DENTAL CARIES, GINGIVITIS AND ORAL HYGIENE STATUS AMONG 3-18-YEAR-OLD CHILDREN WITH TYPE 1 DIABETES MELLITUS ATTENDING KENYATTA NATIONAL HOSPITAL

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Declaration

I, Dr Mohamed A. Sheikh, do hereby declare that this dissertation is my original work and it has not been submitted for the award of a degree in any other institution.

Sign:……. Date: ……

Approval

This dissertation had been submitted for examination with our approval as the University's appointed supervisors.

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Dedication

This dissertation is dedicated to my loving wife, Hothan Hassan and my children: Kheira, Fardowsa and Abdiaziz.

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List of Abbreviations

ADA	American Diabetes Association
BDS	Bachelor of Dental Surgery
DM	Diabetes Mellitus
dmft	decayed ,missing ,filled deciduous teeth
DMFT	decayed, missing, filled permanent teeth
DFS	Decayed, filled tooth surface
HbA_{1c}	Glycated Hemoglobin
HLA	Human Leukocyte Antigen
IEC	International Expert Committee
KNH	Kenyatta National Hospital
MDS	Master of Dental Surgery
Nbi	Nairobi
OHL	Oral health Literacy
OHS	Oral health status
PI	Principal Investigator
RBS	Random Blood Sugar
SPSS	Statistical Package for Social Sciences
TIDM	Type 1 Diabetes Mellitus
T2DM	Type 2 Diabetes Mellitus
UoN	University of Nairobi
WHO	World Health Organization

Abstract

Background: Diabetes mellitus (DM), once considered a disease of the West and the affluent, is now rising at an alarming rate in all populations irrespective of the age. The reduced salivary secretions in children diagnosed with T1DM, tend to increase the likelihood of dental caries in these children. This associated risk, can be mitigated by the child adhering to a prescribed diabetic diet, enriched with fiber and low in simple carbohydrates. On the other hand, gingival bleeding has been shown to be strongly related to the amount of plaque deposits[10.] The prevention of periodontal breakdown associated with gingivitis in diabetic patients has largely been based on improving the oral health practices of the patients.

Study Objective: The main objective of the present study was to determine the dental caries experience, occurrence of gingivitis and the oral hygiene practices of 3-18 year-old children diagnosed with T1DM.

Setting: The Paediatric Outpatient Clinic at the Kenyatta National Hospital in Nairobi, Kenya.

Materials and Methods: This was a descriptive cross-sectional study where a total of 82 children aged between 3 and 18 years diagnosed with T1DM participated. The participants' hospital records were perused to obtain diagnostic tests, duration since diagnosis and the level of control of T1DM. A structured questionnaire was administered to obtain information on the socio-demographic characteristics of the children participating in the study and their caregivers. The children's oral health practices and the frequency of consumption of cariogenic diet were also obtained. In addition, an oral examination of the participants was undertaken to determine their plaque score, gingivitis and dental caries experience.

Data analysis: The data gathered were entered into a computer, coded, cleaned and analyzed using SPSS 20.0 computer software. Fisher's exact test and Pearson's Chi Square were used to test significant associations between two categorical variables within the study population while bivariate analysis, regression models and Odd's Ratios were used to test significant relationships between the dependent variables and the independent variables. The level of significance was pegged at $p< 0.05$, and the outcomes of the study were presented in the form of frequency diagrams, graphs and tables.

Results: The 82 children who participated in this study had a mean age of 11.6 ±4.1 SD, with the duration of having the disease ranging from one month to six years (mean duration of 3.3 years). Seventy two percent (72%) of the children had poorly controlled T1DM, out of whom 52.4% had moderate plaque accumulation. The prevalence of gingivitis was 100%, with 63.4% having mild gingivitis and the remaining children having moderate gingivitis. The prevalence of dental caries among the children was 78%, with a mean DMFT/dmft of 3.23±2.86. overall, the results of the study showed significant relationships between T1DM (level of control and duration) and oral hygiene status ($P<0.05$). On the other hand, there was a significant relationship between the level of control of T1DM and gingivitis ($P<0.05$) while there was no significant relationship between T1DM (level of control and duration) and dental caries experience ($P>0.05$) in this study.

Conclusions: There oral hygiene of the children who participated in this study was poor with a high dental caries experience (78%) and gingivitis (100%). Uncontrolled T1DM and an increase in duration of having T1DM was associated with significant increase in dental plaque scores, gingival scores among the children with poorly controlled T1DM while the disease duration did not show any significant change in the severity of gingivitis. On the other hand, level of control

and the duration of T1DM did not have a significant relationship with the dental caries experience of the study participants.

Recommendations: There is a need to achieve controlled T1DM in child sufferers as this is likely to assist in maintaining a better oral hygiene status as well as the prevention of gingivitis among the children. There is also a need to conduct a comparative study among children with and those without T1DM to assess differences in oral hygiene status, gingivitis and dental caries experience between the groups.

Chapter 1

Introduction and Literature Review

1.0 Introduction

Diabetes mellitus (DM) disease, previously associated with the West and its affluences, is now on the rise at an alarming rate in all populations worldwide. According to the World Health Organization (WHO) report, 347 million people worldwide had diabetes[1] and even in 2014 the International Diabetes Federation (IDF) estimated that 387 million people worldwide had DM with projections of a further increase to 592 million by 2035. Of all the people diagnosed with diabetes mellitus, 80% of them came from the low and middle-income countries[2], with 80% of them dying from DM[3]. The WHO projected that diabetes would be the 7th leading cause of death by 2030[4]. In Kenya, the prevalence of DM is still unknown but estimates from a sample population had provided a non-age adjusted prevalence of 4.2%[5] and an age adjusted prevalence of 5.3% in Nairobi[6].

Children with Type 1 Diabetes Mellitus (T1DM) have been known to have significantly reduced salivary secretion rates[7], a phenomenon that puts them at risk for dental caries occurrence. However, through good diabetic control methods, the most serious salivary changes such as high glucose content can be prevented and a rise in the buffering capacity of saliva achieved[8]. Adhering to a prescribed diabetic diet that is rich in fiber and containing low simple carbohydrates can lead to the slowing down of the formation of dental plaque. This could further hinder the multiplication of acidogenic bacteria within the dental plaque[9], thus lowering the individual's susceptibility to dental caries and gingivitis. Gingival bleeding

has been shown to be strongly related to the amount of dental plaque deposits[10]. Consequently, plaque should be eliminated through proper self-care, regular tooth brushing and professional dental care in order to reduce the risk of gingival diseases in the diabetic patients[11].

The present study was, therefore, designed to determine the dental caries experience, gingivitis and oral hygiene status of 3-18 year-old children diagnosed with T1DM.

