# Caries experience and related factors in 4-6 year-olds attending dental clinics in Kinshasa, DR of Congo

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***Objectives:*** The aim of this study was to examine the prevalence and severity of caries experience (CE) in 4-6 year-olds attending dental clinics in Kinshasa, DR Congo, and to explore possible associations with reported behavioural and socio-demographic factors. ***Methods:*** A convenience sample of children attending five dental clinics was recruited. Carers, usually parents, completed a questionnaire consisting of socio-demographic information, oral health and tobacco consumption profile of parents, socio-economic family situation and oral health habits of the child. Children were clinically examined using WHO criteria by trained dentist-examiners. To investigate factors associated with CE, multivariate logistic regression was applied with the significance level set at 0.05. ***Results:*** Some 158 children with mean age 5.3 (sd 0.7) years were recruited; 80% presented with clinical signs of CE. Between-meal snacking and drinking was reported by 78% and 65%; 35% had sugar-containing drinks. Most (81%) brushed once a day and 82% brushed in the morning. Prevalence of CE was associated with gender, frequency of meals, consumption of drinks during meals and consumption of sugar-containing drinks; severity with type of infant feeding and sugar-content of the last meal at night. ***Conclusion:*** The present study shows that both prevalence and severity of caries experience were associated with reported dietary habits, confirming the importance of preventive interventions dealing with these habits in young children living in a developing country.

**Key words:** *dental caries, primary dentition, oral health, Africa South of the Sahara*

## Introduction

Caries experience remains one of the leading public health challenges in young children, throughout the world (Ferreira *et al.*, 2007; Marthaler, 2004). In recent years a decline in disease prevalence was seen in industrialised countries (Christensen *et al.*, 2010). In some countries, e.g. France, 93% of six-year-old children have been reported to have a completely sound dentition (Lupi-Pégurier *et al.*, 2009). Recently, a report from Italy showed that 78% of Italian four-year-olds were free of any sign of caries experience (Campus *et al.*, 2009). This trend is marked by an increasing unequal distribution of disease prevalence among socioeconomic strata (Christensen *et al.*, 2010; Declerck *et al.*, 2008).

The aetiology of the carious process is complex and the impact of several risk indicators, such as educational level of the parents and socio-economic situation of the family, remains largely unexplained (Ferreira *et al.*, 2007; Van den Branden *et al.*, 2013). Further, it is plausible that the effect of known risk factors might show variations between different social strata within a population and might present different patterns in industrialised versus developing countries. In the latter, only limited information is available on these issues (Ismail, 1998).

Epidemiological data on caries experience in preschool children are not available for Kinshasa, capital of the Democratic Republic of Congo. However, caries experience in the primary dentition has been shown to be the most powerful predictor of caries development in the permanent dentition (Skeie *et al.*, 2006; Vanobbergen *et al.*, 2001). Therefore, it is important to screen the oral health condition of young children and examine related factors, to gain insights into the disease process and its determinants and to develop tailored preventive strategies.

The aim of the present survey was to examine the prevalence and severity of caries experience in 4-6 year-old children living in Kinshasa and to explore possible associations with reported behavioural factors, such as oral hygiene and dietary habits, and socio-demographic factors.

## Material and Methods

This cross-sectional survey is part of a larger study that was undertaken between April 2007 and January 2008, in Kinshasa, DR of Congo. A convenience sample of children was recruited from those attending the dentistry units of five hospitals or private clinics selected for their spread of geographical location. The sample consisted of 710 children below 18 years seeking dental care in the reference period, without selection by gender, nationality or ethnic origin. For the present research, a subsample consisting of 4-6 year-olds (age limits 4.1 and 5.9 years)

was considered. Carers, usually parents, accompanying the children were invited to complete a questionnaire and allow their children to undergo a clinical examination for which informed consent was obtained. The study received approval from the ethical committee of the School for Public Health of the University of Kinshasa.

A questionnaire was developed, based on the specification for oral health surveys proposed by the World Health Organization (WHO, 1997). The questionnaire consisted of socio-demographic information (age and gender of the child), the oral health situation and tobacco consumption profile of the parents, the socio-economic situation of the family, dietary and oral hygiene habits of the child.

