Prevalence of dental caries and tooth brushing habits among preschool children in Khartoum State, Sudan

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Supervisor

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Abstract

Introduction

Dental caries in preschool children remains a major dental public health problem as it affects significant number of preschool children in both developed and developing countries and it is on increase in the developing ones as in Sudan due to the change in life style with the absence of oral health preventive programs and inadequate access to oral health care.

Aim

The aim of this study was to determine the prevalence of dental caries and tooth brushing habits among 3 to 5 year-olds preschool children in Khartoum state.

Materials and Methods

This was a cross sectional descriptive study among 553 preschool children age 3 to 5 year-olds in Khartoum state. Data were obtained through clinical examination using a modified WHO examination sheet and through interviews for mothers/guardians using a structured administered questionnaire.

Results

Five hundred and fifty three preschool children aged 3- 5 year-olds participated in this study with their mothers or guardians (n=553). Girls (n= 287) slightly outnumbered boys (n= 266). The prevalence of dental caries of the children was 52.4% with mean dmft of 2.27. There was an increase in the dmft scores with increasing age. The highest brushing frequency was found among the children whose mothers had a post-graduate degree and the lowest proportion was from uneducated mothers. Eating sugar-containing food was significantly associated with dmft.

Conclusions

The prevalence of dental caries was found to be high among 3 to 5 year old preschool children in Khartoum State and the mean dmft was directly proportional to the age. This was mostly associated with sugar consumption and lack of dental treatment. Preventive efforts related to dietary control and especially sugar intake.

Declaration

I, the undersigned, hereby declare that the work contained in this dissertation is my original work and that it has not been previously in its entirety or in part submitted at any university for a degree.

…… ……

Dr. Sitana Mustafa Idris

Dedication

I would like to dedicate this work to:

My beloved parents, who supported me throughout my life and always being there for me. Your prayers for me were what sustained me thus far

My brothers and sisters, for their constant support, help and love

My husband, who assisted, supported and encouraged me each step of the way.

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CHAPTER 1: INTRODUCTION

Background

The Republic of Sudan is located in northern Africa; it is bordered by 7 countries and the Red Sea, with an area of (1,882,000 km^2). It was the largest country in Africa before the separation of South Sudan in 2011. It consists of 15 administrative states. It is dominated by the River Nile and its tributaries.

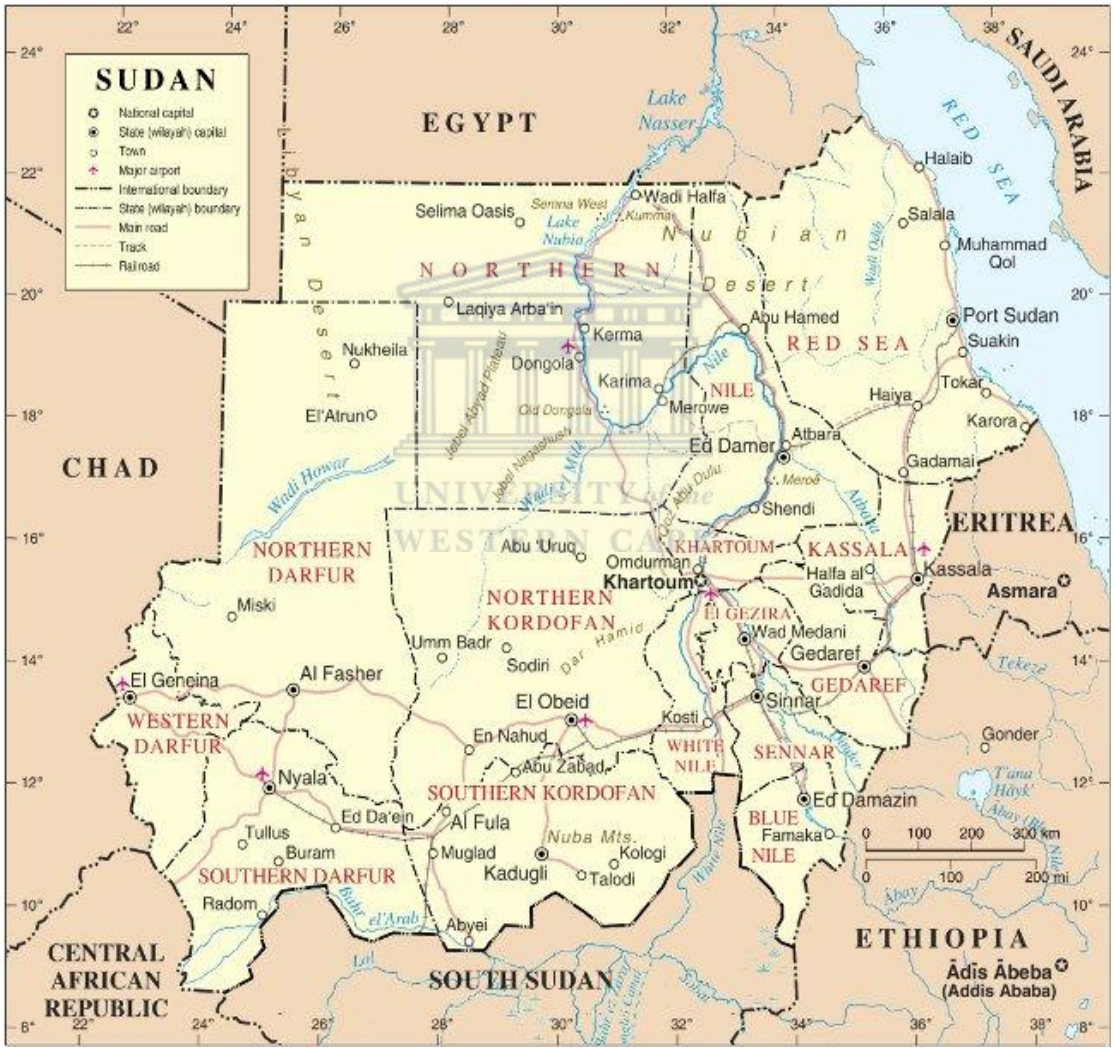


Figure 1: Sudan map

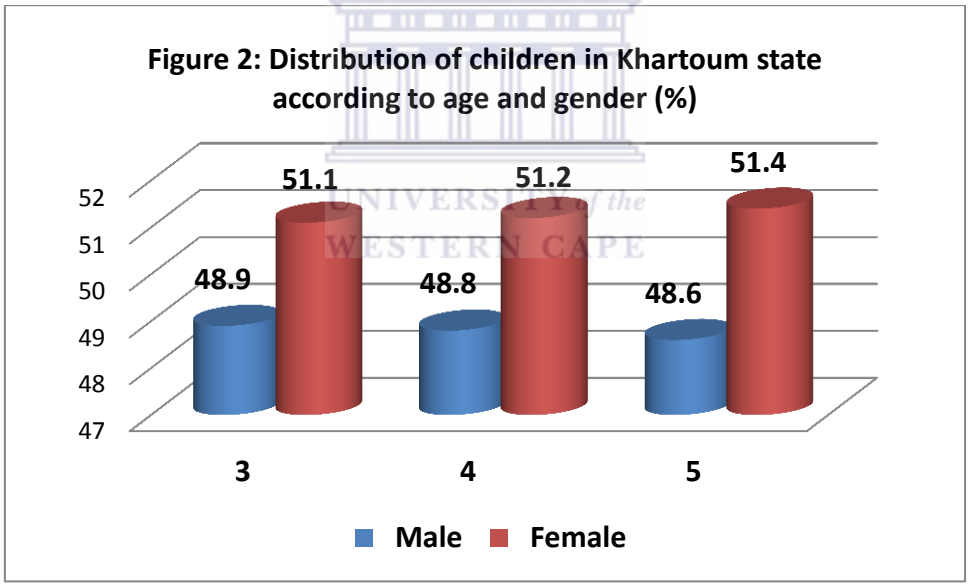
Khartoum is the capital of Sudan and it covers an area of 20,000 square miles and it is surrounded by seven states: River Nile, Kassala, Gedaref, Gezira, White Nile, North Kordofan and Northern state. It is divided into three big cities: Khartoum, Omdurman and Khartoum North and administratively it is divided into seven localities which are:

Khartoum, Jabal Awlya, ShargAlneel, Khartoum North, Omdurman, Ombada and Kararry. It is located in the heart of Sudan at the confluence of the White and Blue Niles where both rivers form the River Nile.

Khartoum State is bordered to the north and the east side on the River Nile State, to north western on the Northern State, and to the east and south-eastern on States of Kassala, Gedaref and Gezira.

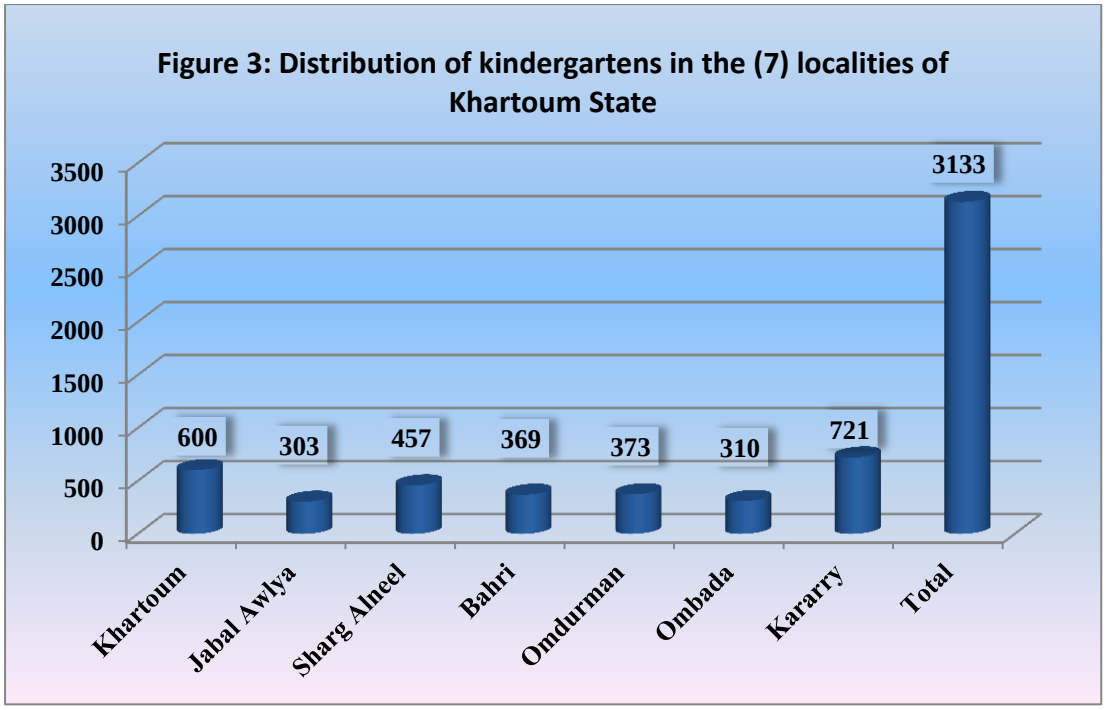
The total population of Sudan in 2012 was 37 195000 and Khartoum State is the most densely populated State (5 858 300), and it constitutes about 15.8% of the population of Sudan.

The distribution of the population aged between 3 to 5 years in Khartoum state according to age group and gender is shown in Figure 2.



Distribution of kindergartens in the (7) localities of Khartoum State

According to information of the Ministry of Education for the year 2012 there were 3133 kindergarten schools distributed in the localities of Khartoum state. The majority of them were located in Kararry and Khartoum localities (Figure 3).



Problem statement

This study was conducted for several reasons:

- Dental caries in preschool age children is a dental public health problem.
- Children with dental caries in their primary teeth are more likely to develop caries in their permanent teeth.
- Treatment of dental caries is expensive.
- There is a paucity of information and no published research on oral health status of the children in Sudan in general and Khartoum State in particular.
- There are no oral health preventive programmes in Khartoum state targeting this age group.