1.1 Literature Review

1.1.1 Diabetes Mellitus

DM is a metabolic disease resulting in an abnormal metabolism of fat, carbohydrate and protein[12, 13]. Two main types of primary DM have been described: Type 1 Diabletes Mellitus (T1DM) and Type 2 Diabetes Mellitus (T2DM)[14]. The T1DM which accounts for 5-10% of all the diabetes cases in the world is a cell-mediated autoimmune disease leading to the destruction of the insulin-producing beta cells in the pancreas. The factor that initiates this cell-mediated autoimmunity is not well understood, although there are strong associations with Human leukocyte Antigen (HLA) loci. Models in the non-obese diabetic mice and the bio-bred diabetes prone rat have indicated that HLA is necessary, but not sufficient, for diabetes to develop[15].

Joint American Diabetes Association (ADA), International Diabetes Federation, European Association for the Study of Diabetes and the International Experts Committee (IEC) have proposed elevated glycated haemoglobin (HbA_{1c}) as an alternative criterion for the diagnosis of diabetes. They have recommended the thresholds of ≥5.7% for impaired glucose tolerance

and ≥6.5% for the confirmation of diagnosis of diabetes on two tests. However, in the majority of children, the diagnosis is made from the constitutional symptoms like polyuria, polydipsia and accelerated weight loss. The most commonly used diagnostic test in children is random blood glucose (RBS) ≥200 mg/dL(11.1mmol/L) with the aforementioned characteristic symptoms. While the IEC has recommended HbA_{1c} assay to be the test of choice for the diagnosis and the management of diabetes, some countries like Kenya have found the costs of providing the HbA_{1c} tests to be prohibitive. In such circumstances, clinicians in these countries have continued to use the alternative diagnostic approaches based on glucose measurements[16].

Initially diabetes management and glycemic control were geared towards normalization of the blood glucose levels. The evidence for the sugar levels was, however, based on studies conducted on adult diabetic patients. The targeted near normal blood glucose levels in children was hardly attainable due to the unique vulnerability of the developing children to episodes of hypoglycemia. To address this dilemma, ADA set age specific targets for the children with a glycemic goal of HbA_{1c} 7.0% and random plasma glucose of 200 mg/dL (11.1mmol/L) being reasonable if they could be achieved without excessive risks of hypoglycemia[17]. Treatment of T1DM entails subcutaneous injection of insulin, regular exercise, diabetic diet and weight control. The long-term complications of uncontrolled diabetes result from microangiopathy leading to nephropathy and retinopathy. There could be a likely risk of chronic ulcers, limp amputations and Charcot's joints[18]. Due to the salivary alterations associated with DM, the affected patients are potentially at risk of greater disruption to the normal oral flora and increased bacterial and fungal colonization in the oral

cavity[19]. There is also diabetes-related tissue damage which is thought to be due to a combination of the following factors: increased circulating levels of pro-inflammatory cytokines[20] and adipokines[21]. These factors lead to structural alterations of the tissues characterized by the incorporation of non-enzymatically glycated proteins[22]. Eventually, there is build-up of oxygen free radicals through metabolic dysregulation of glucose metabolism[23]. Unfortunately, awareness of the long-term complications of this disease by the diabetics is lacking worldwide[24].

The incidence of T1DM has been increasing worldwide and it appears to be more prevalent among children aged 5 years or below[25]. In 2010, the incidence of T1DM in children aged 0–19 years in the United States was 1.7 per 1,000 children[26]. In Sub-Saharan Africa, the incidence has been reported to range from 1.5 per 100,000 persons for Tanzania[27], through 3.5 per 100,000 in Mozambique[28], 2.1 per 100,000 in Ethiopia[29] to 12 per 100,000 persons per year in Zambia[28]. In Kenya, there is no available literature on the incidence of T1DM in children.

T2DM is the most prevalent form of diabetes in the world and it results from insulin resistance. It primarily occurs with increasing age and is associated with both genetic and environmental risk factors. It commonly occurs following a long period of abnormal glycemic control and is part of a metabolic syndrome characterized by hypertension, dyslipidemia and hyperglycemia. T2DM has a stronger genetic aetiology than T1DM although environmental factors such as diet, lack of exercise, obesity and prolonged smoking can impact on the development of T2DM[30]. The majority of young people diagnosed with T2DM were obese, and that there was an apparent general agreement that T2DM in the

young patients was becoming a serious clinical issue[31]. However, within a whole paediatric cohort surveyed in Los Angeles (USA), the overall incidence of T2DM remained low when compared with T1DM and this had led some researchers to question the claims of an "epidemic" of T2DM in children[32].

1.1.2 Dental Caries

Dental caries is a complex, multi-factorial disease, known to be influenced by behavioural and dietary factors[33]. In order for caries to occur, susceptible tooth surface needs to be colonized by a pathogenic biofilm with an adequate source of fermentable carbohydrate for a prolonged period of time. The tooth may, therefore, be susceptible due to its anatomy (normal or disordered formation), iatrogenic factors such as restoration margins and damaged enamel surfaces or due to its local environment such as a reduction in the quantity or quality of saliva[34]. Dental caries is one of the most prevalent chronic childhood diseases globally. It is a major oral health problem, both from a population health perspective and to individual families who have to deal with young children suffering from toothaches[35, 36]. Dental caries has detrimental consequences on children's quality of life by causing pain, premature tooth-loss, malnutrition and finally the influence it has on the overall growth and development of the child[37].

A study done among 52 children aged 3–16 year-old with T1DM attending the outpatient diabetic clinic at Ghent University Hospital, Belgium reported that almost 80% of tooth decay in primary and in permanent dentitions among the diabetic children remained untreated[38.] In Sudan, a prevalence of dental caries among type 1 diabetic children was reported as 60.3% with a DMFT index of 0.09[39]. In Kenya, there is lack of information on

the dental caries experience among diabetic children. Nonetheless, a study done in Nairobi among non-diabetic nursery school children reported 63.5% prevalence of dental caries and a mean decayed, missing and filled teeth index (dmft) of 2.95[40]. Another study done among 12 year old non-diabetic children in Kitale, Kenya, reported an overall caries prevalence of 50.3% with overall DMFT 0.92 ± 1.36 [41].