The assessment of the oral health condition of both parents was based on carers' reports as was the case for the recording of parental smoking habits. Socio-economic situation was evaluated based on the highest educational level attained by each of the parents and was categorised as 'illiterate', 'primary school', 'secondary school' or 'advanced education'. Dietary habits covered items specific for the first two years of life (bottle feeding or breast feeding, feeding at night, feeding on demand) as well as current habits (number of meals, type of food items, type of drinks, between meal drinks). Oral hygiene habit questions included frequency and timing of brushing.

A clinical examination was performed based on visual detection with the child sitting in a dental chair equipped with a light source. The inspection of the oral cavity was undertaken using a dental mirror and standard examination probe; findings were recorded according to the criteria proposed by WHO (1997). Caries experience was scored at the level of cavitation ($d_3$) (excluding non-cavitated or demineralised lesions), with the tooth as unit of observation, and expressed using the $d_3$mft-score (Klein *et al.*, 1938). No tooth brushing (cleaning) was undertaken before the examination. To safeguard consistency, radiographic information, where available, was not used. Each clinical examination was performed by one of thirteen dentist-examiners recruited from participating dental clinics following a pre-survey training session and calibration exercise. Inter-examiner agreement was assessed and was considered to be good (mean Kappa 0.76, range 0.48-0.90).

Data were coded and entered in a spreadsheet then analysed using SPSS v18.0. In addition to descriptive statistics, univariate and multivariate logistic regression were used to determine factors associated with the prevalence (dmft=0 versus >0) and severity ($d_3$mft 1-4 versus ≥5) of caries experience. For all statistical analyses, the significance level was set at 0.05.

## Results

Characteristics of the sample are presented in Table 1. The sample consisted of 158 children, 79 boys and 79 girls, with mean age of 5.3 (sd 0.7) years (range 3.9-6.4). A fifth of the children presented without clinical signs of caries experience, half had a $d_3$mft-score between 1 and 4 and the remaining children, almost a third, had at least 5 teeth with signs of caries experience. Overall caries prevalence was 80%. The mean dmft-score was 3.23 (sd 2.74) and was largely made up of untreated dental caries (Table 1).

Information on parental educational level and oral health is available in Table 2. The data show that 72% of the fathers but only 35% of the mothers received some form of post-secondary education. Fathers reported the presence of oral disease in 48% of cases, mothers in 58%. While 10% of fathers were reportedly smokers, none of the mothers were.

Dietary and oral hygiene habits of the child show that in early infancy, 8% of children were exclusively bottle-fed while 53% received only breast feeding (Table 2). The remaining 39% of the children received a combination of both. Night feeding was common as it was reported by 80%; feeding on demand took place in 87% of the children.

Current dietary habits showed that two-thirds of children had three meals a day, with almost all the others having two (Table 2). They very commonly consumed on a daily basis, sugar-containing foods (93%) with half having these as last meal of the day. Regarding drinking habits, 44% of the children had soft drinks with their meal and 48% water with syrup. Between-meal snacking was reported by 78% of the children, 70% had sugar-containing food items between meals. Drinks were taken between meals by two-thirds of the children, 35% had sugar-containing drinks on these occasions.

Only one child reported not brushing daily. Most brushed once a day on waking in the morning while almost a fifth brushed more often, 13% with a second brushing in the evening, before going to bed (Table 2). Practically all reportedly used toothpaste.

The univariate and multivariate logistic regression analyses had presence of caries experience as their dichotomised outcome variable (Table 3). Univariate analyses showed that girls had a lower risk of presenting with caries experience than boys (OR=0.43, 95%CI: 0.19-0.96). Children reported to have more than two meals a day had a higher risk of presenting with caries experience than others (OR=2.70, 95%CI: 1.26-5.80). This was also the case for children having more than one sugar-containing drink a day compared to those who had one or none (OR=2.47, 95%CI: 1.05-5.85). On the other hand, children from mothers who had suffered