CHAPTER 2: LITERATURE REVIEW

2.1 Definition of terms

Dental caries is defined as "a *progressive, irreversible, microbial disease affecting the hard parts of the tooth exposed to the oral environment, resulting in demineralization of the inorganic constituents and dissolution of the organic constituents, thereby leading to a cavity formation"* (Peter, 2006).

Early childhood caries

Nursing-bottle caries, nursing-bottle mouth, nursing bottle syndrome, night-bottle syndrome, bottle mouth, baby bottle caries, milk bottle syndrome, nursing mouth and rampant caries (Tinanoff, Kaste and Corbin, 1998; Milnes, 1996; Dilley, Dilley and Machen, 1980; Fass, 1962) are different terms used to describe a unique pattern of dental caries in young children (TYAGI, 2008). Early childhood caries is the most contemporary term describing rampant dental caries in infant and toddlers (Tinanoff and O'Sullivan, 1997), and is the most commonly used term today, and is recommended by the Centers for Disease Control and Prevention (CDC) (Peretz and Eidelman, 2003; Kaste and Gift, 1995). Early childhood caries is defined by the American Academy of Paediatric Dentistry (AAPD) (2003a) as "the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child 71 months of age or younger".

Severe Early Childhood Caries (S-ECC)

Severe early childhood caries refers to a more progressive and acute pattern of childhood caries, and the term was developed to identify the children with the highest level of disease in each population (Drury *et al*. 1999). Children with severe early childhood caries (S-ECC) are those who are more likely to present with pain, chewing difficulties, speech problems, general health disorders and psychological problems (Ramos-Gomez *et al*. 2002; Ismail, 1998).

2.2 ECC- A public health problem

Dental caries in preschool children remains a major oral health problem because it affects significant numbers of preschool populations in both developed and developing countries (Vadiakas, 2008). It occurs five times as frequently as asthma and seven times more commonly than hay fever (DHHS, 2000).

Caries in general and ECC in particular represents a serious public health problem (Begzati, Birisha and Meqa, 2010) because it affects normal growth and development as well as social adaptation of young children (Vadiakas, 2008).

More than 51 million school hours are lost each year due to dental-related illness. Poor children suffer nearly 12 times more than rich children (Manson, 2005).

Treatment of ECC is expensive - in 1996 the estimated cost to treat a child with 2-5 carious lesions was U$408 and U$1725 for those with 16-20 carious lesions (Ramos-Gomez *et al*, 1996).

2.3 Measuring dental caries

Dental caries is measured by many indices, and the most universally used index is the DMF index which can be applied for the teeth or tooth surfaces and it is a record of number of decayed, missing and filled teeth (DMFT) or surfaces (DMFS) for permanent dentition (Klein and Palmer, 1937). For primary dentition it is often difficult to distinguish between extracted teeth due to caries and loss due to normal exfoliation, so other indices such as def (decayed, indicated for extraction, and filled) and df (decayed, filled) can be used (Burt and Eklund, 1992). The DMF index is widely used and it provides a reasonably accurate account of changes in the prevalence of dental caries.

According to the classification of the World Health Organization there are five categories of the mean DMFT: very low level of dental caries (DMFT 0.0-1.1), low (1.2-2.6), moderate (2.7-4.4), high (4.5-6-5) and very high (>6.6) (Whelton and O'Mullane, 2002).

2.4 Stages of ECC

The development of ECC occurs in 3 stages. The first stage or initial stage is characterized by the primary infection of the oral cavity with mutans streptococci, the second stage is characterized by the accumulation of these microorganisms to pathogenic levels due to prolonged exposure to cariogenic substrate, and the third stage is characterized by a rapid demineralization and cavitation of the enamel resulting in rampant dental caries (Berkowitz, 2003; Berkowitz, 1996).

2.5 Epidemiology of ECC

ECC is a public health problem that affects children worldwide. The prevalence of ECC varies from one country to another depending on the different diagnostic criteria used (Begzati *et al*. 2010; Kiwanuka, Åstrøm and Trovik, 2004).

An epidemiological study showed that there was decline in the prevalence of dental caries in children and adolescents in the developed countries over the last 20 years, while in developing countries the prevalence was on increase (Whelton and O'Mullane, 2002). Milnes (1996) in his global review of dental caries in primary teeth suggested that the highest prevalence was found in Africa and South-East Asia.

In the United States, the Centers for Disease Control and Prevention reported that the prevalence of dental caries among 2-5 years was 24.2% in the National Health and Nutrition Examination Survey (NHANES) carried between 1988 and 1994, and a prevalence of 27.9% was reported in the NHANES between 1999 and 2004 (Dye *et al*. 2007; Beltran-Aguilar *et al*. 2005). Among Mexican-American children age 2-11 years, the prevalence of dental caries was high during 1999 and 2004 (55.4%) when compared with black children (43.4%) and non-Hispanic white children (38.6%) (Dye *et al*. 2007). A study in Brazil reported an ECC prevalence of 4.9% among 3-5 years preschool children with dmft score of 1.24 (Traebert *et al*. 2009).

A cross-sectional study in Australia in preschool children aged 4-5 years old reported a mean dmft of 1.4 (Hallett and O'Rourke, 2006). In the western countries the prevalence was 19.9% among 3 year-olds (Skeie *et al*. 2005). In Lithuania, the prevalence of ECC among 3 year-old children was 50.6% with a mean dmft of 2.1, and in the same age group the prevalence of S-ECC was 6.5% with mean dmft of 7.8 (Slabšinskienė *et al*. 2010).

A prevalence of 86.31% with mean dmft of 5.8 was found among 1-6 year-olds children in Kosovo, and among the group with ECC the prevalence was 17.36% with a mean dmft of 11 with an age- related increase in the dmft (Begzati *et al*. 2010). In a study conducted in Germany among 5-7 years the average dmft score was 1.88 with 55% of children caries free (Pieper *et al*. 2012). A survey in Japan (2007) showed prevalence of 25.9% among 3 year-old children.

In developing countries the prevalence of ECC for disadvantaged groups was found to be as high as 85% (Thitasomakul *et al*. 2006; Carino, Shinada and Kawaguchi, 2003). Raadal *et al*. (1993) reported that at age 4-5 years in Khartoum, Sudan the prevalence of dental caries was 5.5% with a mean dmft of 1.68, and 58% of children were caries free. Ten years later, another study among 3-5 years reported an increased prevalence of 65.5% with mean dmft of 3.53, with increasing prevalence with increasing age (Awooda *et al*. 2013).

The caries prevalence among Nigerian children age 6-71 months was 10.5% (Sowole, Sote and Folayan, 2007). In Uganda, the caries experience among 3, 4 and 5 year-olds were 45%, 59% and 65% with a mean dmft of 1.7, 2.4 and 3.1 respectively. The decayed component was the major component of the dmft score, and the caries experience was similar among males and females (Kiwanuka, Åstrøm and Trovik, 2004). Among groups of Tanzanian and Finnish 3-7 year-olds children the mean dmft was 2.7 and 1.3 respectively with no differences between boys and girls in either group (Kerosuo and Honkala, 1991).

National surveillance in South Africa that examined trends of dental caries in the primary dentition among 2-5 year-olds from 1981 to 1997 found that there was a reduction in caries prevalence throughout the 17-year study (Cleaton-Jones, Williams and Fatti, 2000). However, two studies conducted in Western and Southern Cape of South Africa found high prevalence of 77% and 82% among 4-5 year-olds respectively (Jacobs, 2006; Van Wyk *et al*. 2004).

A national survey of the oral health of 5-year-old children in the United Arab Emirates (2010) found a mean dmft index of 5.1 and only 17% of the children were caries-free (El-Nadeef, Hassab and Al-Hosani, 2010). Research data from Riyadh, Saudi Arabia reported that the mean dmft among 4-6 year-old preschool

children was 6.9 (Wyne *et al*. 1995) and in Syria the prevalence of ECC among 3-5 years was 48% (Qadri *et al*. 2012).

Tyagi (2008) conducted a study in India in Davangere preschool children age 2-6 year-olds and found a prevalence of dental caries to be 19.2% with mean dfs of 7.7. Another study in India in Ludhiana city found much higher levels in 3-6 year-old children of 52.87%, 45.1% and 58.55% for the age groups of 3-3.11, 4-4.11 and 5-5.11 years respectively (Simratvir *et al*. 2009). The highest ECC prevalence was reported by Sankeshwari *et al*. (2012) among 3-5 year-olds children in Belgaum City as 63.17%.

In Hong Kong, Lo, Loo and Lee (2009) the mean dmft score of 3-5 year-olds children was 1.5 and it increased with age, from 1.2 at age 3 to 2.0 at age 5, and the proportion of children with caries experience was 31% for 3 year olds and 42% for 5 year olds. Data from Pakistan showed a prevalence of 40.5% in 3-5 year-olds children (33.3% in 3 year-olds, 47.6% in 4 year-olds and 75% in 5 year-olds), the mean dmft 1.85 (1.55 in 3 year olds, 2.09 in 4 years and 4.66 in 5 years) which was mainly due to untreated carious lesions and 59.5% were caries free (Sufia *et al*. 2011). In Thailand children aged 36-47 months had a prevalence of dental caries of 82% with a mean dmft of 5.5 (Senesoombath *et al*. 2010).

2.6 Aetiology and risk factors

Dental caries is a multi-factorial disease that occurs due to the interaction between pathogenic microorganisms, fermentable carbohydrates, susceptible tooth and host over a period of time (Tyagi, 2008; Harris *et al*. 2004; Lee *et al*. 1994). In addition other predisposing factors include biological and demographic factors such as age, oral hygiene, socioeconomic, cultural characteristics and low parental education (Johnston and Messer, 1994).

Pathogenic Microorganisms

Mutans streptococci (MS) are the most common type of microorganisms associated with dental caries due to its increased ability to adhere to the tooth surfaces, copious production of acid, and survival and maintenance of its metabolism at low pH conditions (Loesche, 1969).

Colonization of a child's oral cavity with MS is the result of transmission of these microorganisms from the child's primary caregiver usually the mothers (Zafar, Harnekar and Siddiqi, 2009; Douglass, Li and Tinanoff, 2008; Seow, 1998; Li and Caufield, 1995) during nurturing habits such as cleaning a pacifier by putting it in the mother's mouth before giving it to the child, kissing the child directly on the mouth and pre-tasting food before giving it to the child (Aaltonen and Tenovuo, 1994; Aaltonen, 1991). Preschool children with high colonization levels of MS have been shown to have greater caries prevalence. Several studies have shown that the earlier MS is detected in the child's mouth, the higher the caries experience (Alaluusua and Renkonen, 1983).

Nutrition/ sugar consumption and dental caries

Diet and nutrition can affect the teeth in two ways: by altering the structure of teeth, causing dental caries and by dental erosion in which both primary and permanent teeth can be affected (Rugg-Gunn, 2002). Under-nutrition and deficiencies of specific nutrients are associated with enamel hypoplasia which increases susceptibility to dental caries (Moynihan, 2005; Harris *et al*. 2004; Moynihan, 2003). It can also result in salivary gland atrophy, reduced salivary flow rate and consequently buffering capacity which will increase susceptibility to dental caries (Moynihan, 2003).There is much evidence from a variety of studies showing that the most important factor for the development of dental caries is sugar (Moynihan, 2005).

Sucrose, glucose, fructose, and maltose are all cariogenic sugars (Moynihan, 2003), while lactose is the least cariogenic. Sucrose is the most cariogenic in the group of carbohydrates, not only because its metabolism produces acid but also because MS utilize this sugar to produce the extracellular polysaccharide glucan polymers that enables MS to adhere firmly to teeth and inhibit the diffusion property of plaque (Tinanoff and Palmer, 2003; Tanzer, 1992).The frequency of intake of sugars, sugar rich foods and drinks, and the total amount of sugar consumed influence the pathogenesis of dental caries (Moynihan, 2003).

Most dietary factors found to be significant are related to the consumption of sugar amount, frequency and time of consumption (Harris *et al.* 2004). Most children with caries consumed sugars between meals (89.5%) (Cvetkovi, Vulovi and Ivanovi, 2006).

Begzati, Birisha and Meqa (2010) found that the frequency of sweets consumption in 93% of children was 1-3 or more times per day and this frequency was statistically correlated with ECC. However, the intake of sugar less than 4 times a day with meals was shown to have little effect on the development of dental caries (Gustafsson *et al.* 1954).