A critical review of dental caries-associated risk factors and T1DM databases from 2000 to 2010 reported inconsistent relationships between T1DM and dental caries. In that review, some articles found non-significant relationship between T1DM and dental caries experience while other researchers found significant relationships[42]. These inconsistent relationships could be attributed to the level of metabolic control and also to the traditional caries risk indicators as important factors for dental caries development in children and adolescents with T1DM[43]. A study done in Finland among 80 children and adolescents with T1DM reported that poor control of diabetes and longer duration (>2 years) was associated with higher Decayed Filled Surface (DFS) scores.[8] Furthermore, a study on dental caries increments among 10-15 year-olds in Lithuania concluded that diabetes-induced changes in salivary glucose content and albumin concentrations form other factors involved in caries development among diabetics[44].

1.1.3 Gingivitis

Gingivitis is defined as gingival inflammation without any loss of attachment and may be purely plaque induced or may be exacerbated by local or systemic factors[10]. It may also be associated with a slight increase in clinical probing depth as a result of erythema and swelling of the gingivae resulting in false pocketing. There is a loss of the stippling of a

normal gingiva and an increase in the flow of gingival crevicular fluid. The gingival pocket commonly bleeds on gentle probing of the sulcus. This condition is entirely reversible with the removal of the aetiological agent (dental plaque) with no permanent loss of periodontal attachment. Chronic gingivitis can persist without the development of progressive periodontal destruction[45]. It has been reported that chronic hyperglycemia created a microvascular environment in the gingiva that was in many aspects similar to acute inflammation. These changes included increased vascular permeability, increased leukocyte adhesion molecule expression and enhanced leukocyte rolling. The resultant pro-inflammatory state is a confirmed risk factor in the initial development of gingival diseases and eventual progression periodontal breakdown[46].

Children with chronic medical diseases have added risks of gingivitis. In a study done at KNH among paediatric oncology patients reported high plaque index and high gingivitis[47]. Another study also conducted at KNH reported 44.4% of children with heart diseases had poor oral hygiene[48] while Silva from Brazil found 98% of children with heart disease had visible dental plaque and 99% had either severe or moderate gingivitis in one or more examined surfaces[49]. Diabetes as one of the chronic medical diseases leads to an increase in gingival inflammation and a reduction in the time taken for the gingivitis to develop[50]. A controlled experimental gingivitis in Switzerland among patients with T1DM had also reported that diabetics develop an earlier and higher inflammatory response to a comparable bacterial challenge[51]. A study among diabetic children in Brazil found no increase in gingivitis despite significantly poor plaque control[52]. On the contrary, another study among

72 diabetic children (2-15 year-old) from Libya reported higher gingival scores in the diabetic children and recommended additional care for the prevention of gingivitis[53].

1.1.4 Oral Hygiene Status

Poor oral hygiene in diabetic patients can lead to gingivitis. A probable cause of an increased plaque accumulation in diabetic patients includes increased glucose content of the saliva, which is a precursor for the development of dental plaque[54, 55]. Furthermore, lack of compliance with the recommended diabetic therapy could in turn reflect on poor attitudes towards the maintenance of oral hygiene[54]. In a study done in Libya among 2-15 year-old children with T1DM and also another study conducted in Spain reported a high plaque and gingival scores among diabetic children[53, 44]. A study done in Belgium among 3-16 year-old diabetic children also reported a moderate plaque deposit[38]. These high plaque scores are reported among diabetic children despite a reported favourable oral hygiene practices among diabetic children in Lithuania where almost all the children (99.3%) reported using fluoridated toothpastes and the majority of them brushed their teeth once a day or more often[44].

As the child's caregivers make decisions for their health-care, they play a very important role in achieving the best oral health outcomes for the young children[56]. Consequently, the caregivers' poor oral health knowledge could lead to potential detrimental implications for the paediatric population[57]. The oral health behaviours of parents have a very important influence to their children's acquisition of positive oral health practices as they grow along[58]. It was, therefore, not surprising that the caregivers' socioeconomic status, education, oral

health knowledge and oral health status had been shown to be associated with their children's oral health behaviours[59, 60]. Most children aged 4 to 11 years were said to be dependent on adults for their T1DM management and lived under the supervision of their caregivers[61]. Researchers have linked oral health literacy (OHL) with wide spectrum of oral health behaviors and outcomes. The caregivers' OHL had been known to be a determinant of their children's Oral Hygiene Status (OHS) [62], and may even act as a modifier in the association between OHS and children's oral health–related quality of life[63]. The other determinants of dental care-seeking behavior include family-level characteristics such as awareness and recognition of oral conditions or symptoms as well as the extent to which parents value oral health[64]. Inadequacy in parental knowledge of their infant children's oral health may result in the caregivers routinely overestimating their children's OHS[65, 66].

1.2 Statement of the Problem

From the literature review, DM has been shown to an increasing chronic disease of children, and that it also requires significant adjustments in life. DM can lead to decreased quality of life especially when not holistically managed[67]. T1DM has contributed greatly to the high mortality of diabetic patients and increased prevalence of the oral health complications observed in these patients. Children with T1DM are at an increased risk of developing dental plaque[54, 55], with an early onset and accelerated progression of gingivitis[50]. Likewise, diabetes induced changes in salivary glucose content and albumin concentrations are involved in dental caries development among diabetics[44]. The awareness of these complications by the diabetic patients is still lacking worldwide[24] including Kenya and so is the lack of preventive

dental care for these children[60]. Poor oral hygiene practices by these children can lead to increased susceptibility to dental caries and gingivitis.

1.3 Justification of the study

There have been no studies undertaken in Kenya to determine the prevalence of dental caries among children diagnosed with T1DM. The few studies conducted in other nations have reported inconsistent relationships between T1DM and dental caries. It was likely DM could be a contributory factor to the increased incidence of dental caries, particularly when the affected individual had increased risk from other dental caries risk factors[42].

Research conducted in Columbia on gingivitis among patients with T1DM had reported contradictory results on the association between T1DM and gingivitis. In spite of similar oral hygiene practices among diabetic and non-diabetic children, diabetic children had been shown to have poorer oral hygiene[50]. There exists, therefore, a need to provide some baseline data on the dental caries, gingivitis and oral hygiene practices of children in Kenya diagnosed with T1DM.

1.4 Objectives

1.4.1 Main Objective

To determine the dental caries experience, gingivitis and the oral hygiene status among 3-18 year-old children diagnosed with T1DM, and attending Paediatric Outpatient Clinic at KNH.

1.4.2 Specific Objectives

1. To determine the oral hygiene status using Plaque Score (PS) of 3-18 year-old children diagnosed with T1DM.
2. To determine the gingivitis using Gingival Index (GI) and dental caries experience (dmft/DMFT) of 3-18 year-old children with TIDM.
3. To determine the level of control and duration of T1DM and its relationship with the oral hygiene status, gingivitis and dental caries.