**Table 1.** Sample characteristics

| Characteristic | Value | |
|---|---|---|
| Number of children | 158 | |
| Boys | 79 | (50%) |
| Girls | 79 | (50%) |
| Mean age (sd) in years | 5.3 | (0.7) |
| Age range in years | 3.9 - 6.4 | |
| Caries experience ($d_3$ level) | 126 | (80%) |
| Mean dmft (sd) | 3.23 | (2.74) |
| d (sd) | 3.20 | (2.74) |
| m (sd) | 0.01 | (0.11) |
| f (sd) | 0.02 | (0.24) |
| $d_3$mft = 0 | 20% | |
| $d_3$mft 1-4 | 51% | |
| $d_3$mft ≥5 | 29% | |

d=decayed primary tooth; m= primary tooth missing as a result of caries; f=filled primary tooth

**Table 2.** Reported levels of the socio-demographic, dietary habits and (reported) oral hygiene habits variables

| Characteristic (number of respondents) | n | % |
|---|---|---|
| **Socio-demographic Variables** | | |
| Educational level, father (n=137) | | |
|   Illiterate | 2 | 2 |
|   Primary school | 2 | 2 |
|   Secondary school | 34 | 25 |
|   Higher education | 99 | 72 |
| Educational level, mother (n=148) | | |
|   Illiterate | 2 | 1 |
|   Primary school | 2 | 2 |
|   Secondary school | 93 | 63 |
|   Higher education | 51 | 35 |
| Dental disease present, father (n=155) | 74 | 48 |
| Dental disease present, mother (n=155) | 90 | 58 |
| Tobacco consumption, father (n=158) | 15 | 10 |
| Tobacco consumption, mother (n=158) | 0 | 0 |
| **Dietary Habits** | | |
| Infant feeding type (n=153) | | |
|   Bottle feeding exclusively | 12 | 8 |
|   Bottle and breast feeding | 60 | 39 |
|   Breast feeding exclusively | 81 | 53 |
| Infant feeding – timing (n=154) | | |
|   At night | 123 | 80 |
|   On demand | 115 | 87 |
| Number of meals/day (n=140) | | |
|   1 | 3 | 2 |
|   2 | 39 | 28 |
|   3 | 94 | 67 |
|   4 | 3 | 2 |
|   5 | 1 | 1 |
| Consumption of pasty food (n=157) | 69 | 44 |
| Consumption of sticky food (n=154) | 72 | 47 |
| Consumption of sugar-containing food (n=157) | 146 | 93 |
| Consumption of salty food (n=154) | 64 | 42 |
| Sugar-containing last meal (n=155) | 77 | 50 |
| Soft drink consumption during meals (n=157) | 69 | 44 |
| Water with syrup during meals (n=156) | 75 | 48 |
| Between-meal snacking (n=157) | 122 | 78 |
| Sugar-containing snacks between meals (n=157) | 110 | 70 |
| Drinks between meals (n=153) | 100 | 65 |
| Sugar-containing drinks between meals (n=151) | 53 | 35 |
| **Oral hygiene habits** | | |
| Brushing frequency per day (n=156) | | |
|   <once | 1 | 1 |
|   once | 126 | 81 |
|   >once | 29 | 19 |
| Brushing occasion(s) (n=153) | | |
|   Only upon waking | 125 | 82 |
|   Only at breakfast | 1 | 1 |
|   Upon waking and at night | 20 | 13 |
|   Upon waking and after each meal | 5 | 3 |
|   After each meal | 2 | 1 |
| Dentifrice use (n=157) | | |
|   Yes | 156 | 99 |

dental disease themselves were at lower risk of having experienced caries than the children of mothers with no dental history (OR=0.38, 95%CI: 0.17-0.82). Children who took drinks with meals instead of between meals had a lower risk of caries experience (OR=0.27, 95%CI: 0.12-0.62). Multivariate analyses revealed significant associations with gender (OR=0.41 with 95%CI: 0.17-0.97 for girls), frequency of meals taken per day (OR=2.60 with 95%CI: 1.13-6.02 for >twice/day vs ≤twice/day), consumption of drinks with meals (OR=0.23 with 95%CI: 0.09-0.61) and consumption of sugar-containing drinks more than once per day (OR=3.76 with 95%CI: 1.38-1.24). However, it should be noted that it was impossible to fit the model for some variables.

