed. Calculation of per capita sugar consumption was performed using gross national annual sugar consumption for 1969–2009 national population census years. **Results:** There was a gradual increase in per capita sugar consumption, from 35.5 g/day in 1969 to 60.8 g/day in 2009. Dental caries experience in deciduous teeth for children 3–5 years of age increased from a decayed, missing and filled teeth/decayed and filled teeth (dmft/dft) index of 1.5 in the 1980s to 2.95 in the 2000s. At 12 years of age, caries experience for permanent teeth increased from a DMFT of 0.2 to a DMFT of 0.92 over the same period. Dental caries prevalence for both deciduous and permanent teeth also increased with time. **Conclusion:** These observations suggest that dental caries prevalence and experience increased with time, in parallel to an increase in per capita sugar consumption. However, a clearer understanding can be derived from longitudinal studies, based on actual household age-specific sugar consumption and dental caries incidence.

Key words: *Sugar, caries experience, socio-economic development*

INTRODUCTION

Dental caries is one of two dental diseases considered as the most important global oral health burdens, the other being periodontal diseases[1]. One of the major reasons for concern regarding dental caries is its association with tooth loss. In Kenya, it has been demonstrated that dental caries is the principal cause of tooth loss in all age groups, for both children and adults, and these observations have been made in community and hospital settings[2,3]. At the global level, there has been growing concern that the burden of dental caries in developing countries, particularly in Africa, will increase as a result of growing consumption of sugars and inadequate interventions[1].

The common household sugar, sucrose, is one of the three major factors incriminated in the aetiology of dental caries, the others being bacteria and susceptible teeth. Evidence incriminating sugar has been clearly demonstrated in numerous studies[4–8]. These studies have demonstrated that decayed, missing and filled teeth (DMFT) scores for caries experience tend to rise with an increase in sugar consumption. Screebny[4], for instance, demonstrated that a per capita sugar consumption of >50 g per person, per day, is likely to result in caries experience of more than three DMFT at 12 years of age, whereas consumption of <50 g per person, per day, results in less caries experience. This was an important finding, given that one of the World Health Organization (WHO) global oral health goals for the year 2000 stated that the global average for dental caries was to be no more than three DMFT at 12 years of age[1]. It has also been demonstrated that there is a relationship between socio-economic development and caries experience, with countries undergoing socio-economic transition having higher DMFT scores, most probably because of an increase in sugar consumption, among other factors[5].

Kenya has recently (2014) been reclassified as a middle-income country from its former status as a developing country, raising the possibility that dental caries in this country could be increasing, in parallel

with the rise in socio-economic development, which is usually accompanied by an increase in sugar consumption, as proposed by Lalloo *et al.*[5]. However, even before this transition, there were claims over the years that dental caries experience in Kenya was increasing, and this was attributed to increased sugar consumption[2,9]. However, after a review of the data available, Manji[9] concluded that there was no sufficient evidence to suggest that dental caries in Kenya was increasing. To date, no evidence has been adduced to confirm the claims.

In his review, Manji[9] pointed out several problems that hindered comparison of findings from the various studies, leading to an ambiguous conclusions. These problems included use of different population groups and different dental caries diagnostic criteria and methods. His comments suggested that most of the studies he reviewed were conducted without following standardised guidelines.

We therefore set out to examine the data available providing evidence of an increase in the per capita sugar consumption in Kenya from the year 1969 to 2009. We also sought evidence suggesting a corresponding increase in dental caries experience and prevalence, taking into consideration Manji's[9] experiences. To demonstrate the pattern for both deciduous and permanent teeth, we sought data for both younger and older children.

METHODS

Population changes

Since 1969, the Kenyan government has consistently conducted national population censuses every 10 years. The total population for Kenya was therefore extracted from the national population census reports prepared by the Kenya National Bureau of Statistics for every census year from 1969 to 2009[10]. Actual census data computed for respective census years were used because these were considered more accurate than inter-censual population projections. Inter-censual population growth rates were also obtained from the same source.