1.5 Hypothesis

The level of control and duration of T1DM are not related with the dental caries experience, gingivitis and oral hygiene status of these children

1.6 Variables

1.6.1 Socio-demographic Variables

Age of the child

Gender of the child

Level of education of the child

Residence

Age of the caregiver

Level of education of the caregiver

Children's visit to the dentist

Oral hygiene practices of the children

Dietary practices of the children

1.6.2 Independent Variable

T1DM: level of control and duration since diagnosis of T1DM.

1.6.3 Dependent Variables

Dental caries (dmft/DMFT)

Gingivitis (Gingival index: Loe and Silness 1967)

Oral hygiene status (Plaque Score: silness and Loe 1964)

Chapter 2

2.0 Materials and Methods

2.1 Study Area

The study was conducted at KNH which is a national referral hospital located in Nairobi, the capital city of Kenya. Nairobi is situated at an altitude of about 1700 metres above sea level and covers an area of approximately 684 km^2. Nairobi is a metropolitan city with a population of approximately 3.138 million (2009 census). It is a major industrial and administrative centre of Kenya, with many modern industries that provide a large proportion of employment to the residents. Majority of Nairobi residents live in unplanned, poorly-served informal settlements, with poor sanitation and poor access to safe drinking water. The KNH, located within Nairobi, is a national referral and a teaching hospital. It has a well-established Paediatric Outpatient Clinic that also caters for children with endocrine disorders. These children diagnosed with endocrine disorders usually attend Tuesday's diabetic clinics, majority of them have T1DM. Being a referral facility, some children come from outside Nairobi City County. As of January 2015, there were two hundred and fifty children with T1DM registered in the Paediatric Outpatient clinic at KNH. These patients were put on a recall schedule to monitor and manage their sugar levels. However, not all the registered children complied with their appointments leading to erratic patients flow duration the period of data collection. Some children had either dropped out or opted to be managed at the referring facilities.

2.2 Study Design

The present study was a descriptive cross-sectional hospital based study.

2.3 Study Population

The study population was composed of all the 3-18 year-old children attending the Paediatric Outpatient Clinic at KNH and diagnosed with T1DM. The chronological age based on the date of birth of the children given by the caregivers was used to determine the age of the child.

2.4 Sample Size Determination

Taking the proportion of untreated decay in the primary and permanent dentition in diabetic children to be 80%[38], the following formula was used in the sample size determination:

$$\frac{N=Z^2 P (1-P)}{d^2}$$

Where:

N= the desired sample size (where population >10,000)

P= reported prevalence of untreated dental caries among diabetic children.

Z= standard normal deviate, usually set at 1.96 equivalent to 95% confidence level.

d= Degree of precision normally set at 0.05

Since the study population is less than 10,000 the sample size for this study was adjusted using the correction formula:

$$nf= \frac{n}{1+N/n}$$

Where 120 was the average number of children diagnosed with T1DM expected to be seen in the Paediatric outpatient clinic at KNH during the study period. A minimum sample size of 80 children was used for this study.

2.5 Sampling Method

This was a purposive sampling method where all the 3 to 18 year-old children diagnosed with T1DM and attending KNH Paediatric Outpatient Clinic were recruited using the ADA criteria (2005) for the diagnosis and glycemic control of T1DM. The data collection was undertaken between January and May 2015.

2.6 Inclusion Criteria

a. Children aged between 3 and 18 years diagnosed with T1DM and attending the Paediatric Outpatient Clinic at the KNH between January and May 2016.
b. Children whose parents or guardians gave written informed consent.
c. Children who assented to the study.

2.7 Exclusion Criteria

a. Children below 3 years.
b. Children whose parents/guardians did not give informed consent to participate in the study.
c. Children who did not assent to the study
d. Children with no confirmed T1DM diagnosis.
e. Uncooperative children.
f. Children with other chronic diseases like thyroid disease, epilepsy, heart disease and malignancies.

2.8 Data collection Tools and Techniques

2.8.1 Data Collection Instruments

The diagnosis of T1DM was obtained from the patient's medical records. HbA_{1c} of ≥6.5% or a random blood glucose (RBS) ≥200 mg/dL(11.1mmol/L) were used as the cut off points for the confirmation of T1DM diagnosis as was recommended by the IEC[16]. In terms of the level of control of T1DM, the ADA criteria of HbA_{1c} ≥7.0% or RBS of ≥200 mg/dL(11.1mmol/L) was used to determine uncontrolled T1DM[17]. The month and the year of diagnosis were recorded so as to calculate the duration of having T1DM. A semi-structured modified WHO oral health questionnaire was administered by the principal investigator (PI) for the purpose of collecting the socio-demographic data of both the child and the caregiver and the children's oral hygiene practices **(Appendix iii)**. The socio-demographic data included the child's age, gender and level of education, the caregiver's age, level of education and residence. Additionally, the caregivers of the children aged between 3 and 12 years were interviewed, while the older children aged between 13 and 18 years had the interviews administered to them.

In addition, an oral examination of each child was carried out by the PI using sterile mouth mirrors and WHO probes to collect information on dental plaque score, gingivitis and dental caries experience. The examination was conducted in the Paediatric Outpatient Clinic examination room, under field condition, with the children seated on a normal chair facing a natural source of light from the sun. Young patients unable to sit on the chair alone had the caregiver seated on the chair and holding the young patient on the lap. Dental Plaque (Plaque Score - Silness and Loe 1964) and gingivitis (Gingival index -Loe and Silness 1963) were

scored on the modified WHO Oral Health Assessment Form (2005) **(Appendix ii)**. The data for each child were entered in individual data collection forms **(Appendix ii and iii)** by a trained assistant.

The mean plaque score (PS) was calculated and interpreted as shown below:

PS= Total scores

No. of teeth examined

Mean PS	**Interpretation**
0.1 – 0.9	Mild plaque deposit
1.0 – 1.9	Moderate plaque deposit
2.0 – 3.0	Severe plaque deposit

The mean gingival index (GI) scores was also calculated and interpreted as shown below:

GI = Total scores

Number of teeth examined

Mean GI	**Interpretation**
0.1 – 0.9	Mild gingivitis
1.0 - 1.9	Moderate gingivitis
2.0 – 3.0	Severe gingivitis

Dental caries was determined using WHO criteria (2005). Each tooth was recorded as decayed, missing or filled; (dmft or DMFT). Prior to using the WHO probe to detect dental caries, the tooth was wiped with dry sterile gauze. Caries was recorded as present when a lesion in a pit, fissure or on the smooth tooth surface had unmistakable decay or was detected by probe catching. No radiographs were used to detect especially the proximal caries. Initial caries seen as a white spot lesion was not considered as a tooth decay. A missing primary or

permanent tooth was scored for caries by the PI if a history of loss due to caries was established.