Results of univariate and multivariate logistic regression analyses, with severity of caries experience as outcome variable (dmft 1-4 versus ≥5), are also shown in Table 3. Univariate analyses revealed significant associations with infant feeding practices. Children having a mix of both bottle and breast feeding presented lower disease levels (OR=0.16, 95%CI: 0.04-0.66 vs bottle feeding only) while having a sugar-containing meal in the evening was associated with increased risk (OR=2.39 with 95%CI: 1.16-4.92). Multivariate analyses were complicated by the fact that the model could not be fitted for several variables. From those included: type of infant feeding (OR=0.12, 95%CI: 0.03-0.58 for mixed feeding pattern and OR=0.17, 95%CI: 0.03-0.84 for breastfeeding only vs bottle feeding only) and sugar-content of the last meal in the evening before sleeping (OR=3.39 with 95%CI: 1.46-7.86 for sugar-containing vs no sugar-containing meal) were significant.

## Discussion

The aim of the research presented in this paper was to examine the prevalence and severity of caries experience in preschool children attending dental clinics in Kinshasa, DR of Congo, and to explore associated factors. The results show a high prevalence of caries experience in the primary dentition of 4-6 year-olds in this area (80%).

Earlier data with respect to this disease and age group, are not available for this area but the findings confirm earlier reports from other emerging countries (Olojugba and Lennon, 1987; Wyne, 2008). It is clear that oral health continues to present an important public health problem in this continent.

When looking at determinants for experiencing caries ($d_3mft=0$ vs >0), analyses indicate that caries experience is associated with gender, frequency of meals taken per day, consumption of drinks during meals and frequency of consumption of sugar-containing drinks. In this age group considered, girls were less likely to experience dental caries than boys. This confirms earlier reports where it was shown that girls present less disease when young, a situation that reverses in the permanent dentition (Declerck *et al*., 2008). Up to now, no plausible explanation has been provided for this finding.

The prevalence of caries experience was also associated with the frequency of intake of meals. In this sample about two thirds of the children took three meals per day, despite the unfavourable economic situation and limitations in food supply and availability in the

**Table 3.** Univariate and multivariate logistic regression models for prevalence ($d_3$mft=0 versus ≠0) and severity ($d_3$mft 1-4 versus ≥5) of caries experience in 4-6 year-olds from Kinshasa

| | Prevalence | | | | Severity | | | |
|---|---|---|---|---|---|---|---|---|
| | Univariate | | Multivariate | | Univariate | | Multivariate | |
| Variable | OR | 95%CI | OR | 95%CI | OR | 95%CI | OR | 95%CI |
| Gender (ref. Boys) | | | | | | | | |
| Girls | **0.43** | **0.19-0.96** | **0.41** | **0.17-0.97** | 0.85 | 0.42-1.71 | 0.93 | 0.41-2.07 |
| Educational level of father (ref. <HE) | | | | | | | | |
| Higher education (HE) | 1.48 | 0.69-3.17 | | | 0.76 | 0.37-1.57 | | |
| Education level of mother (ref. <HE | | | | | | | | |
| Higher education (HE) | 1.84 | 0.78-4.37 | | | 0.51 | 0.24-1.09 | | |
| Dental history of father (ref. No) | | | | | | | | |
| Yes | 0.53 | 0.24-1.18 | 2.0 | 0.63-6.8 | 1.34 | 0.66-2.71 | 1.32 | 0.60-2.88 |
| Dental history of mother (ref. No) | | | | | | | | |
| Yes | **0.38** | **0.17-0.82** | | | | | | |
| Tobacco use by father (ref. No) | | | | | | | | |
| Yes | 2.02 | 0.65-6.28 | 0.7 | 0.14-3.74 | 1.75 | 0.37-5.84 | | |
| Brushing frequency (ref. once/day) | | | | | | | | |
| >once/day | 0.63 | 0.26-1.50 | | | 1.49 | 0.62-3.55 | | |
| Dietary habits in first two years (ref. Bottle feeding) | | | | | | | | |
| Breast feeding | 0.80 | 0.16-4.11 | | | 0.29 | 0.07-1.25 | **0.17** | **0.03-0.84** |
| Bottle and breast feeding | 0.83 | 0.17-4.10 | | | **0.16** | **0.04-0.66** | **0.12** | **0.03-0.58** |
| Number of meals/day (ref. <3) | | | | | | | | |
| 3 or more | **2.70** | **1.26-5.80** | **2.60** | **1.13-6.02** | 0.95 | 0.45-1.99 | | |
| Sugar-containing last meal of the day | | | | | | | | |
| Yes (ref. No) | 1.09 | 0.51-2.34 | 0.33 | 0.08-1.18 | **2.39** | **1.16-4.92** | **3.39** | **1.46-7.86** |
| Between-meal snacking (ref. No) | | | | | | | | |
| Yes | 1.00 | 0.40-2.54 | 2.28 | 0.37-1.,98 | 1.11 | 0.48-2.57 | | |
| Drinks during meals (ref. No) | | | | | | | | |
| Yes | **0.27** | **0.12-0.62** | **0.23** | **0.09-0.61** | 0.39 | 0.12-1.24 | 0.35 | 0.10-1.21 |
| Drinks between meals (ref. No) | | | | | | | | |
| Yes | 0.86 | 0.39-1.91 | | | 1.58 | 0.77-3.28 | | |
| Water with syrup (ref. No) | | | | | | | 1.63 | 0.81-3.31 |
| Yes | 0.75 | 0.35-1.61 | | | | | | |
| Sugar-containing drinks (ref. No) | | | | | | | | |
| Yes | 0.89 | 0.41-1.91 | 2.6 | 0.76-1.0 | 1.51 | 0.75-3.06 | | |
| Frequency of sugar-containing drinks/day (ref. once) | | | | | | | | |
| >once | **2.47** | **1.05-5.85** | **3.76** | **1.38-1.24** | 0.75 | 0.37-1.53 | | |