Studies on preschool children from the age of 1 to 5 years found that the daily consumption of sugar containing drinks especially during the night, and daily sugar intake were independent risk factors for the development of ECC (Karjalainen *et al*. 2001; Rodrigues and Sheiham, 2000).

Due to the presence of a positive association between the free sugars consumption (all monosaccharide's and disaccharides added to foods by the manufacturer, cook or consumer, and those naturally present in honey, fruit juices, fruit concentrates and syrups) and dental caries the WHO (2014) recommended that ''the amount of intake of free sugars should be reduced throughout life and for both adult and children the intake of free sugars should not exceed 10% of total energy.

Host/ tooth factor

Host risk factors for the development of dental caries are: reduced salivary flow, immunological factors, enamel defects (hypoplasia), tooth morphology and genetic characteristics of the tooth (size, surface and depth of fissures) and crowded or malaligned teeth (Schafer and Adair, 2000; Seow, 1998). Tooth morphology and enamel structure are important factors for caries occurrence because food debris and microorganisms accumulate and adhere to the tooth surface accelerating the carious process (Peretz and Eidelman, 2003).

Lack of enamel maturation or the presence of developmental structural defects in the enamel may increase the risk of dental caries in preschool children (Tinanoff and Reisine, 2009). The prevalence of enamel defects are common in the primary dentition ranging from 13-39% in normal full term infants (Seow, 1991). A strong correlation has been reported between the presence of enamel hypoplasia and high counts of MS (Li *et al*. 1994).

Saliva is an important local predisposing factor for caries occurrence – a chronic decrease or cessation of salivary flow is often followed by high caries prevalence (Cvetkovi, Vulovi and Ivanovi, 2006). It is a major factor in the development or inhibition of dental caries (Peretz and Eidelman, 2003). In addition saliva acts as a 'defence' system for the tooth against caries; it removes food and debris, provides a buffering action against the acids produced by cariogenic microorganisms and functions as a mineral reservoir for calcium and phosphate essential for remineralisation process (Zafar *et al*. 2009).

Time factor

The time factor determined the other three factors (tooth, microorganism and fermentable carbohydrates). The longer the teeth are exposed to fermentable carbohydrates, the more acid will be produced leading to enamel demineralization (Peretz and Eidelman, 2003).

Feeding habits and ECC

Breastfeeding

The relationship between breastfeeding and dental caries is unclear and it is confounded by many biological variables, such as mutans streptococci, enamel hypoplasia, intake of sugars, as well as social variables such as parental education and socioeconomic status, all of which may affect oral health (Seow, 1998). ECC or rampant tooth decay is only associated with breastfeeding when it is prolonged and on demand (Rugg-Gunn, 2002; Curzon and Drummond, 1987).

Depending on the weaning time, twenty five percent of children with S-ECC were fed longer than one year in comparison with 2.5% of caries-free children (Dilley, Dilley and Machen, 1980). Some epidemiological studies have suggested that the high frequency of breastfeeding at the age of 1 year increased the risk of S-ECC (Feldens *et al.* 2010; van *et al.* 2006; Sayegh *et al.* 2002). In contrast Sankeshwari *et al*. (2012) found a noticeable decrease in the prevalence of ECC in children who were breastfed up to two years, while the prevalence was increased in children who breastfed for approximately 2 years.

Mothers should be educated to stop the night breastfeeding after one year of age and shift to use of cup at 10 months of age, and start cleaning the child's mouth and teeth regularly once the first primary tooth has erupted (Bourne, 2007). Furthermore, the American Dental Association (2009) recommended weaning from the breast soon after the child's first birthday. Breastfeeding was recommended up to 2 years of age, with the introduction of appropriate solid food after the age of 6 months to complement the nutrients supplied by breast milk (WHO, 2003; WHO, 1998).

Bottle feeding

Bottle feeding, especially nocturnal feeding is a risk factor for ECC since most contain some form of sugar (Azevedo *et al*. 2005; Twetman, Garcia-Godoy and Goepferd, 2000; Picton and Wiltshear, 1970). In developed countries the primary risk factor for ECC considered to be the use of a "nap time" bottle that contains a fermentable carbohydrates such as milk, milk with sugar, sweetened milk with formula, fruit juice or other sweetened solutions (Ribeiro and Ribeiro, 2004). However, under normal conditions milk is not cariogenic and may provide some protection against caries and it is the added sweeteners to the bottle and use of pacifiers dipped in sweetened liquids that leads to the development of ECC (Holt *et al.* 1982).

Bottle feeding all day and night, duration of feeding and sweetened contents are significant risk factors for ECC (Hallet and O'Rourke, 2003; Karjalainen *et al.* 2001; Milgrom *et al*. 2000). Among Syrian children age 3-5 year-olds diagnosed with ECC, bottle feeding occurred in 63%, and breast feeding in 37% (Qadri, Nourallah and Splieth, 2012).

In Lithuania, among 3 year-old children 95% who had S-ECC were sleeping with a bottle containing carbohydrates during the day and night (Slabšinskienė *et al*. 2010). This has been shown to be the most significant risk factor of S-ECC together with a high frequency of sugar intake (Johnsen and Nowjack-Raymer, 1989; Dilley *et al*. 1980). The reduction of the infant salivary flow rate during sleep decreases the oral clearance and increases the contact time of plaque and substrates making the teeth more susceptible to caries (Schafer and Adair, 2000; Seow, 1998; Firestone, 1982).

Parent's education

The level of mother's education has been found to be an important indicator for the development of dental caries in their children. Low mothers' educational levels were associated with severe dental caries in preschool children (Traebert *et al*. 2009).

Dini *et al*. (2000) and Al-Hosani and Rugg-Gunn (1998) showed that the level of parent's education was correlated with the occurrence and severity of ECC, in which low prevalence of dental caries and low mean dmft scores were associated with higher levels of parental education. In another study carried by Subramaniam and Prashanth (2012) thirty eight percent of the children whose mothers were uneducated had high caries prevalence (37.9%) compared to the children whose mothers had higher education.

A higher prevalence of ECC and higher sugar consumption rate was found among Ugandan children who had mothers with lower level of education (Kiwanuka *et al*. 2004). A recent study carried out in Sudan showed that there was no significant effect of the mother's education on the prevalence of dental caries: 65% of children whose mothers were uneducated had caries while the prevalence of dental caries was 64.6% in those who had educated mothers (Awooda *et al*. 2013). Sufia *et al*. (2009) showed that the higher the level of maternal education the better the dental health practices of their children. These practices are tooth brushing at correct the time using a tooth brush and toothpaste and sugar consumption control.

Mother's age

In a study carried out in Pakistan to investigate the influence of mother's age, education, occupation and income on the dental health behaviour and caries experience of the preschool children found that there was no association between mother's age and caries experience of the child (Sufia *et al*. 2009). However, children with younger mothers experienced more dental caries than those with older mothers, probably due to the fact that younger mothers paid less attention to the dental health of children (Matilla *et al*. 2000; Paunio *et al*. 1993).

In contrast, Sufia and co-workers (2009) reported that a higher percentage of younger mothers cleaned their children's teeth after meals using tooth brushes and toothpaste and had taken their children to the dentist.

2.7 Risk assessment

The goal of caries-risk assessment in young children is to prevent caries initiation before the first signs of disease (Tinanoff, Kanellis and Vargas, 2002). ‘‘Caries risk assessment is the determination of the incidence of caries during a certain time period’’ (AAPD, 2005). The American Academy of Paediatric Dentistry in (2003b) identified several groups at risk for ECC: (1) children with special healthcare needs, (2) from low socioeconomic and ethno-cultural groups, (3) with suboptimal exposure to topical or systemic fluoride, (4) with poor dietary and feeding habits, (5) whose caregivers and/or siblings have caries, (6) and those with visible caries, white spots, plaque, or decay.

Risk assessment strategies that are most applicable for use in clinical practice, can be easily performed, are inexpensive, require no special equipment or supplies, and provide reliable results. Indicators of caries risk that meet these criteria includes: previous caries experience, presence of white spot lesions or enamel defects, visible plaque, perceived risk by dental professionals, screening tests for mutans streptococci and socioeconomic level of family (Tinanoff *et al*. 2002).

Previous caries experience

One of the best predictors of future caries is previous caries experience (Birkeland *et al.* 1997). Children under the age of 5 years with a history of dental caries should be classified as being at high risk for future decay (Tinanoff and Reisine, 2009).

White spot lesions

White spot lesions are the precursors to cavitated lesions. There are only a few studies that have examined the staining of pits and fissures (Steiner *et al*. 1992), and hypoplastic lesions as caries- risk variables (Li *et al*. 1996).

Visible plaque

The presence of visible plaque on primary teeth can be used as indicator of caries risk. Several studies have shown that there is a correlation between visible plaque on primary teeth and caries risk (Alaluusua and Malmivirta, 1994; Roeters *et al*. 1995).

Perceived risk by dental professional

Dentists without using specific criteria are reasonably able to predict caries risk in children without time or money consuming methods (Alanen *et al*. 1994).

Microbiological testing

The quantity of MS in a child's oral cavity is a risk indicator for dental caries. The count of salivary MS can be determine by simple microbiological testing in the dental clinic and have been reported to have a good specificity (ability to correctly identify those who will not get the disease) but less sensitivity (ability to correctly identify those who will get the disease) (Edelstein and Tinanoff, 1989). In general children who are highly infected with MS have higher caries prevalence and higher caries rate than children with low MS levels (Litt *et al*. 1995).

Socioeconomic status

Socioeconomic status can influence health literacy which in turn can affect general health (Zafar *et al*. 2009).

There is strong evidence to support the association between socioeconomic status and dental caries prevalence. Preschool children from low income families with lower levels of maternal education, especially of illiterate mothers are more likely to have caries (Ann *et al*. 2011; Hashim *et al.* 2009; Maciel *et al*. 2001; Vargas *et al*. 1998; Beck, 1998).

Social status has an indirect influence on caries risk due to its association with certain behaviors such as inappropriate bottle feeding habits, poor oral hygiene (lack of tooth brushing) and high sugar consumption (Litt *et al*. 1995). Eckersley and Blinkhorn (2001) in Northwest England found that children from low income families had visited the dentist less frequently, at an older age and only when there was a dental problem.

2.8 Consequences of ECC

Dental caries in preschool children remain a major problem because it affects high numbers preschool children in both developed and developing countries (Vadiakas, 2008). It occurs five times more frequently than asthma and seven times more commonly than hay fever (DHHS, 2000).

There is strong evidence that untreated dental disease is an important aetiological factor in the pathogenesis of infective endocarditis, which is a condition that carries high mortality rate (Child, 1996). Caries in general and ECC in particular represent a serious public health problem (Begzati, Birisha and Meqa, 2010). It affects normal growth, development and social adaptation of young children (Vadiakas, 2008). It's infectious, and results in impairment of nutrition and esthetics with accompanying psychological problems (Wyne *et al*. 1995).

More than 51 million school hours are lost each year to dental-related illness; poor children suffer nearly 12 times more than rich ones (Manson, 2005).

ECC has been related to failure to thrive, decreased capability to study, increased risk of caries development in the permanent dentition and an increase in the possibility of enamel defects on the successors of carious primary teeth (Broadbent *et al*. 2005; Acs *et al*. 1999; Gray *et al*. 1991).

Rapid progression of dental caries usually causes complications such as pulpitis and apical periodontitis leading to excessive dental treatment such as: pulp therapy and extractions that makes treatment more difficult (Vinckier *et al*. 2001). Moreover, early extraction of primary teeth may predispose to malocclusion in the permanent dentition (Greenwell *et al*. 1990). ECC was shown to adversely affect the child's development, especially body weight and height (Ayhan, Suskan and Yildirim, 1997). Severe forms of ECC may require treatment under general anaesthesia, and the treatment cost is high (Peressini *et al*. 2004).