Sugar consumption

Data on sugar consumption were obtained from statistical abstract reports, which are produced annually by the Kenya National Bureau of Statistics[11]. In these reports, sugar consumption for the whole Kenyan population is recorded in metric tons per year.

Caries experience

Data sought were mainly for dental caries experience and prevalence in children 3–15 years of age. However, some age groups were excluded because of lack of comparable data. For instance, studies on children with mixed dentition, especially those 6–11 years of age, were sought but it was found that the age group and subgroups studied by different authors at different points in time were not comparable. Studies covering the age group 3–5 years were extracted to provide dental caries data for deciduous teeth[12–15], and studies covering the 12 years' age group provided data for permanent teeth[12,16–18]. The location of the study sample (rural or urban), authors and year of publication were noted.

To avoid some of the problems enumerated by Manji[9], dental caries data were obtained by reviewing published scientific reports from studies conducted according to methodologies, examination procedures and diagnostic criteria defined by the WHO[19].

Data analysis

Per capita sugar consumption in kg per person per year was computed by converting total sugar consumption from metric tons to kg and dividing by the total population for the respective census year. To compute sugar consumption in g per person per day, the per capita sugar consumption in kg per person, per year, was converted into g and divided by the total number of days in the year (365 days). Dental caries experience and prevalence for the particular age groups and dentition were recorded directly from the findings of the specific studies identified for this purpose.

RESULTS

Population growth and age distribution

During the study period, the population increased in an almost linear fashion from 10.9 million in 1969 to 38.6 million in 2009 (*Table 1*). However, the inter-censual population growth rate remained stationary, at 3.4%, until 1999, when there was a marked decrease, to 2.9%, followed by a slight increase in 2009. According to the 2009 national population census, children ≤ 15 years of age represented $> 45\%$ of the total population (*Table 2*). Those ≤ 5 years of age represented 18.4% of the total population and 40.8% of those ≤ 15 years of age.

Sugar consumption

The per capita sugar consumption increased from 35.5 g per person, per day, in 1969 to 60.8 g per person, per day, by 1989. Thereafter, there was a marked decrease, to 43.1 g per person, per day, in 1999 followed by a slight increase by 2009 (*Figure 1*). This

Table 1 Population growth of Kenya, according to the National Population and Housing Census

Census year	Population (millions)	Inter-censual population growth rate (%)
1969	10.9	–
1979	15.3	3.4
1989	21.4	3.4
1999	28.7	2.9
2009	38.6	3.0

Table 2 Distribution of the Kenyan population, stratified by age group, according to the 2009 Population and Housing Census

Age (years)	Number of people (millions)	Percentage of total population
≤15	17.50	45.3
16–30	11.10	28.7
31–45	5.50	14.2
46–60	2.80	7.3
61–75	1.20	3.1
≥76	0.50	1.3
Not stated	0.02	0.05
Total	38.62	

pattern was similar to that of the inter-censual population growth rate. However, in all years, except 1989, per capita sugar consumption was less than the critical 50 g per person, per day, proposed by Screebny[4]. Sugar consumption, in kg per person, per year, is given in *Figure 1*.

Dental caries prevalence

In most of the studies analysed, except that of Manji[12], in which the decayed and filled teeth (dft) index was used, dental caries experience in deciduous teeth was assessed using the dmft index (*Table 3*). The caries experience obtained for deciduous teeth increased from 1.5 in studies conducted in the 1980s to nearly 3 in studies conducted after 2000 (*Table 3*). For permanent teeth in 12-year-old children, Manji[12] reported dental caries experience of DMFT = 0.2 in 1984, whereas Frencken *et al.*[16] reported DMFT = 0.51 in 1986 for children living in urban areas (*Table 4*). This DMFT value had risen to 0.92 in the period after 2000, as reported in 2010 by Owino *et al.*[18] (*Table 4*). The general trend was an increase in caries experience, with time, for both deciduous and permanent teeth. However, the prevalence reported by Musera[17] was unusually high, possibly because of the combination of rural and urban locations in their study sample. In this particular study, the overall prevalence was much higher among rural children than among urban children. Similarly, the dental caries prevalence and experience reported by Njoroge[15] may have been influenced by the rural location of the sample.