OR=odds ratio; CI=confidence interval; results significant at 5% level marked in bold
It was not possible to fit the model for variables with missing data in the table

Democratic Republic of Congo. The reported frequency of meals could be explained by the fact that most of the fathers, being responsible for their families, reached a relatively high educational level in this sample and consequently are part of middle or higher strata of society allowing them to provide sufficient food for their offspring. In addition, in these social circles it is often seen that people change dietary habits moving towards more western consumption patterns. This is further supported by several of the reported habits including 93% of the children having sugar-containing meals and 70% eating these food items between meals.

An interesting finding in the univariate analysis was the inverse association between a positive history of dental disease in the mother and caries experience of the child. It could be speculated that mothers that suffered themselves from dental caries, will try to prevent this same situation for their children. A study published in Nigeria supports this hypothesis, but this explana-

tion remains to be confirmed (Adeniyi et al., 2009). It was also interesting to notice that reports of a positive dental history differed substantially between fathers and mothers (48% vs 58%). This confirms earlier work undertaken in the Democratic Republic of Congo where higher disease levels were seen in women than in men (Kalenga et al., 1985).

When factors associated with severity of caries experience were explored, a significant association was seen with infant feeding practices and sugar containing meals in the evening before sleeping. Reported habits revealed that about half of the children received a combination of breastfeeding and bottle feeding and about a third were exclusively breast fed. This trend towards combined feeding practices can be ascribed to the fact that mothers are nowadays, as a consequence of emancipation, more often employed and obliged to rely on others for the feeding of their children while at work. In addition, when a child didn't receive enough food during the day,

the mother will breastfeed the child at night (80%) and on demand (87%). It is not unusual, according to African tradition, for a child to fall asleep with the nipple of their mother's breast in his mouth. The fact that a child received breastfeeding, exclusively or in combination with bottle feeding, seems to lower the risk for caries development. The protective properties of breast milk are still debated (WHO, 2003) and findings are contradictory (Mohebi *et al*., 2008).

Also with respect to disease severity, sugar-containing food intake in the evening before sleeping seems to be an important factor (Olojugba and Lennon, 1990; Rugg-Gunn, 1990). It can be hypothesised that the impact of sugar-containing items in the oral cavity is higher during the night when the output of the salivary glands is greatly reduced and thus less buffering is provided (Adeniyi *et al*., 2009; Campus *et al*., 2009; Levine, 2001; WHO, 2003). Since brushing and possible exposure to fluoride (provided the toothpaste contains fluoride) was in most cases limited to the morning (82%), fluoride levels will be lowest and plaque accumulation greatest during the night, further promoting caries activity.