2.9 Treatment of ECC

Most researchers agree that the best approach to the "treatment" of ECC is prevention, since treatment of ECC is expensive and mainly carried out under general anaesthesia or sedation and this is risky for children (Peretz and Eidelman, 2003). Treatment of ECC includes different types of interventions depending on the progression of the disease, the age of the child, and the social, behavioural and medical history of the child (Zafar *et al.* 2009).

2.10 Prevention of ECC

Dental Health education

Educational programmes have been used to decrease dental caries in children (Gallagher and Rowe, 2001; Gomes, Fonseca and Rodriques, 2001). There are three key messages currently used in dental health education: reduce the frequency of sugar intake, brush teeth regularly with a fluoridated toothpaste and visited a dentist regularly (Health Education Authority, 1989). People should be motivated to use fluoridated toothpaste with correct method of tooth brushing for effective removal of dental plaque (Ramya *et al.* 2011).

Oral health education preventive programmes for preschool children often involve education of the parent or carer. These educational messages attempt to persuade parents/carers not to put children to bed with a bottle, to reduce the child's high frequency consumption of sugars, and to brush children's teeth daily.

Burt and Eklund. (1999) have suggested that while educational programmes may improve knowledge, they only have a temporary effect on plaque levels and no marked effect on caries experience. Despite these limitations, oral health education undoubtedly remains an important component of preventive dental programmes (Tinanoff *et al.* 2002).

Dental visit

The first visit to dentist should occur before the eruption of the first tooth, so that parents can be taught how to clean their infant's teeth. During the first dental visit, a risk assessment is necessary to counsel the parent on how to prevent dental caries (Zafar *et al*. 2009).

In a study carried in Thailand, 88% of children had never visited a dentist and for those who visited dentist the main reason was pain (Senesombath *et al*. 2010). Lo, Loo and Lee. (2009) in Hong Kong found that only 26% of children had visited a dentist and in the United States, Kopycka- Kedzierawski and Billings (2011) found that about thirty percent of children had never had a dental check-up.

Fluoride and dental caries

The action of fluoride is in the process of remineralisation and inhibition of demineralisation of enamel (Featherstone, 2000). Topical application of fluoride is most effective in the prevention of ECC (Sanchez and Childers, 2000).

Community water fluoridation

The effectiveness of water fluoridation in reduction of dental caries is 50-70% in children (CDC, 1999). The optimum concentration of fluoride is in the range of 0.7 mg/L-1.2 mg/L (CDC, 2001). Water fluoridation has been shown to be one of the most cost-effective means of reducing tooth decay in children (Klein *et al*. 1985). In studies examining the before and after measurements of caries, starting or continuing fluoridation decreased dental caries experience among children aged 4 to 17 years by a median of 29.1% during 3 to 12 years of follow-up (Kumar and Moss, 2008).

Fluoride varnish

The application of fluoride varnish every 6 months is effective in preventing dental caries in both primary and permanent teeth of children and adolescents (ADA, 2006) and it reduces dental caries by a third (Marinho *et al*. 2002). The varnishes must be applied by a professional to maintain their cariostatic effect.

Salt fluoridation reduces the prevalence of dental caries to be about 50% (Estupinan *et al*. 2001).

Fluoride tablets

Fluoride tablets provide both systemic and topical effects and it reduces the new carious lesions for up to 30% (Allukian and Horowitz, 2003; Stephen, 1993).

Fluoridated toothpaste

Proper oral hygiene and use of fluoridated toothpaste are the most important factors in the prevention of dental caries (Slabsinskiene *et al*. 2010). To prevent ECC in preschool children by home-care approaches, brushing with a small amount of fluoridated toothpaste is effective when it starts soon after tooth eruption (Pine *et al.* 2000).

The efficacy of fluoridated toothpastes in the prevention of dental caries in children and adolescents has been reported (Marinho *et al*. 2003; Mohan *et al*. 1998). Fluoridated toothpastes have contributed considerably to recent declines in the incidence of dental caries (Naylor and Murray, 1983). The use of a "pea-size" of toothpaste, low in fluoride concentration (<500 ppm) has been recommended by the European Academy of Paediatric Dentistry (Oulis *et al*. 2000).

In Nigerian preschool children aged between 6-71 months, more than half of children brushed their teeth with toothbrush and paste (Sowole *et al.* 2007).

Nearly all preschool children aged 3-5 years in Uganda brushed their teeth at least daily with fluoridated toothpaste (Kiwanuka *et al.* 2004).

Results of a similar study in Lithuania showed that 62.5% of the parents who have caries-free children started to brush their teeth soon after the eruption of the first tooth, and 52.5% of the parents having children with S-ECC did not brush their children's teeth at all (Slabsinskiene *et al*. 2010).

Lo *et al.* (2009) found that children with low dmft scores are those who started tooth brushing at an earlier age and those who brushed their teeth more frequently (Lo *et al*. 2009). A high dmft score was reported for children who did not brush their teeth at all (Begzati *et al*. 2010). Senesombath *et al.* (2010) found that children aged 36-47 months with fewer dental caries are those with higher tooth brushing frequency and those whose parents or caregivers help and supervise them during brushing.

Other studies have shown that daily tooth brushing with fluoridated toothpaste in 3-6 year olds significantly reduces caries incidence (Schwarz *et al.*1998; Sjogren *et al.* 1995).

Marinho *et al.* (2003) in a systematic review concluded that supervised tooth brushing with fluoridated toothpaste containing 1000-1100 ppm fluoride will reduce the prevalence of dental caries in children by 32%. In another systematic review of 70 controlled clinical trials Marinho *et al*. (2009) found that tooth brushing was associated with 24% reduction of dental caries Lower percentages of dental caries were found in children who used fluoridated dentifrices (Subramaniam and Prashanth, 2012).

Children who have an adult assisting with brushing are more likely to be caries-free than children who brushed their own teeth (Peretz and Eidelman, 2003). Preschool children whose parents began caring earlier for their teeth within the first year of life, and those whose parents helped them during tooth brushing have better dental health status and lower dmft scores (1.56) (Pieper *et al*. 2012).

In India, preschool children who started brushing their teeth after 1 year of age showed a high severity of dental caries, and less dental caries was found among children who brushed their teeth twice daily (Retnakumari and Cyriac, 2012). Gibson and Williams (1999) concluded that the consumption of sugars and sugary foods in children who brushed their teeth twice a day or more did not appear to be associated with caries. Similar findings were reported by Burt and Pai (2001) that the consumption of sugars remains a moderate risk factor for caries in those who had adequate exposure to fluoride.

The results of a study in children aged 6-60 months showed that 9% of children at age 60 months were brushing their teeth less than once per day, 47% were brushing once a day, and 43% were brushing 2 or more times per day (Franzman *et al*. 2004). In the same study Franzman *et al.* (2004) suggested that parents with high educational levels were brushing their children's teeth more frequently than those with lower educational levels. Parents should supervise children aged 2-7 years during brushing and should ensure that only a small pea sized amount of fluoridated toothpaste is used and that swallowing of the paste is avoided (DHC, 2002).

An evaluation of a supervised tooth brushing program for 5 and 6 year olds children in England found a reduction of 11% in the caries increment (Jackson *et al*. 2005).

This review has shown that dental caries is a public health problem among preschool children all over the world. Although it is preventable disease, dental health education, use of fluoride especially a supervised tooth brushing with a fluoridated toothpaste and regular dental visit are the main preventive measures for dental caries.

CHAPTER 3: AIM and OBJECTIVES

3.1 Aim

To determine the prevalence of dental caries and tooth brushing habits among 3 to 5 year-old preschool children in Khartoum State, Sudan.

3.2 Objectives

To determine:

1. The dmft of the sample
2. The proportion of caries free teeth
3. Tooth brushing frequency

and

4. To compare dmft and tooth brushing habits
5. To make recommendations to Directorate of Oral Health- Ministry of Health- Khartoum State.

CHAPTER 4: METHODOLOGY

4.1 Study design

This study is a descriptive, cross sectional study of prevalence of dental caries and tooth brushing habits among preschool children 3 to 5 year-olds.

4.2 Study site and study population

This study was carried out among a systematically randomly selected kindergarten schools in the 7 localities of Khartoum state: Khartoum, Jabal Awlia, Om Dorman, Umbada, Karari, Khartoum North and Sharq Elnil. These 7 localities comprise 3,133 kindergarten schools. Basic information regarding the schools was obtained from the Ministry of Education, Khartoum state and more detailed information regarding the number and age of the children was obtained from the localities.

4.3 Sample size and sample

The sample size for pre-school children was calculated according to the following formula:

$$n = \frac{z2\ pq\ *deff}{d2}$$

Where:

n= sample size

z= (1.96) value of normal curve corresponding to level of confidence (95%)

p= (0.607) proportion of students with caries in pre-school children

q= 1-p (0.393) students with no caries in basic public schools.

d= desired margin of error (5%)

deff = design effect (1.5)

$$n = \frac{(1.96)2*0.607*0.393}{(0.05)2} = 367$$

n*deff = 367*1.5 = 551 ≈ 555

Twenty eight kindergarten schools were randomly selected, and 20 children aged between 3-5 years were selected from each school.

4.4 Inclusion criteria

- Preschool children attending kindergartens in Khartoum- State aged 3-5 year-olds.
- Kindergarten schools had more than 20 children in the 3-5 year age group.

4.5 Data collection

Data was collected by using two instruments: a data capture sheet modified from WHO assessment form (1997) for clinical dental examination (Appendix 1) and a structured administered questionnaire for mothers/guardians (Appendix 2). The questionnaire was written in English but administered in Arabic to the mother by the researcher during the interview.

4.5.1 *Cross infection control measures*

A sterile set of instruments was used for each child. Gloves were changed before examination on every subject. Face mask, sterile cotton rolls also had been used.

Used instruments were collected and putted in a separate box and then washed and autoclaved at the end of the working day. Used gloves, masks, tissue papers and pouches were disposed in a waste bag.

4.5.*2 Questionnaire*

The dental health related habits were assessed using structured administered questionnaire that was completed by interviewing the mothers/guardians (n=553) (Appendix 2). The questionnaire obtained information on the knowledge about the causes of dental caries, tooth brushing habits of their children (age of starting brushing, frequency, tool of brushing, help of mother during brushing and fluoride

content in the tooth paste), breast feeding and bottle feeding habits, dietary habits and dental visits.

The questionnaire was piloted prior to the main study on 12 mothers/guardians to check the clarity and ease of understanding. Following the pilot, some of the questions were reformulated in the final draft.

4.5.3 *Clinical dental examination*

Clinical dental examinations were carried out at the kindergarten schools by a calibrated dentist with the child seated in an upright position. All children were examined with a dental mirror and a probe in the class room of the school using natural daylight.

4.5.3.1 *Diagnostic criteria*

The criteria for the diagnosis of dental caries were according to the criteria of the WHO (1997).

Dentition coding was as follows:

1) **Sound crown =A**

A crown was recorded as sound if it showed no evidence or untreated clinical caries. The stages of caries that precede cavitation, as well as other conditions similar to the early stages of caries, are excluded because they cannot be reliably diagnosed. Thus, crown with the following defects, in the absence of other positive criteria, were coded as sound:

1. White or chalky spots.
2. Discoloured or rough spots.
3. Stained pits or fissures in the enamel that catch the explorer but do not have a detectably softened floor, undermined enamel, or softening of the walls.
4. Dark, shiny, hard, pitted areas of enamel in a tooth showing signs of moderate to severe fluorosis.
5. Lesions that, on the basis of distribution or history, appeared to be due to abrasion.

2) **Decayed tooth = B**

Caries is recorded as present when a lesion in a pit or fissure, or on a smooth tooth surface, has an unmistakable cavity, undermined enamel, or a detectably softened floor or wall. A crown with a temporary filling, or one which is sealed but also decayed should also be included in this category.

3) **Filled with decay = C**

A crown was recorded as filled with decay, when it has one or more permanent restorations and one or more areas that are decayed.

4) **Filled no decay = D**

A crown was considered filled with out decay, when one or more permanent restorations are present and there is no caries anywhere on the crown. A tooth that has been crowned because of previous decay is recorded in this category. A tooth that has been crowned for reasons other than decay (e.g. a bridge abutment).

5) **Missing tooth, as a result of caries = E**

This code was used for tooth that has been extracted because of caries and was recorded under coronal status.