2.8.2 Validity And Reliability of the Data

The questionnaires used in the study were first pretested by the PI at site during the pilot study carried out at the Paediatric Outpatient Clinic at KNH. The PI was initially calibrated on 10 children by the supervisors on plaque score, the gingival index and dmft/DMFT to ascertain inter-examiner reproducibility. The mean results of the Cohen's Kappa were 1.00 for plaque score, 1.00 for gingivitis and 0.90 for dental caries. The PI employed a standardized examination procedure for all the participants. An assistant trained and pretested by the PI entered the scores in the data collection forms **(Appendices ii and iii).** A duplicate clinical examination was conducted on every 5th child to ascertain intra-examiner consistency. A total of 16 children were re-examined and then Cohen's Kappa scores were obtained as 1.00 for plaque score, 1.00 for gingivitis and 0.95 for dental caries.

2.8.3 Data Quality and Control

Completeness of questionnaires and the validity of responses obtained were confirmed by the PI. The data obtained were properly coded and entry made in the computer using SPSS version 20 computer software. All the information collected was stored in a password protected computer while the questionnaires and the clinical examination forms were kept in lockable drawers for confidentiality.

2.8.4 Data Analysis And Presentations

Data were analyzed using SPSS version 20.0 computer software to obtain descriptive analysis and frequency distribution data. Pearson's Chi-Square and Fisher's exact test were

used to compare categorical variables within the study population while regression models were used to test the associations between the variables. Bivariate analysis was employed to test any relationship between T1DM variables (level of control and duration) plaque score, gingivitis and dental caries experience. An ordinal probit regression models were used to test relationships between T1DM, plaque score and gingival scores while a negative binomial regression was used to analyse relationship between T1DM and DMFT/dmft scores. Level of control and the duration of having T1DM were used as covariates to assess their effect on the plaque, gingival and DMFT/dmft scores. The lower confidence interval (CI) was set at 5% while the higher confidence interval was set at 95%. The Odd's ratio (OR) was used to test effects of level of control and duration of T1DM on plaque scores, gingival scores and DMFT/dmft counts. The results were presented in form of tables and figures.

2.8.5 Ethical Considerations

1. Approval to carry out this study was obtained from the KNH-University of Nairobi Ethics and Research Committee (Ref. P09/11/2014).
2. Informed written consent was obtained from the caregivers. The children's assent was also obtained.
3. Confidentiality was maintained and the information obtained was used solely for the purpose of the study and for the benefit of the community.
4. Data collected was stored in a locked cabinet, coded and input into a password protected computer.

5. All the children and the accompanying caregivers were given oral health education and any emergencies referred to the KNH dental clinic or University of Nairobi Dental Hospital.
6. The findings of this study will only be used for the purpose of a dissertation submitted in partial fulfillment of the requirement for the master of dental surgery in paediatric dentistry of the University of Nairobi. The findings will also be disseminated through publication and a written report to KNH.

2.8.6 Limitations of the study

1. Since no radiographic or other modes of investigations were used, dental caries could have been under reported.
2. A low sample size of 82 children in the study arising from low flow of patients during the period of the study.
3. Two methods of diagnosis of T1DM were used, hence providing lack of uniformity in the diagnosis.

Chapter 3

3.0 Results

3.1.0: Socio-demographic Characteristics

A total of 82 children aged between 3 to 18 years, 39(47.6%) males and 43 (52.4%) females, participated in the study. Their mean age was 11.6 ±4.1 SD, out of whom 45(54.9%) were aged between 12 and 18 years, 31(45.1%) were aged between 6 to 11 years and only 6(7.3%) had their ages between 3 and 5 years. In terms of the level of education of the children, 53(64.6%) were in primary school, 23(28%) were in secondary school while 6(7.3%) were in preschool. On the other hand, sixty two children (75.6%) came from within Nairobi county while the remaining, 20(24.4%) came from outside Nairobi county.

On the caregivers' socio-demographic characteristics, the age of the caregivers ranged from 21 to 56 years and majority of them 43(52.4%) were aged between 31 and 40 years. Most of the children 52(63.4%) were accompanied by their mothers and only 5(6.1%) of them were not brought by their parents. Apart from 2(7.3%) of the fathers and 2(3.7%) of the mothers 73(94.8%) of the parents had formal education. A combined 54(65.8%) of the caregivers were either business people or skilled workers while 17(20.7%) reported being unemployed. The rest of the socio-demographic characteristics are shown in figure 1 and table 1

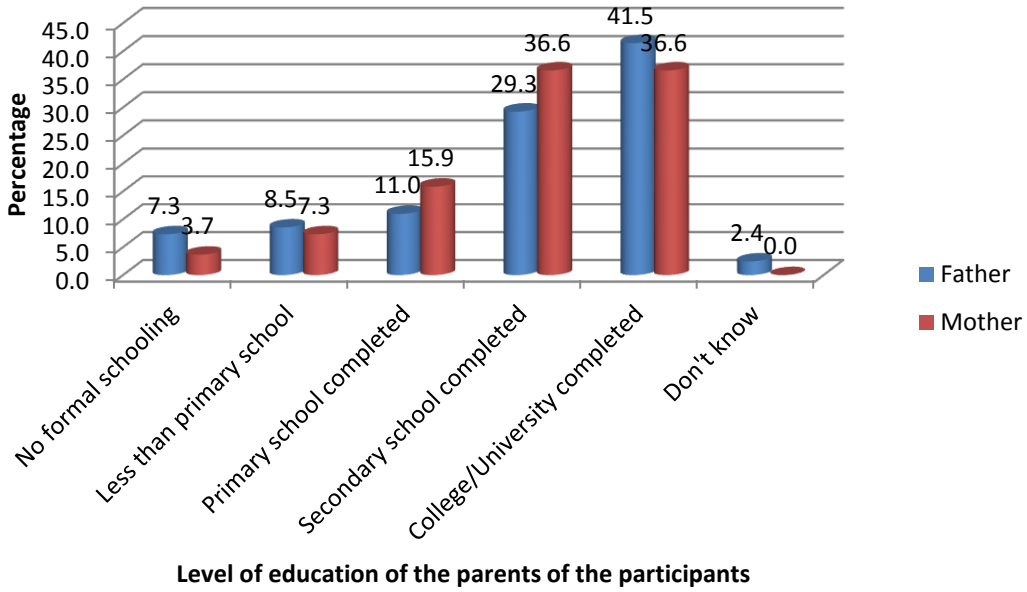

Fig 1: Level of Education of the parents

Table 1: **S**ocio-demographic characteristics of the caregivers of the children

	Frequency	**Percent**
Age of Caregiver of the parents		
21 - 30 years	16	19.5
31 - 40 years	43	52.4
41 - 50 years	18	22.0
51 - 56 years	5	6.1
Caregiver accompanying the child		
Mother	52	63.4
Father	25	30.5
Aunt/Uncle	5	6.1
Parent's occupation		
Unemployed	17	20.7
Unskilled worker	5	6.1
Skilled worker	27	32.9
Businessman	27	32.9
Other	6	7.3