The importance of dietary habits is underlined by the fact that, both regarding prevalence and severity of caries experience, sugar-containing food intake in the evening before sleeping was found to be significant.

Somewhat surprising was the observation that reported oral hygiene habits seemed not to impact on prevalence nor on severity of caries experience in preschool children. Brushing frequency was limited to once a day in most children and the timing of tooth brushing was mostly in the morning upon waking. It has been shown earlier that these habits should be regarded as risk behaviour and can be associated with the prevalence of caries in children (Ferreira *et al*., 2007; Peres *et al*., 2005). Preventive interventions focusing on these behaviours have been shown to have a marked impact on disease prevalence (Stecksén-Blicks *et al*., 2008). In this study, most children were reported to use toothpaste though it was not known whether the paste contained fluoride. Some products claiming fluoride content on the package, were tested and found to be fluoride-free (own results). Similar findings have been reported in a recent paper by Benzian *et al.* (2012). In addition, it should be mentioned that fluoride levels in drinking water (natural water sources, tap water and bottled water) are extremely low in the Kinshasa area.

In many reports socio-demographic variables have been shown to be important discriminators of oral health inequalities (Christensen *et al*., 2010). This is not remarkable since dental caries is a multi-factored disease related to lifestyle. In our findings, socioeconomic status seems not to play an important role. A possible explanation could be that educational level is a poor proxy for socioeconomic status in the sample. In addition, it should be mentioned that a clear analysis of this factor was hampered by the rather homogenous middle status composition of the sample studied.

The reported educational levels attained by the sample's parents were higher than normal for the Democratic Republic of Congo where reported literacy levels are 77% for men and 57% for women over the age of 15 (2010 estimates, Central Intelligence Agency, 2013). In this survey an important difference in reported highest educational level attained was seen between fathers and mothers. This difference in level reflects the socio-cultural context in the Democratic Republic of Congo where parents do not encourage daughters to engage in advanced studies, but rather reserve this privilege for their sons, again because of limited financial resources.

Further, no association was seen between reported tobacco consumption of the parents and the oral health condition of their child, a factor that was described by several authors in recent reports (Leroy *et al*., 2008). About 10% of fathers were reported to be smokers but none of the mothers. This clear difference can easily be explained by the socio-cultural situation in the Congolese society where smoking is tolerated in men but considered as delinquent and frivolous behaviour for women. This study demonstrates the fact that in developing countries, where life styles differ from those in westernised countries, dietary habits seem to impact considerably on oral health.

This study presents several shortcomings that need to be considered. The sample on which the analyses were based, was a convenience sample of children attending selected dental clinics in the Kinshasa area. This may have introduced some selection bias. However, in this society, it is difficult to reach children of this age in other ways. The educational level of the sample's parents was higher than that of the national population. The sample size was rather limited and a larger sample would allow further refinement of the analyses. In addition, the prevalence of the disease under investigation and exposure to associated factors was widespread in the sample, hampering more detailed analysis and interpretation. No attempt was made to assess the presence of plaque, reflecting brushing efficiency, as a variable in the analyses principally because of insufficient agreement between the examiners involved. It is also possible that limitation in carers' recall and motives of social desirability could have distorted responses to the questionnaire (Persson *et al*., 1984). Bias introduced in this way would have attenuated the effect of the variables considered rather than reinforce them. Finally, the poor fit of the multivariate model dealing with severity of caries experience compromises its interpretation.

## Conclusions

Although the prevalence of caries experience recorded in this survey cannot be considered representative for the whole population of 4-6 year-olds in Kinshasa, the present analyses illustrate that reported dietary habits (especially frequency, timing and sugar content of meals) are significantly associated with prevalence and severity of caries experience in preschool children attending dental clinics in Kinshasa. This was not the case for reported oral hygiene habits and the included socio-demographic factors. Further research with a larger sample, representative of the population, would be useful to confirm these findings and further explore associated factors.

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