6) **Not recorded = F**

This code was used for any tooth that could not be examined for any reason.

4.5.3.2 *Calibration*

Prior to the clinical dental examinations, the examiner was calibrated on a group of pre-selected children (12 children were examined) who possessed the same characteristics to be assessed in the main study in order to assess intra-examiner agreement. The kappa statistic was 0.925.

4.6 *Data analysis*

The collected data from the dental examination and from the questionnaire was categorized, coded and entered into a computer. The data was captured in Excel.

Basic descriptive analysis was done using the Excel environment. The database was imported into the statistical package for social sciences (SPSS), version 11.5 computer software programs to perform complex statistical analysis.

Descriptive statistics was used to describe the demographic factors. The tests of significance used were independent sample t-test, Chi-square test and one way ANOVA test.

4.7 *Ethical considerations*

The protocol was submitted to the Senate Research Ethics Committee of the University of The Western Cape for ethical approval and permission to carry out the study.

Participation was voluntary and they were informed that they were free to withdraw from the study at any time and that all information gathered from the study would be kept strictly confidential

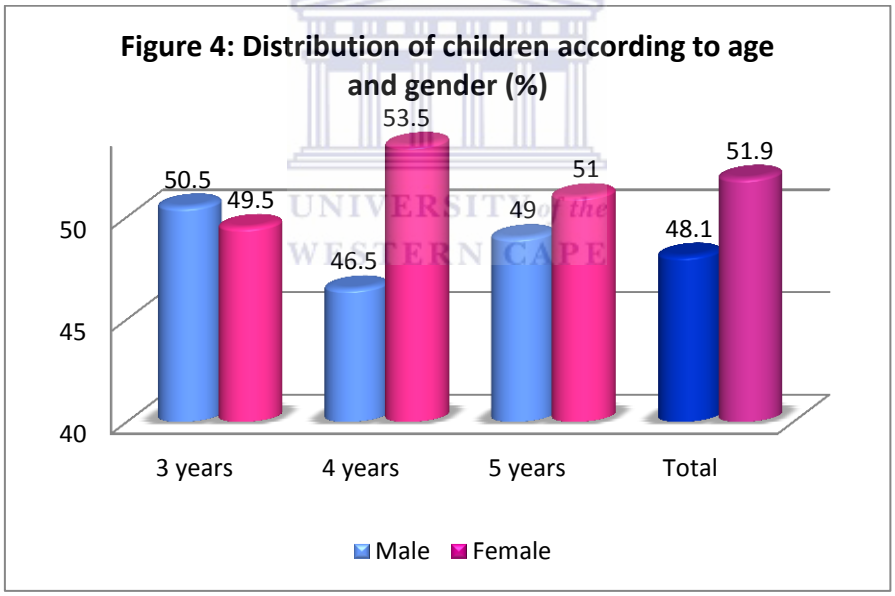
Two informed consent forms (Appendix 3 and 4) were signed by the mother/ guardian prior to the interview and before the oral examination. The examination of the study population did not include any radiographic examination. After clinical dental examinations mother/ guardian were informed about any necessary dental treatments and those who needed treatment were referred for the necessary treatments to the dental clinic of their choice.

CHAPTER 5: RESULTS

5.1 Demographic information

Five hundred and fifty three preschool children aged between 3 and 5 years old participated in the study with their mothers or guardians (n=553). The demographic characteristics of the study population are presented in Figure 4. Girls (n= 287) slightly outnumbered boys (n= 266).

The calculated statistical sample size was 551 children and this was rounded to 555 children and the final sample size was 553 since two unusable questionnaires were excluded from the data analysis.



About half of the mothers were aged between 30 and 39 years old, 31.5% had a university level education and 8% were uneducated (Table 1).

Table 1: Distribution of mothers/guardians according to age and level of education

		n	Percent
Age	<20 years	6	1.1
	20-29 years	210	38.0
	30-39 years	277	50.1
	≥40 years	60	10.8
Level of education	No education	45	8.1
	Primary/basic	143	25.9
	Intermediate school	18	3.3
	High school	155	28.0
	University	174	31.5
	Postgraduate	18	3.3
	Total	**553**	**100**

5.2 Caries Experience (Children)

The caries experience was 52.4% with a mean dmft of 2.27(11.09% decayed, 0.3% missing due to caries and 0.03% filled). The decayed component comprised the bulk of the mean dmft and the filled component the least (Table 2). The most commonly decayed tooth was the lower right second molar (9.6%).

Table 2: Percentage of decayed, missing and filled teeth

dmft Status	Percentage
Caries-free	88.58
Decayed	11.09
Filled	0.03
Missing as a result of caries	0.3
Total	**100**

There was an increase in the dmft scores with increasing age, with the mean dmft being 1.35, 2.18 and 2.79 in the 3, 4 and 5 year olds respectively. There was no significant difference in the mean dmft scores between males and females (Table 3).

Table 3: Mean dmft according to age and gender

	n	Mean dmft	Std. Deviation
Age			
3 years	103	1.53	2.46
4 years	254	2.18	3.24
5 years	196	2.79	4.04
Gender			
Male	266	2.28	3.32
Female	287	2.27	3.57
Total	**553**	**2.27**	**3.45**

5.3 Dental Caries and Mothers' characteristics

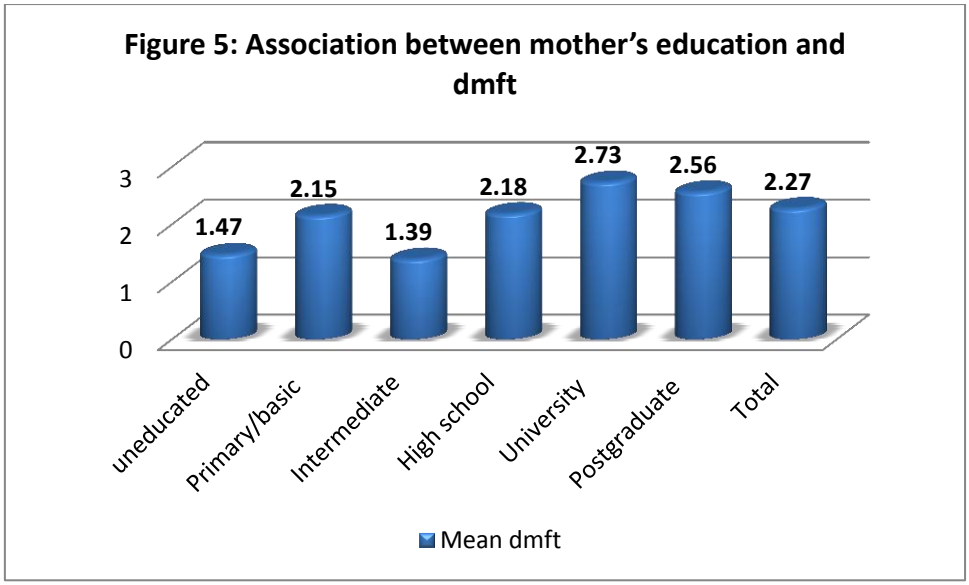
As shown in Table 4, children with mothers younger than 20 years old had lower dmft scores than those with mothers older than 20 years.

Table 4: Association between age of mothers and dmft

	Frequency	Mean dmft	Std. Deviation
<20 years	6	3.33	3.50
20-29 years	210	2.24	3.60
30-39 years	277	2.24	3.29
≥40 years	60	2.43	3.66
Total	553	2.27	3.45

Chi-square test performed, p-value = 0.865

The differences in dmft between of children of uneducated and educated mothers were very variable and not significant (Figure 5).



Chi-square test performed, p-value = 0.213

5.4 Tooth brushing habits

The number of children who brushed their teeth regularly (at least twice a day) was 490 (88.6%) (Table 5).

Table 5: Does your child brush his/her teeth?

	n	Percent
Regularly brush	490	88.6
Sometimes brush	53	9.58
Not brush	10	1.8
Total	553	100

According to Table 6, only 6.8% of mothers reported that they started brushing soon after the first tooth erupted, while 92.6% only after their child turned 3 years old. 83.3% of children were brushing their teeth once a day and 15.1% were brushing twice a day (Table 6). Table 6 also depicts information regarding tooth brushing tools, mother assistance during brushing, using fluoridated toothpaste and spitting out the toothpaste after brushing.

Table 6: Tooth brushing habits

	n	Percent
Age of starting tooth brushing		
Soon after the first tooth came out	37	6.81
When they turned 1 year old	101	18.60
When they turned 2 years old	233	42.90
When they turned 3 years old	132	24.30
Others	40	7.36
Tooth brushing frequency		
Once a day	453	83.4
Twice a day	82	15.1
Three times a day	8	1.5
Tooth brushing Tools		
Toothbrush	542	99.9
Miswak	1	0.001
Mother helps during brushing		
Yes	285	52.5
Sometimes	100	18.4
No	158	29.1
Knowledge of using fluoridated toothpaste		
No	8	1.47
Yes	226	41.62
Don't know	309	56.90
Spitting out the toothpaste		
Yes	488	89.87
No	45	8.28
Don't know	10	1.84
Total	**543**	**100**

By comparing the age of starting brushing with dmft, it was seen that children whose mothers started to brush their teeth at an earlier age, had lower dmft scores than those whose mothers started to brush their teeth after 2 years (Table 7).

Table 7: Association between dmft and age starting brushing

	N	Mean dmft	Std. Deviation
Soon after the first tooth came out?	37	1.97	2.53
When they turned 1 year old	101	1.86	2.97
When they turned 2 years old	233	2.21	3.14
When they turned 3 years old	132	2.96	4.53
Others	40	2.20	2.96
Total	543	2.31	3.47

One way ANOVA test performed, p-value = 0.139 (not significant)

The mean dmft decreased with the increased frequency of tooth brushing. Lower dmft scores were found among children who brushed their teeth three times a day (Table 8).

Table 8: Association between dmft and tooth brushing frequency

	n	Mean dmft	Std. Deviation
Once a day	453	2.35	3.49
Twice a day	82	2.21	3.44
Three times a day	8	1.25	2.12
Total	**543**	**2.31**	**3.47**

One way ANOVA test performed, p-value = 0.646 (not significant)

No statistically significant difference was found between the mother help during brushing and the mean dmft of their children (Table 9).

Table 9: Association between dmft and mother help during brushing

	n	Mean dmft	Std. Deviation
Yes helping children	285	2.45	3.63
Sometimes helping children	100	1.92	2.77
Not helping children	158	2.31	3.56
Total	**543**	**2.31**	**3.47**

One way ANOVA test performed, p-value = 0.423

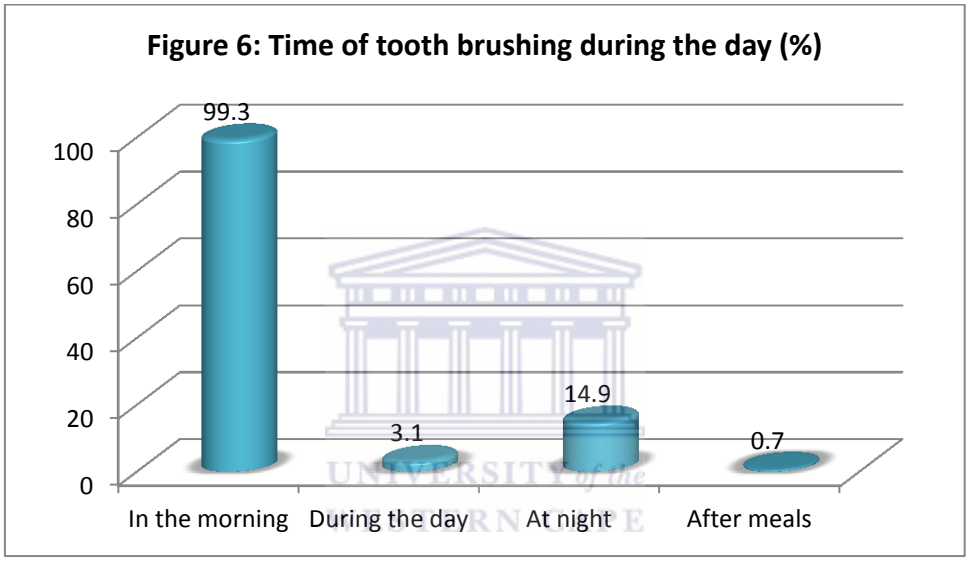
There was no significant difference between the mean dmft scores of children whose mothers were sure that they were using a toothpaste containing fluoride and children whose mothers did not (Table 10).