3.2.0: Type I Diabetes Mellitus

From the patients' hospital records, 45(54.9% of the children had a valid HbA_{1c} diagnostic test for T1DM while 37(45.1%) were confirmed to have T1DM using random blood sugar. There was a significant relationship between the diagnostic test used and the gender of the children as shown in table 2. From the results of the tests, majority of the participants with T1DM had poorly controlled T1DM at 59(72%) compared to controlled T1DM, 23(28%). However, the age and gender distribution in accordance with the level of control did not show any significant relationship as shown in table 3. The duration since the diagnosis of T1DM ranged from as low as 1 month to 6 years with a mean duration of 3.3 years. Age and gender distributions of the children with T1DM in accordance with duration since diagnosis are shown in table 4.

Table 2: Age and Gender distribution of children with T1DM in accordance with diagnostic tests used

Age of the children	RBS	**HB1aC**	**Statistical test**
3 - 5 years	3 (3.7%)	3 (3.7%)	Fisher's Exact Test
6 - 11 years	14 (17.1%)	17 (20.7%)	p = 1.00
12 - 18 years	20 (24.4%)	25 (30.5%)	
Total	37 (45.1%)	45 (54.9%)	
Gender of the children			
Male	18 (22.0%)	21 (25.6%)	χ^2 =0.03, df = 1
Female	19 (23.2%)	24 (29.3%)	p = 0.86
Total	37 (45.1%)	45 (54.9%)	

Table 3: Age and gender distribution of children with T1DM in accordance with level of control of T1DM

Age of the child	**Controlled**	**Uncontrolled**	
3 - 5 years	3 (3.7%)	3 (3.7%)	Fisher's Exact Test
6 - 11 years	6 (7.3%)	25 (30.5%)	p = 0.22
12 - 18 years	14 (17.1%)	31(37.8%)	
Total	23 (28.0%)	59(72.0%)	
Gender			
Male	12 (14.6%)	27 (32.9%)	χ^2 =0.27, df = 1,
Female	11 (13.4%)	32 (39.0%)	p = 0.60
Total	23 (28.0%)	59 (72.0%)	

Table 4: Age and gender distribution of children with T1DM in accordance with duration since diagnosis

	<1 year	**1- 5 years**	**6-10 years**	**>10 years**	**Total**	**Fisher's Test**
Age of the child						
3 - 5 years	2 (2.4%)	4 (4.9%)	0 (0.0%)	0 (0.0%)	6 (7.3%)	
6 - 11 years	5 (6.1%)	20 (24.4%)	5 (6.1%)	1 (1.2%)	31 (37.8%)	P= 0.664
12 - 18 years	4 (4.9%)	30 (36.6%)	9 (11.0%)	2 (2.4%)	45 (54.9%)	
Total	11(13.4%)	54 (65.9%)	14 (17.1%)	3 (3.7%)	82 (100.0%)	
Gender						
Male	5 (6.1%)	26 (31.7%)	6 (7.3%)	2 (2.4%)	39 (47.6%)	p= 0.914
Female	6 (7.3%)	28 (34.1%)	8 (9.8%)	1 (1.2%)	43 (52.4%)	
Total	11 (13.4%)	54 (65.9%)	14 (17.1%)	3 (3.7%)	82 (100.0%)	

3.3.0: Oral Hygiene Practices

Majority of the children 51(62.2%) cleaned their teeth once a day, compared to 28(34.1%) children who cleaned their teeth 2 or more times a day. One child reported cleaning his teeth just several times a month. Table 5 shows the methods used by the children to clean their teeth and gums, all the children reported using a toothbrush to clean their teeth. Except one child (1.2%), the rest of the children used fluoridated toothpaste to clean their teeth. On inquiry of the visit to the dentist, 10 (12.2%) of the children visited the dentist in the last 12 months because of pain and treatment follow-ups as shown in table 6.

Table 5: Methods used to clean the child's teeth or gums

	No./percent Yes	**No./percent No**
Toothbrush	82 (100%)	0 (0%)
Wooden toothpicks	5 (6.1%)	77 (93.9%)
Plastic toothpicks	0 (0.0%)	82 (100%)
Thread (dental floss)	0 (0.0%)	82 (100%)
Charcoal	0 (0.0%)	82 (100%)
Chewing stick/miswaki	2 (2.4%)	80 (97.6%)

Table 6: Oral hygiene practices and reason for visit to the dentist by the children who participated in the study

Frequency of dental visits in the last 12 months	Number	percent
Once	8	9.8
Twice	1	1.2
Four times	1	1.2
Not visited dentist in the last 12 months	62	75.6
Never visited a dentist	10	12.2
Total	82	100
Reason for the dental visits (only those who visited the dentist in the last 12 months)		
Pain or trouble with teeth, gums or mouth	4	40
Treatment/follow-up treatment	4	40
Routine check-up of teeth/treatment	1	10
I don't know/don't remember	1	10
Total	10	100

3.3.1: Dietary Practices of the children

A proportionately high number of the children 70(85.4%) reported never consuming snacks. Similarly, majority of the children reported never consuming fizzy drinks, jam/honey or anything containing sugar as shown in table 7.

Table 7: Dietary practices of the children in the study

Foods	Several times a day	Everyday	Several times a week	Once a week	Several times a month	Never
Fresh fruits	5(6.1%)	36(43.9%)	22(26.8%)	12(14.6%)	4(4.9%)	3(3.7%)
Snacks	1(1.2%)	1(1.2%)	0(0.0%)	7(8.5%)	3(3.7%)	70(85.4%)
Fizzy drinks	1(1.2%)	0(0.0%)	2(2.4%)	4(4.9%)	6(7.3%)	69(84.1%)
Jam/honey	1(1.2%)	4(4.9%)	2(2.4%)	3(3.7%)	5(6.1%)	67(81.7%)
Chewing gum with sugar	0(0.0%)	3(3.7%)	2(2.4%)	0(0.0%)	1(1.2%)	76(92.7%)
Sweets/candy	0(0.0%)	1(1.2%)	0(0.0%)	5(6.1%)	3(3.7%)	73(89.0%)
Milk with sugar	0(0.0%)	1(1.2%)	0(0.0%)	0(0.0%)	1(1.2%)	80(97.6%)
Tea with sugar	0(0.0%)	1(1.2%)	0(0.0%)	1(1.2%)	1(1.2%)	79(96.3%)
Coffee with sugar	0(0.0%)	1(1.2%)	0(0.0%)	1(1.2%)	0(0.0%)	80(97.6%)

3.4.0: Oral Hygiene Status

A moderate plaque deposit (mean plaque score of 1.6 ± 0.37) was found in the children and a relatively lower mean score (1.4±0.19) in the primary dentition compared to a mean score of 1.6 in both the mixed and in the permanent dentitions. There was a statistically significant relationship between age of the child and the plaque score ($p<0.05$). On the contrary, no differences were found in the plaque accumulation between the male and the female participants (χ^2 (1) =.284, $p >0.05$). The details of the mean plaque scores among the children

according to the age, gender and type of dentition are shown in table 8 while table 9 shows the plaque deposit according to the age and gender of the children.