Table 3 Trends in dental caries prevalence and experience in deciduous teeth of 3- to 5-year-old children

Source/Reference	Age (years)	Caries prevalence(%)	Caries experience
Manji[12,*]	5	43.2	1.50 (dft)
Masiga *et al.*[13,*]	3–5	45.0	1.72 (dmft)
Ngatia *et al.*[14,*]	3–5	63.5	2.95 (dmft)
Njoroge[15,**]	3–5	59.5	2.46 (dmft)

dft, decayed and filled teeth; dmft, decayed, missing and filled teeth.
*Urban location.
**Rural location.

Table 4 Trends in dental caries prevalence and experience in the permanent teeth of 12-year-old children

Source/Reference	Location of study	Caries prevalence (%)	Caries experience (DMFT)
Manji[12]	Urban	11.7	0.20
Frencken *et al.*[16]	Urban	22.2	0.51
Musera[17]	Urban + Rural	60.6	2.40
Owino *et al.*[18]	Urban	44.5	0.92

DMFT, decayed, missing and filled teeth.

DISCUSSION

Since the early 1980s, claims have been made to the effect that dental caries prevalence and experience in

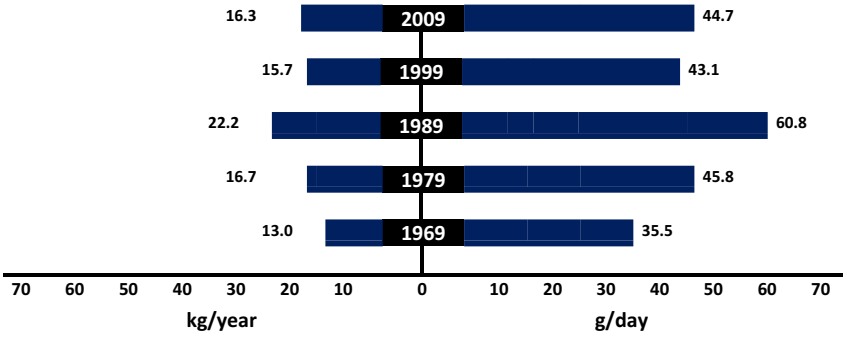

Figure 1. Per capita sugar consumption during population census years.

Kenya was increasing[2,9]. This was attributed to the observed increase in sugar consumption and changes in dietary lifestyles[2,9]. However, no evidence has been provided to support this claim. Manji[9], in his attempt to address this issue, examined data published on dental caries from the 1930s to the early 1980s. Whilst conceding that there had been a marked increase in sugar consumption, he found no evidence to suggest that there was an increase in caries experience in Kenya.

Among the problems experienced by Manji[9] in comparing findings from different studies, were the use of different population groups, different caries criteria and methods used to diagnose dental caries and the use of non-standardised examiners. In the present review, only reports from studies conducted according to WHO[19] criteria and methodologies were considered.

Our findings suggest that changes in daily per capita sugar consumption were influenced more by population growth rate than by the general trend in population increase. For instance, the general trend of sugar consumption was an increase over time. However, when the inter-censal population growth rate declined from 3.4% to 2.9% in 1999 (*Table 1*), this was accompanied by a marked decline in per capita daily sugar consumption (*Figure 1*). The reason for this is not clear and further examination of market forces that may have contributed to this pattern is necessary.