Table 10: Association between dmft and use of fluoridated tooth paste

	N	Mean dmft	Std. Deviation
Using fluoridated toothpaste	226	2.27	3.15
Not using fluoridated toothpaste	8	1.38	2.07
Don't know	309	2.37	3.72
Total	**543**	**2.31**	**3.47**

One way ANOVA test performed, p-value=0.703

Figure 6 shows that the highest percentage (99.3%) of children brushed their teeth in the morning and 14.9% were brushed at night.



There was no statistical difference between the dmft and the time of brushing per day, however, children who brushed their teeth during the day had a lower dmft score 1.12 (Table 11).

Table 11: Association between dmft and time of tooth brushing during the day

	Frequency	Mean dmft	Std. Deviation	*p-value*
Morning	539	2.32	3.48	0.746
During the day	17	1.12	2.34	0.15
At night	81	2.17	3.39	0.697
After meals	4	3.25	2.22	0.587

One way ANOVA test performed, p-value>0.05(not significant)

5.5 Tooth brushing and Mother characteristics

The highest percentage of children (77.78%) who brushed their teeth regularly was found among the children whose mothers had a post-graduate degree and the highest proportion of children who did not brush their teeth regularly was from uneducated mothers and this was statistically significant (Table 12).

Table 12: Association between mother level of education and tooth brushing habit

Level of education	Does your child brush his /her teeth?			
	Yes	**Sometimes**	**No**	**Total**
None	17	5	21	43
%	39.53	11.63	48.84	100
Primary/basic education	71	22	48	141
%	50.35	15.60	34.04	100
Intermediate school	12	1	4	17
%	70.59	5.88	23.53	100
High school	74	32	47	153
%	48.37	20.92	30.72	100
University	97	38	36	171
%	56.73	22.22	21.05	100
Postgraduate	14	2	2	18
%	77.78	11.11	11.11	100
Total	285	100	158	543
%	52.49	18.42	29.10	100

Chi square test performed, p-value=0. 007

There was no significant association between the mother level of education and the age at which the child started brushing their teeth (*p-value*= 0.058). More than 42% of mothers started brushing their child's teeth after they turned 2 years old. Around 22% of postgraduate mothers started brushing their children teeth soon after the first tooth erupted (Table 13).

Table 13: Association between the mother level of education and age of starting tooth brushing for children

Level of education	Age of starting tooth brushing					
	Soon after first tooth erupted	When they turned 1 year old	When they turned 2 years old	When they turned 3 years old	Others	**Total**
None	2	11	12	13	5	**43**
%	4.65	25.58	27.91	30.23	11.63	**100**
Primary/basic education	9	16	64	45	7	**141**
%	6.38	11.35	45.39	31.91	4.96	**100**
Intermediate school	2	2	6	6	1	**17**
%	11.76	11.76	35.29	35.29	5.88	**100**
High school	8	27	70	34	14	**153**
%	5.23	17.65	45.75	22.22	9.15	**100**
University	12	41	75	31	12	**171**
%	7.02	23.98	43.86	18.13	7.02	**100**
Postgraduate	4	4	6	3	1	**18**
%	22.22	22.22	33.33	16.67	5.56	**100**
Total	**37**	**101**	**233**	**132**	**40**	**543**
%	**6.81**	**18.60**	**42.91**	**24.31**	**7.37**	**100**

Chi square test performed, p-value=0. 058

Ninety percent of children with uneducated mothers brushed their teeth once a day. The highest proportion of children who brushed twice a day was found among the children whose mothers had a post- graduate education (Table 14).

Table 14: Association between mother level of education and brushing frequency

Level of education	Brushing frequency			Total
	Once a day	Twice a day	Three times a day	
None educated	39	2	2	43
%	90.70	4.65	4.65	100
Primary/basic education	110	28	3	141
%	78.01	19.86	2.13	100
Intermediate school	17	0	0	17
%	100	0	0	100
High school	130	20	3	153
%	84.97	13.07	1.96	100
University	143	28	0	171
%	83.63	16.37	0	100
Postgraduate	14	4	0	18
%	77.78	22.22	0	100
Total	453	82	8	543
%	83.43	15.10	1.47	100

Chi square test performed, p-value=0. 073

The association between the mother's level of education and the use of fluoridated toothpaste was highly significant (p-value=0.001). The highest percentage of mothers that used fluoridated toothpaste was found among the postgraduate educated mothers (77.78%) and the lowest among the uneducated mothers (9.3%) (Table15).

Table 15: Association between mother level of education and use of toothpaste that contains fluoride

Level of education	Does your child use toothpaste that contains fluoride?			
	Yes	No	Don't know	Total
None educated	4	2	37	43
%	9.30	4.65	86.05	100
Primary /basic education	30	1	110	141
%	21.28	0.71	78.01	100
Intermediate school	2	0	15	17
%	11.76	0.00	88.24	100
High school	69	3	81	153
%	45.10	1.96	52.94	100
University	107	2	62	171
%	62.57	1.17	36.26	100
Postgraduate	14	0	4	18
%	77.78	0.00	22.22	100
Total	**226**	**8**	**309**	**543**
%	**41.62**	**1.47**	**56.91**	**100**

Chi square test performed, p-value=0. 001

There was no significant difference in the association between the mother's age and the assistance of mother during brushing. All mothers younger than 20 years old helped their children to brush their teeth (Table 16).

Table 16: Association between mother age and mother help during brushing

Mother age	Do you help your child to brush his/her teeth?			
	Yes help	Sometimes help	Not help	Total
	n (%)	n (%)	n (%)	
<20	4 (66.67)	0	2 (33.33)	6 (100)
20-29	101 (48.79)	41 (19.81)	65 (31.40)	207 (100)
30-39	148 (54.81)	52 (19.26)	70 (25.93)	270 (100)
≥40	32 (53.33)	7 (11.67)	21(35)	60 (100)
Total	285 (52.49)	100 (18.42)	158 (29.1)	543 (100)

Chi square test performed, p-value =0.42

5.6 Causes of tooth decay

Table 17 depicts the knowledge of mothers regarding the causes of dental caries. 'Too much sugar' was reported to be the main cause of dental caries (82.8%).

Table 17: Causes of tooth decay

	n	Percent
Too much sugar	458	82.8
Bad oral hygiene	395	71.4
Germ	188	34
Others	21	3.8

5.7 Feeding habits

The vast majority of mothers (97.28%) reported breast feeding their children and about 25% of children were bottle-fed. The percentage of both breast-fed and bottle-fed children together was 22.9% (Table 18).

Table 18: Feeding habits

	n	Percent
Breast feeding		
Yes	538	97.28
No	15	2.71
Bottle feeding		
Yes	140	25.31
Sometimes	6	1.08
No	407	73.59
Breast and bottle feedings	127	22.96
Total	**553**	**100**

The association between the dmft and breast feeding showed that the mean dmft was slightly lower in children who were breast fed (Table 19).

Table 19: Association between breast-feeding and dmft

Did you breast-feed your child?	n	Mean dmft	Std. Deviation
No breast- fed	15	3.4	3.07
Breast- fed	538	2.24	3.46

Independent samples T-test performed, p-value=0.200

No significant difference was found in dmft scores between children who were bottle-fed and children who were not bottle-fed (Table 20).

Table 20: Association between bottle-feeding and dmft

	n	Mean dmft	Std. Deviation
Not bottle-fed	407	2.21	3.47
Bottle-fed	140	2.51	3.41

Independent samples T-test performed, p-value=0.376

Data on bottle content, frequency of bottle feeding per day, sugar addition to the bottle and nocturnal use of bottle are presented in Table 21.

Table 21: Bottle-feeding characteristics

	n	Percent
What do/did you put in the bottle (milk)?		
Yes	135	92.5
No	11	7.5
What do/did you put in the bottle (juice)?		
Yes	82	56.2
No	64	43.8
What do/did you put in the bottle (other)?		
Yes	4	2.7
No	142	97.3
Bottle-feeding frequency		
Once	16	11
Twice	37	25.3
Thrice	41	28.1
More than three times	52	35.6
Do/did you add sugar to the contents in the bottle?		
Yes	94	64.4
Sometimes	6	4.1
No	46	31.5
Does your child fall asleep with the bottle in his/her mouth?		
Yes	37	25.3
Sometimes	6	4.1
No	103	70.5
Total	**146**	**100**

The association between the dmft and the content of bottle was not statistically significant (Table 22).

Table 22: Association between the bottle-content and dmft

	n	Mean dmft	Std. Deviation	sig
Milk				
Yes	135	2.56	3.44	0.167
No	11	1.09	2.12	
Juice				
Yes	82	2.18	3.15	0.299
No	64	2.78	3.64	
Other				
Yes	4	0.25	0.50	0.188
No	142	2.51	3.40	

Independent samples T-test performed, P-value>0.05

When dmft was compared to the frequency of bottle feeding there was no statistically significant difference. The highest dmft scores were found among children who were bottle-fed three and more times per day (Table 23).

Table 23: Association between bottle-feeding frequency and dmft

	n	Mean dmft	Std. Deviation
Once a day	16	2.25	3.51
Twice a day	37	1.68	2.39
Thrice a day	41	2.88	3.21
More than three times a day	51	2.76	4.02
Total	**145**	**2.46**	**3.38**

One way ANOVA test performed, p-value=0.381

Table 24 shows that there was no association between dmft scores and the addition of sugar to the bottle content.

Table 24: Association between adding sugar to the bottle content and dmft

Adding sugar	n	Mean dmft	Std. Deviation
Yes	94	2.34	3.59
Sometimes	6	3.83	2.23
No	46	2.48	3.05
Total	**146**	**2.45**	**3.38**

One way ANOVA test performed, p-value=0.578

Higher dmft scores were found among children who sleep with a bottle (Table 25), but this was not significant.

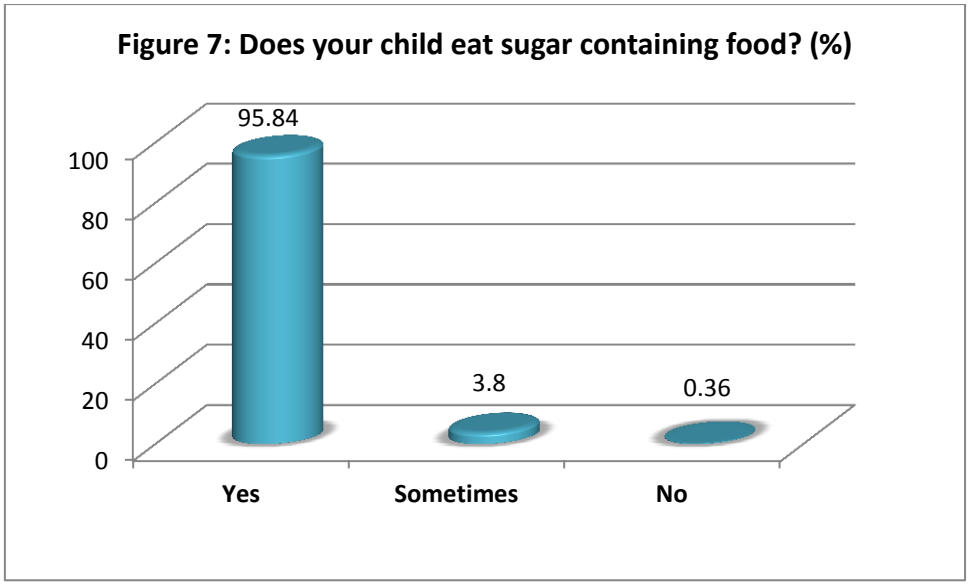
Table 25: Association between falling sleep with the bottle in a mouth and dmft

	N	Mean dmft	Std. Deviation
Yes	37	3.00	3.37
Sometimes	6	2.00	1.90
No	103	2.27	3.45
Total	**146**	**2.45**	**3.38**

One way ANOVA test performed, p-value=0.506

5.8 Sugar consumption

Nearly 30% eat sugar-containing food more than three times per day (Figure 7 and 8). More than 95% of the children were eating sugars every day (Figure 9), Sweets and chocolates were most commonly eaten.