Table 8: Mean plaque score of the children by their age, gender and type of dentition

	Mean plaque score	Std. Deviation
Age of the child		
3 - 5 years(n=6)	1.4	.25
6 - 11 years(n=31)	1.6	.34
12 - 18 years(n=45	1.6	.41
Gender		
Male(n=39)	1.6	.38
Female(n=43)	1.6	.37
Type of dentition		
Primary/Deciduous	1.4	.19
Permanent	1.6	.38
Mixed	1.6	.40
Overall	1.6	.37

Table 9: Plaque deposits of the children by age and gender of the children

	Mild plaque deposit	Moderate plaque deposit	Statistical test
Age of the child			
3 - 5 years	5 (6.1%)	1 (1.2%)	Fisher's Exact = 8.668
6 - 11 years	6 (7.3%)	25 (30.5%)	p = 0.01
12 - 18 years	14 (17.1%)	31 (37.8%)	
Gender			
Male	13 (15.9%)	26 (31.7%)	χ^2 (1) =0.28,
Female	12 (14.6%)	31 (37.8%)	p = 0.59
Total	25 (30.5%)	57 (69.5%)	82(100.0%)

3.4.1: Relationship between T1DM and Plaque Score

A bivariate analysis run to test any significant relationships between level of control and duration since diagnosis of T1DM against plaque deposits did not show any significant relationships as shown in table 10.

Table 10: Bivariate analysis between T1DM and plaque deposits by the children

	Mild plaque deposit	Moderate plaque deposit	Total	Test
Level of control of T1DM				
Controlled	9 (11.0%)	14 (17.1%)	23 (28.0%)	χ^2 (1) = 1.127, p = 0.288
Uncontrolled	16 (19.5%)	43 (52.4%)	59 (72.0%)	
Total	25 (30.5%)	57 (69.5%)	82 (100%)	
Duration since diagnosis of T1DM				
Less than 1 year	4 (4.9%)	7 (8.5%)	11 (13.4%)	Fisher's Exact = 1.770, p =0 .690
1 - 5 years	18 (22.0%)	36 (43.9%)	54 (65.9%)	
6 - 10 years	3 (3.7%)	11 (13.4%)	14 (17.1%)	
Above 10 years	0 (0.0%)	3 (3.7%)	3 (3.7%)	
Total	25(30.5%)	57(69.5%)	82(100.0%)	

An ordinal probit regression model shown in table 11 revealed that uncontrolled T1DM and increase in the duration of having the disease contributed to increase in plaque scores. The odds of having a plaque score of 2 in the uncontrolled T1DM was 6.368{4.90-8.27} times that of controlled T1DM, a statistically significant relationship (χ^2 (1) = 193.08, p<0.05). Likewise, the risk of having a high plaque scores in the uncontrolled group was 1.24 times that of the controlled group (OR 1.24; 0.98-1.56), but was not statistically significant

(p>0.05) The percentage change in plaque score was a 0.3% increase for every unit increase in duration in months; OR=1.00(1.000-1.006) which was statistically significant(p<0.05).

Table 11: The relationship between the duration and level of control of T1DM, and plaque scores of the children.

Parameter		**B**	**Hypothesis Test**			**Exp(B) (CI)**
			Wald X^2	**Df**	**p≤0.00**	
Threshold	[PS=0]	-1.810	140.193	1	0.00	0.16(.121-.221)
	[PS=1]	0.05	0.18	1	0.67	1.05(.850-1.287)
	[PS=2]	1.85	193.08	1	0.00	6.37(4.904-8.268)
Duration (Months)		0.003	4.12	1	0.04	1.00(1.000-1.006)
[Uncontrolled]		0.213	3.31	1	0.07	1.24(.984-1.558)
[Controlled]		0[a]				1
(Scale)		1[b]				

3.5.0: Gingivitis

The children had a mean gingival score of 1.3 ± 0.28 (moderate gingivitis). The mean gingival score was lower in the 3-5 year-olds (1.2±0.19) who had primary dentition (1.2±0.29). There were no statistically significant relationships between severity of gingivitis, age and gender of the children as shown in Table 12.

Table 12: Severity of the gingivitis in relation to age and gender of the children in the study

		Mild gingivitis	Moderate gingivitis	Statistical Tests
Age of the child	**Gingival score**			
3 - 5 years	1.2	5(6.1%)	1(1.2%)	Fisher's Exact =4.27,
6 - 11 years	1.3	23(28.0%)	8(9.8%)	p = 0.13
12 - 18 years	1.4	24(29.3%)	21(25.6%)	
Gender				
Male	1.3	26(31.7%)	13(15.9%)	χ^2 (1) =0.34, p=0.56
Female	1.4	26(31.7%)	17(20.7%)	

3.5.1: The relationship between gingivitis, duration and level of control of T1DM

A bivariate analysis was run to test significant relationships between level of control and duration since diagnosis of T1DM against severity gingival scores did not show any significant relationships as shown in table 13.

Table 13: Bivariate analysis between T1DM (control and duration) and severity of gingivitis

	Gingivitis			
	Mild	**Moderate**	**Total**	**Test**
Level of control				
Controlled	16 (19.5%)	7 (8.5%)	23 (28.0%)	χ^2 (1) = .521, p =
Uncontrolled	36 (43.9%)	23 (28.0%)	59 (72.0%)	.470
Total	52 (63.4%)	30 (36.6%)	82 (100%)	
Duration since diagnosis of T1DM				
Less than 1 year	8 (9.8%)	3 (3.7%)	11 (13.4%)	Fisher's Exact =
1 - 5 years	36 (43.9%)	18 (22.0%)	54 (65.9%)	3.228,
6 - 10 years	6 (7.3%)	8 (9.8%)	14 (17.1%)	p = .342
Above 10 years	2 (2.4%)	1 (1.2%)	3 (3.7%)	
Total	52 (63.4%)	30 (36.6%)	82 (100.0%)	

An ordinal probit regression model was used to test the relationships between gingival score changes with level of control and duration of having T1DM. Uncontrolled T1DM and an increase in duration of having the disease led to an increase in gingival scores. The odds of having moderate gingivitis in uncontrolled T1DM was 19.55{10.10-37.47} times that of controlled T1DM, a statistically significant relationship (χ^2 (1) = 80.20, $p< 0.05$). The percentage change in gingival scores resulted in 0.1% increase for every unit increase in duration in months; a non-significant relationship (O.R 1.00{.998-1.004} with $p> 0.05$. This ordinal probit regression model is illustrated in table 14.