Screebny[4] demonstrated that sugar availability in amounts of <50 g per person, per day, is always associated with DMFT scores of <3. All nations that fell into this category were developing nations. Availability of sugar of > 50 g per person, per day, was associated with caries experience of a DMFT score of 3 or > 4. In our study, for all years except 1989, the per capita sugar consumption was <50 g per person, per day. However, the observation that the per capita sugar consumption, although <50 per person, per day, was increasing, should be of concern. Furthermore, Kenya is now classified as a middle-income country because of the increased level of socio-economic development. Such increased level of socio-economic development has been associated with increased sugar consumption and caries experience[5]. However, Woodward *et al.*[6] have demonstrated that, for industrialised countries, the association between dental caries and sugar was not strong. This may suggest that with increased socio-economic development and industrialisation, other factors affecting dental caries experience may emerge and even mask the influence of sugar consumption[6–8]. The possibility that Kenya, or any other country with emerging socio-economic development and industrialisation, may follow this path cannot be ruled out.

In all the dental caries studies we have cited for Kenya, the caries experience was <3 dmft/DMFT[12–18] (*Tables 3* and *4*). This appears to correspond well with the sugar consumption for Kenya, of <50 g per person, per day, when the findings from previous studies are considered[4]. However, the increasing trend in both caries prevalence and experience for both deciduous and permanent teeth may be a reflection of the increasing trend in per capita sugar consumption that we have demonstrated (*Figure 1*). Of greater concern in children is the higher and increasing caries experience in deciduous teeth compared with permanent teeth. After 2000, the dmft was approaching 3. This calls for maternal empowerment and intervention to reduce the caries risk in children ≤ 5 years of age, who constitute 18.4% of the total population and 40.8% of those ≤ 15 years of age[10].

The observations made in this study regarding changes in caries prevalence and experience parallel to changes in per capita sugar consumption are unlikely to be explained by fluoride distribution in water, use of fluoridated toothpaste or the pattern of oral hygiene practices and status in Kenya[20–22]. There is no evidence to suggest that there have been any significant changes in these factors over time.

The use of per capita sugar consumption computed from gross national consumption may not accurately describe the actual consumption patterns at the household level because different income, gender and age groups may have different consumption patterns[6]. There may also be rural–urban differences in the pattern of sugar consumption. In addition, there are no national oral health surveys, conducted during different time periods, which could demonstrate specific annual changes in caries experience over time in Kenya. The use of different age categories and geographical locations, in different studies, makes comparison difficult. It is also notable that the caries prevalence and experience data we have reviewed are from isolated sample surveys that had not been designed to demonstrate changes in trends over time. We also recognise that apart from the role of sugar in influencing dental caries experience, other factors, such as poor oral hygiene, changes in prevalence and frequency of use of fluoridated dentifrices, as well as changes in the pattern and distribution of fluoride in water, food and drink, are expected to play a role[6–8]. It is possible that for a given population group, these factors may affect the quantity of sugar required to generate a caries experience of DMFT = 3.

Notwithstanding these limitations, it is our considered view that dental caries prevalence and experience in Kenya has been increasing over time. This increase may be because of the observed increase in per capita daily sugar consumption that has been demonstrated in this study. However, the limitations we have men-

tioned call for investment in programmes that can monitor changes in caries experience over time and document changes in actual age and gender-specific per capita sugar consumption at the household level. It is also necessary to investigate whether factors such as oral hygiene status, use of fluoridated dentifrices and distribution of fluoride in water may significantly change the 50 g per person, per day, sugar-consumption threshold determined in previous studies[4]. Sheiham[7], for instance, has proposed that where fluoride is widely available, acceptable levels of sugar consumption should increase to 15 kg per person, per year. Lower sugar levels have been recommended where fluoride is not available[6–8]. Since 1979, sugar consumption in Kenya has consistently been above 15 kg per person, per year, with an increasing trend over time (*Figure 1*). Currently, Kenya does not have a policy on water fluoridation. Therefore, such studies may lead to determination of the maximum per capita sugar consumption that is appropriate for the Kenyan population.

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Conflict of Interest

The authors have no conflict of interest to declare.

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