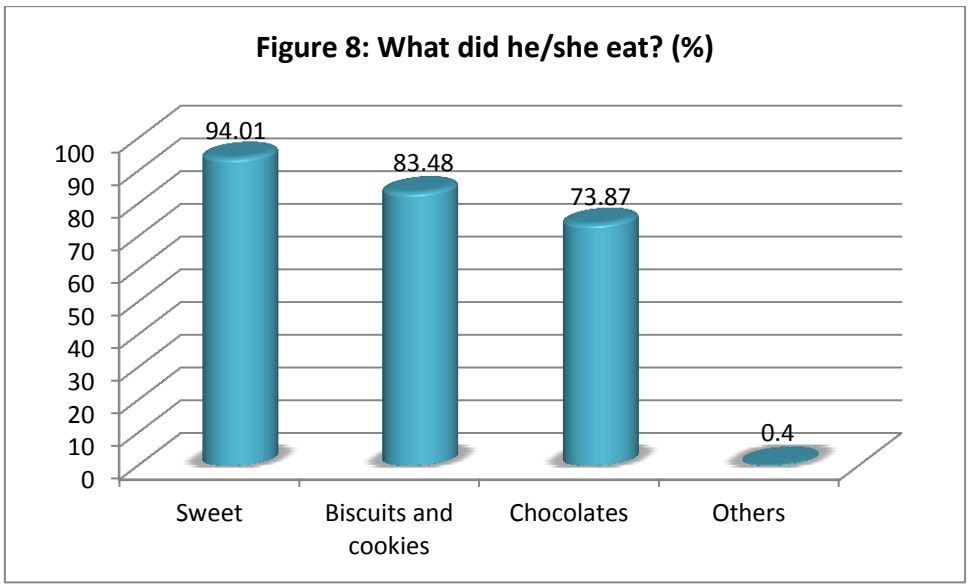


Eating sugary food was significantly associated with higher dmft scores (Table 26).

Table 26: Association between eating sugar containing food and dmft

Eating sugary food?	Frequency	Mean dmft	Std. Deviation
Yes	530	2.36	3.49
Sometimes	21	0.33	0.80
No	2	0.50	0.71
Total	**553**	**2.27**	**3.45**

One way ANOVA test performed, p-value=0. 023

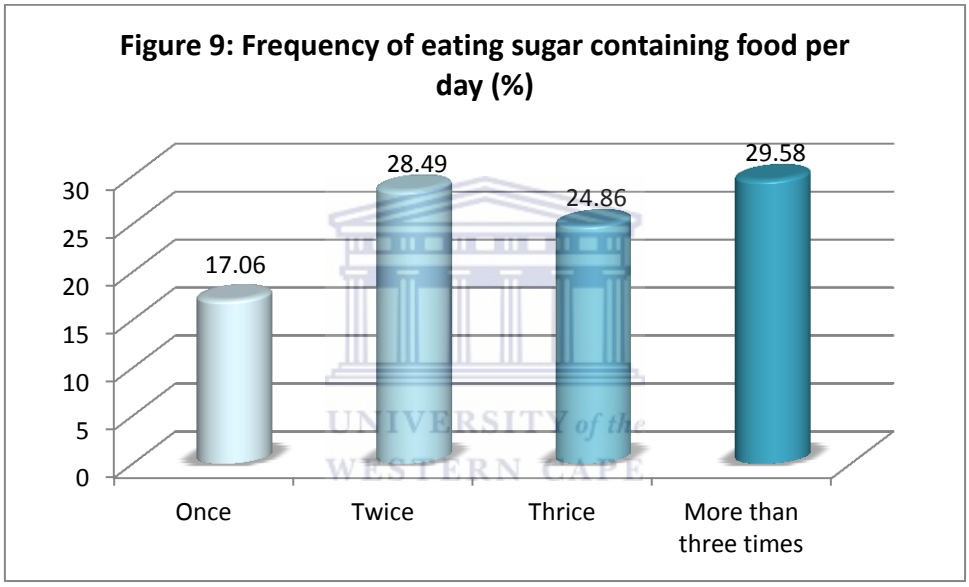


There was a statistically significant difference between foods containing sugar (sweets and chocolates) and the dmft scores (Table 27).

Table 27: Association between type of sugar containing food and dmft

	n	Mean dmft	Std. Deviation	*p-value*
Sweets				0.001
Yes	518	2.36	3.53	
No	33	1.06	1.48	
Chocolates				0.001
Yes	407	2.54	3.66	
No	144	1.56	2.67	
Biscuits and cookies				0.237
Yes	460	2.35	3.52	
No	91	1.92	3.07	

Independent samples T-test performed



A highly significant difference was found between the mean dmft and the frequency of eating food containing sugar per day. The dmft scores increased with the increasing number of times sugar was eaten per day ranging from 1.34 once per day to 2.8 for three and more times per day (Table 28).

Table 28: Association between frequency of eating sugary food and dmft

	n	Mean dmft	Std. Deviation
Once a day	94	1.43	2.40
Twice a day	157	1.80	3.01
Thrice a day	137	2.80	4.00
More than three times a day	163	2.80	3.72
Total	**551**	**2.28**	**3.45**

One way ANOVA test performed, p-value=0. 001

5.9 Dental visits

Dental visits were not common as only about 9% of children had visited a dentist and the most common reason for the visit was toothache (Table 29 and 30). In 41.2% of children the dentist only did an examination of the mouth and teeth (Table 31).

Table 29: Dental visits

	n	Percent
Visited dentist	51	9.22
Not visited dentist	502	90.78
Total	553	100

Table 30: Reasons for taking child to the dentist

	n	Percent
Routine check-up	8	15.7
Toothache	25	49
Others	18	35.3
Total	51	100

Table 31: What did the dentist do?

	n	Percent
Only an examination	21	41.2
Pulled out the tooth/teeth	13	25.5
Did a filling	7	13.7
Other	16	31.4

Table 32: Association between mother's age and dental visit

Age	**Dental visit**		
	Visited	Not visited	Total
<20	0	6 (100)	6 (100)
20-29	18 (8.57)	192 (91.43)	210 (100)
30-39	27 (9.75)	250 (90.25)	277 (100)
≥40	6 (10)	54 (90)	60 (100)
Total	51 (9.22)	502 (90.78)	553 (100)

Chi square test performed, p-value =0.837

Table 32 depicts the relationship between the age of mothers and dental visit. All children with uneducated mothers never visited a dentist. The highest number of dental visits was found among children whose mothers were university graduated (27%) while the lowest was among children with uneducated mothers (2.2%) (Table33).

Table 33: Association between mother level of education and dental visit

Level of education	Have you ever taken your child to the dentist?		
	Yes	**No**	**Total**
	n (%)	**n (%)**	**n (%)**
Not educated	1 (2.22)	44 (97.78)	45 (100)
Primary/basic education	9 (6.29)	134 (93.71)	143 (100)
Intermediate school	2 (11.11)	16 (88.89)	18 (100)
High school	10 (6.45)	145 (93.55)	155 (100)
University	27 (15.52)	147 (84.48)	174 (100)
Postgraduate	2 (11.11)	16 (88.89)	18(100)
Total	**51 (9.22)**	**502 (90.78)**	**553 (100)**

Chi square test performed, p-value =0.016

CHAPTER 6: DISCUSSION

Dental caries in preschool children is a public health problem although it is a preventable disease and one in which prevention should begin early in life. The present study investigated the prevalence of dental caries and tooth brushing habits in a random sample of preschool children in Khartoum State, Sudan. The prevalence of dental caries was measured using the WHO criteria (1997) and information on the causes of dental caries, tooth brushing habits, feeding habits, dietary habits and dental visits was obtained by interviewing the mothers/guardians of the children using a structured administered questionnaire.

The prevalence of dental caries varies widely throughout the world and it is not easy to compare the prevalence of ECC between the different studies due to the differing measurement criteria that are used. Studies are conducted for a variety of reasons, each with different aims and objectives. The external validity of the findings is therefore restricted i.e. the extent to which inferences can be made is limited to specific populations and may not necessarily reflect local, regional or national trends. This is important as there may be considerable variations in the prevalence and manifestation of ECC within sub-populations in an area as diverse as sub-Saharan Africa.

The prevalence of dental caries among the preschool children in the present study was 52.4% in Khartoum State, Sudan. The mean dmft was 2.27 and according to the WHO criteria this mean dmft is low. A study in Khartoum State a decade ago, by Raadal *et al*. (1993) reported a lower dmft score of 1.68 and a more recent 2013 study in the same age group found a higher dmft of 3.53 (Awooda *et al.* 2013). This big variation in the dmft scores seems to be due to the different sample selection criteria.

Internationally, the mean dmft in studies carried out in different countries in Asia was found to range from a low of 1.5 in Hong Kong and 1.85 in Pakistan to 5.5 in Thailand (Lo *et al*. 2009; Sufia *et al*. 2011; Senesombath *et al*. 2010).

In the present study the mean dmft was 1.35, 2.18 and 2.79 among 3, 4 and 5 year-olds respectively, while the results of a study in Uganda showed higher dmft scores of 1.7, 2.4 and 3.1 among the same age groups (Kiwanuka *et al*. 2004). In these two studies the dmft was directly proportional to the age.

Wyne *et al*. (1995) showed that in Riyadh, Saudi Arabia the mean dmft among 4 to 6 year-old preschool children was 6.9 which is very high when compared to the present study. The mean dmft increased dramatically with age, and the finding is similar to those reported by Awooda *et al.* (2013), Sufia *et al*. (2011), Begzati *et al*. (2010) and Lo *et al.* (2009).

The present study concurred with other studies that reported no gender difference in the caries prevalence in preschool children (Awooda *et al*., 2013; Slabšinskienė *et al*., 2010; Kiwanuka *et al*. 2004; Kerosuo and Honkala, 1991), as there was no difference in the mean dmft scores between boys (2.28) and girls (2.27).

There is conflicting evidence regarding the association between the mother's age and caries experience of the child. A study from Pakistan reported no association (Sufia *et al.* 2009), while other studies found that children with younger mothers experienced more dental caries possibly because the younger mothers paid less attention to the dental health of children (Matilla *et al*. 2000; Paunio *et al*. 1993). The present study found that children with mothers younger than 20 years old had lower dmft scores than those with mothers older than 20 years and this may be due to the fact that younger mothers had fewer children so they were better able to take care of their oral health. However, this finding may not be generalizable to the population at large since the sample size was small.

The level of a mother's education has been reported to be a risk factor for the development of dental caries in their children. Maternal education has been correlated with the occurrence and severity of ECC, in which low prevalence of dental caries and low mean dmft scores were associated with higher levels of parental education (Subramaniam and Prashanth, 2012; Traebert *et al*. 2009; Kiwanuka *et al*. 2004; Dini, *et al.* 2000; Al-Hosani and Rugg-Gunn, 1998). The contrasting finding of the present study, where the dmft of children with uneducated mothers was nearly half that of educated mothers, could be related to the small sample sizes. Nonetheless, since educated mothers have better incomes than uneducated mothers it could be that they are able to afford a more 'cariogenic' diet (sweets and chocolates) for their children. Other studies have reported that there is no significant effect of the mother education on the dental caries (Awooda *et al*. 2013; Sufia *et al*., 2009).

Tooth brushing with fluoridated toothpaste is important for the prevention of dental caries in children. To prevent ECC in preschool children by home-based care approaches, brushing with small amount of fluoridated tooth paste is effective when it starts soon after teeth eruption (Pine *et al*. 2000). In the present study a high percentage of children were brushing their teeth on a daily basis and more than 90% of the mothers reported that they started tooth brushing for their children after they turned 3 years old. Children, whose mothers started to brush their teeth at an earlier age, showed slightly lower dmft scores than those whose mothers started to brush their teeth after 2 years, however the difference was not statistically significant. Similar findings have been reported by other studies (Pieper *et al*. 2012; Retnakumari and Cyriac, 2012; Slabsinskiene *et al*. 2010; Lo *et al*. 2009).

Furthermore, children who brushed their teeth more than once per day experienced lower caries levels. These results were similar to those of Senesombath *et al.* (2010) and Retnakumari and Cyriac. (2012). However, it was found that mother support during brushing was not associated with the mean dmft of their children. The dmft scores were similar between children who were assisted by mothers during brushing and those who were not assisted. However, these findings do not concur with the findings of the systematic review of Marinho *et al.* (2003) and with other studies (Pieper *et al*. 2012; Peretz and Eidelman, 2003).

The results of a study by Sufia *et al*. (2009) showed that the higher the level of maternal education the better the dental health practices of their children. These practices include tooth brushing at the right time using tooth brush and toothpaste and sugar consumption control. These results confirmed the data reported by Franzman *et al*. (2004) who found that parents with high educational levels were brushing their children's teeth more frequently than those with lower educational levels. Similar findings were observed in the present study. The highest proportion of children who brushed twice a day was found among the children whose mothers had a post-graduate education. Nearly all the mothers in the present study reported that they breast-fed their children and about quarter of children were bottle-fed. Nearly thirty three percent of children were both breast and bottle-fed. It has been reported that there is an increase in the prevalence of dental caries in children who are bottle fed compared with breast fed children (Qadri *et al.* 2012).

However, there is still much controversy regarding the association between breast feeding and dental caries since the latter is associated with other factors such as sugar intake and microorganism (Seow, 1998).

Some researchers have reported that prolonged breast feeding of more than one year and high frequency of feeding were risk factors for ECC (Feldens *et al*. 2010; van *et al*. 2006; Sayegh *et al*. 2002). On the other hand, the results of the present study found that the mean dmft was slightly lower in children who were breast fed. This finding was similar to that of Sankeshwari *et al*. (2012) who observed that there was a noticeable decrease in the prevalence of ECC in children with breastfed up to two years and vice versa. Rugg-Gunn (2002) and Curzon and Drummond (1987) concurred that ECC was only associated with breastfeeding when it was 'prolonged' and when feeding was 'on demand'.

A primary risk factor for ECC is the use of bottle that contains fermentable carbohydrates (Slabšinskienė *et al*. 2010; Ribeiro and Ribeiro, 2004; Hallet and O'Rourke, 2003; Karjalainen *et al*. 2001; Milgrom *et al*. 2000; Holt *et al*. 1982). The present study found no association in dmft scores between children who were bottle-fed and children who were not. Furthermore, studies have reported that bottle feeding during day and night, frequency, duration of feeding and sweetened contents were also found to be significant risk factors for ECC (Hallet and O'Rourke, 2003; Karjalainen *et al*. 2001; Milgrom *et al*. 2000). In the present study, the highest dmft scores were found among children who were bottle-fed more than three times a day, however there was no association between dmft scores and the addition of sugar to the bottle content.

Nocturnal bottle feeding has been found to be a significant risk factor in the development of dental caries in primary teeth (Slabšinskienė *et al*. 2010; Lo *et al*. 2009; Schafer and Adair, 2000) and despite the fact that the present study found higher dmft scores among children who sleep with a bottle, this finding was not statistically significant.

Most dietary factors found to be significant are related to the consumption of sugar amount, frequency and time of consumption (Harris *et al.* 2004). Studies on preschool children concluded that daily consumption of sugar containing drinks especially during night, and daily sugar intake were independent risk factors for the development

of ECC (Karjalainen *et al.* 2001; Rodrigues and Sheiham, 2000). The present study found that more than 95% of the children were eating sugars every day, and nearly 30% ate sugar-containing food more than three times per day. Sweets and chocolates were most commonly eaten. Eating sugary food was significantly associated with higher dmft scores 2.8 compared with 0.50 for children who were not eating sugary food.

The dmft scores increased with the increasing frequency of eating sugar per day ranging from 1.34 for one time per day to 2.8 for three and more times per day. This finding is supported by Moynihan (2003) and Harris *et al*. (2004). Furthermore, the different types of sugar containing food (sweets and chocolates) were associated with high dmft scores. Begzati, Birisha and Meqa. (2010) found that the frequency of sweets consumption in 93% of children was 1-3 or more times per day and this frequency was significantly associated with ECC.

Dental visits play an important part in the preventive activities and education of children and are essential before the eruption of the first tooth of the child. During the first dental visit it is necessary to counsel the parent and educate them on how to prevent dental caries (Zafar *et al*. 2009). Dental visits were not common among the study children as less than ten percent of the children had visited a dentist and the most common reason for a visit was toothache. In a study carried out in Thailand, 12% of children reported visiting a dentist mainly on account of pain (Senesombath *et al*. 2010). Slightly higher dental attendances were reported in Hong Kong by Lo *et al.* (2009) and by Kopycka- Kedzierawski and Billings (2011).

CONCLUSIONS

In summary, the present study found that the prevalence of dental caries among preschool children was high and the mean dmft was directly proportional to the age. This was mostly associated with sugar consumption and therefore calls for preventive efforts to control sugar intake.

Tooth brushing is an important preventive practice for children and a high number of children were found to be brushing their teeth regularly and children who brushed more frequently had lower dmft levels.

There was no association between dental caries and bottle-feeding. Dental visits were uncommon among the study participants and efforts are needed to improve the utilization of dental services and determine what the barriers are to attendance.

The results of the present study indicate that there are areas for further investigation. There is urgent need for a comprehensive oral preventive programme for preschool children. This programme should be designed to include counselling of mothers/guardians and kindergarten school teachers for promoting healthy behaviours of children through dietary counselling, oral hygiene instructions including supervised tooth brushing at least twice daily.

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Appendix 1: Data capture sheet

Prevalence of dental caries and tooth brushing habits among preschool children in Khartoum State, Sudan
Modified WHO Oral Health Assessment Form (1997)

Form No ☐☐☐ **Data collector** ☐ **Date** ☐☐☐

Personal information

School No ☐☐ School type: Public (1) Private (2) ☐

Child name: …….. … Gender: Male (1) Female (2) ☐

Age ☐☐

Dentition status and treatment need

Dentition status	Treatment need
A= Sound	**0** = None
B = Decayed	**1** = Filling
C = Filled with decay	**2** = Extraction
D = Filled no decay	3 = Pulp care
E = Missing as a result of caries	**4** = Need for other care
F = Not recorded	

55	54	53	52	51	61	62	63	64	65	
										Dentition status
										Treatment need

85	84	83	82	81	71	72	73	74	75	
										Dentition status
										Treatment need

Appendix 2: Questionnaire

Questionnaire for Mothers: Prevalence of dental caries and tooth brushing habits among preschool children in Khartoum State, Sudan

Form No	Data collector	Date
☐☐☐	☐	☐☐☐

Child name: ----------

Please Tick(√) in the appropriate box

1) **Age**
   a) < 20 ☐
   b) 20 – 29 ☐
   c) 30 – 39 ☐
   d) ≥ 40 ☐

2) **Level of education**
   a) None ☐
   b) Primary/basic education ☐
   c) Intermediate school ☐
   d) High school ☐
   e) University ☐
   f) Postgraduate ☐

3) **What causes tooth decay? (you can tick more than one box)**
   a) Germs ☐
   b) Too much sugar ☐
   c) Bad oral hygiene ☐
   d) Other (please explain): ……
   e) Don't know ☐

4) **Does your child brush his/her teeth?**
   a) Yes ☐
   b) No ☐
   c) Sometimes ☐

5) **If yes or sometimes, what does the child use to brush their teeth?**
   a) Toothbrush ☐
   b) Miswak ☐
   c) Finger ☐
   d) Other (please explain): ……

6) **If yes or sometimes, when do he/she brush? (you can tick more than one box)**
   a) In the morning ☐
   b) During the day ☐
   c) At night ☐
   d) After meals ☐
   e) Other (please explain): ……

7) Do you help your child to brush his/her teeth?

a) Yes ☐
b) No ☐
c) Sometimes ☐

8) Does your child spit out the toothpaste after brushing?

a) Yes ☐
b) No ☐
c) Don't know ☐

9) Does your child use toothpaste that contains fluoride?

a) Yes ☐
b) No ☐
c) Don't know ☐

10) When did your child start brushing his/her teeth?

a) Soon after the first tooth came out ☐
b) When they turned 1 year old ☐
c) When they turned 2 years old ☐
d) When they turned 3 years old ☐
e) Other (please explain): ……

11) Did you breast-feed your child?

a) Yes ☐
b) No ☐

12) Do/Did you bottle-feed your child?

a) Yes ☐
b) No ☐
c) Sometimes ☐

13) If yes or sometimes, what do/did you put in the bottle? (you can tick more than one box)

a) Milk ☐
b) Juice ☐
c) Other (please explain): ……

14) If yes, how many times a day do/did you feed her/him the bottle?

a) Once ☐
b) Twice ☐
c) Thrice ☐
d) More than three times ☐

15) If yes, do/did you add sugar to the contents in the bottle?

a) Yes ☐
b) No ☐
c) Sometimes ☐

16) Does your child fall asleep with the bottle in his/her mouth?

a) Yes ☐
b) No ☐
c) Sometimes ☐

17) Does your child eat sugar-containing food?

a) Yes ☐
b) No ☐
c) Sometimes ☐

18) If yes or sometimes, what did he/she eat? (you can tick more than one box)

a) Sweets ☐
b) Chocolates ☐
c) Biscuits and cookies ☐
d) Other (Please explain): ……

19) If yes or sometimes, How frequently does your child eat sugar-containing food per day?

a) Once ☐
b) Twice ☐
c) Thrice ☐
d) More than three times ☐

20) Have you ever taken your child to the dentist?

a) Yes ☐
b) No ☐

21) If yes, why did you take your child to the dentist?

a) For a routine check up ☐
b) Toothache ☐
c) Other (Please explain): ……

22) If yes, what did the dentist do? (you can tick more than one box)

a) Only an examination ☐
b) Pulled out the tooth/teeth ☐
c) Did a filling ☐
d) Other (Please explain): ……
e) Don't know ☐

THANK YOU FOR YOUR TIME!

Appendix 3: Informed consent for questionnaire

Informed consent

I am Dr.Sitana MI Elidrissi, working at Oral Health Directorate, Ministry of Health, Khartoum State. I am presently a Master's Degree student in Dental Public Health at University of the Western Cape, South Africa. I am carrying out research on the oral health of preschool children in Khartoum State.

I would like to ask you a few questions regarding your child's oral health, tooth brushing and eating habits. This will take about 15 minutes of your time. All information obtained will be treated with utmost confidentiality.

Your participation in this research is completely voluntary, you may decline to participate in the study or withdraw from the study at any time without giving any reason and this will have no adverse effects on you.

If you need any further information regarding the study, please do not hesitate to contact me (Tel: 0912874710).

Thanking you in anticipation

Dr.Sitana

I understand the information that has been provided to me and agree to participate in the study.

Name: …….. **Signature:** …….

Date: …….

Name of Witness: …… **Signature:** ……..

Appendix 3: Informed consent for information sheet

Information sheet

I am Dr.Sitana MI Elidrissi, working at Oral Health Directorate, Ministry of Health, Khartoum State. I am presently a Master's Degree student in Dental Public Health at University of the Western Cape, South Africa. I am carrying out research into the oral health of preschool children in Khartoum State. This will be done by examining the teeth of children. This research is important and will be of great value and it will add to the existing knowledge of tooth decay in children.

The process will take about 10 – 15 minutes. There are no risks involved if your child participates in this study.

All information gathered as part of the study will be treated as strictly confidential. No one will have access to this information except the researcher. Neither your child name nor any thing that identifies him/her will be used in any reports of this study.

If you have any questions or queries regarding the study, please contact me (Tel 0912874710).

The information above has been explained to me and I agree to allow my child to participate in the research. I understand that at any time I may withdraw my child from this study without giving a reason and without it affecting my child's normal care and education.

Name: …….. **Signature**: …….

Date: …….

Name of Witness: ….……. **Signature**: ……