Table 14: Gingival score in relation to duration and level of control of T1DM of the participants

Parameter		**B**	**Hypothesis Test**			**Exp(B) (CI)**
			Wald X^2	**df**	**p≤0.05**	
Threshold	[GI=0]	-2.048	150.10	1	0.000	.129(0.09-0.18)
	[GI=1]	0.522	21.095	1	.000	1.686(1.35-2.11)
	[GI=2]	2.973	80.201	1	0.000	19.547(10.200-37.47)
Duration		0.001	.600	1	.439	1.001(.998-1.00)
[Uncontrolled]		0.068	.288	1	.591	1.071(0.84-1.37)
[Controllled]		0[a]				1
(Scale)		1[b]				

3.6.0: Dental Caries

3.6.1: Prevalence of Dental Caries

The overall percentage of the participants with dental caries was 78% with an average DMFT/dmft of 3.2±2.9 and a mean DMFT/dmft of 3.5 at 12 years. The total DMFT/dmft

scores ranged from 0 to 11 per child and the mean DMFT/dmft increased with age of the children as shown in Fig. 2.

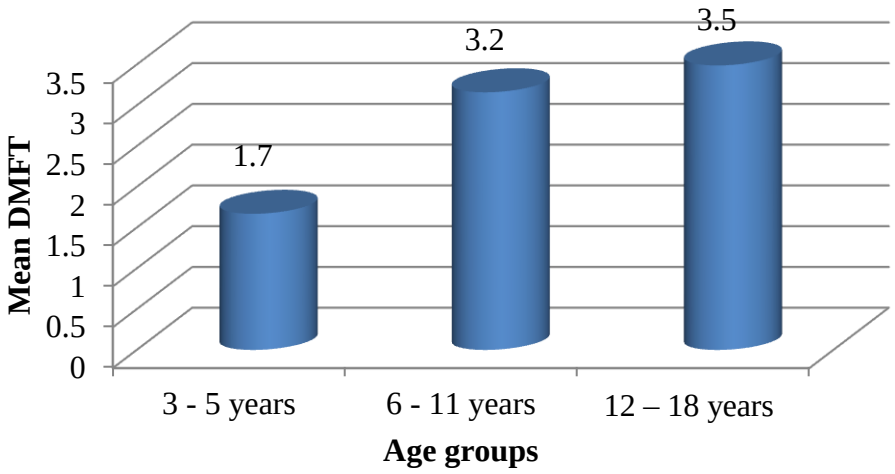

Fig. 2: Mean DMFT/dmft of the participants

3.6.2: Dental Caries in Relation to Age and Gender of the Children

The average DMFT/dmft was higher among children aged 12-18 years who were in permanent dentition (3.49±2.93). None of the children had a filled tooth and, therefore, the average score was mainly brought by the decayed component of the DMFT/dmft. The mean DMFT/dmft according to the children's age and gender was not statistically significant as shown in table 15.

Table 15: Mean DMFT/dmft according to age and gender of the children in the study

	DMFT/dmft Mean±SD	**Dt Mean±SD**	**Mt Mean±SD**	**ft Mean±SD**
Age of the child				
3 - 5 years(n=6)	1.7±2.4	1.7±2.4	0.00±0.00	0.00±0.00
6 - 11 years(n=31)	3.2±2.8	2.9±2.6	0.3±0.8	0.00±0.00
12 – 18 years(n=45)	3.5±2.9	3.20±2.8	0.3±0.7	0.00±0.00
	F(1,80)=0.44, p=0.51	F(1,80)=0.50, p=0.48	F(1,80)=0.241, p=0.63	
Gender				
Male	3.3±2.9	3.1±2.7	0.3±0.8	0.00±0.00
Female	3.2±2.8	2.93±2.66	0.23±0.65	0.00±0.00
	t(80)=0.23, p=0.82	t(80)=0.22, p=0.84	t(80)=0.31, p=0.76	

3.6.3: Mean DMFT/dmft in relation to level of control and duration since the participants' diagnosis of T1DM

Table 16 below shows the variation of mean DMFT/dmft in relation to level of control and duration since diagnosis of T1DM. There was a higher mean DMFT/dmft among the children with uncontrolled T1DM (3.41±2.817) and those with longer duration of having T1DM (4.00±3.61).

Table 16: DMFT/dmft in relation to level of control and duration since the participants' diagnosis of T1DM

	DMFT Mean±SD	dt Mean±SD	mt Mean±SD	ft Mean±SD
Level of control of T1DM				
Controlled	2.8±2.98	2.74±2.99	.13±.63	0.00±0.00
Uncontrolled	3.4±2.82	3.08±2.56	.31±.75	0.00±0.000
Duration in years				
Less than 1 year	4.36±3.80	4.18±3.49	.18±.61	0.00±0.00
1 - 5 years	3.17±2.65	2.91±2.46	.31±.797	0.00±0.00
6 - 10 years	2.43±2.71	2.14±2.51	.14±.54	0.00±0.00
Above 10 years	4.00±3.61	4.00±3.61	0.00±0.00	0.00±0.00
Total	3.23±2.86	2.99±2.67	.26±.72	0.00±0.00

The DMFT/dmft scores were analysed using a negative binomial regression model where changes of the total scores were related to level of control and increase in duration since diagnosis of T1DM. Children with uncontrolled T1DM were 1.28 times more likely to have a higher DMFT/dmft scores than those with controlled diabetes (O.R 1.28{0.711-2.29}) with a $p>0.05$; a statistically non-significant relationship. The percentage change in DMFT/dmft scores was a 0.2% decrease for every unit increase of duration in months. The expected log counts of DMFT/dmft decreased by 0.002 for each one month increase in duration. In essence, increase in duration of having T1DM had more of a protective rather than a detrimental effect on the dental caries experience among the diabetic children (O.R. 0.998{0.992-1.005}. This apparent decrease in DMFT/dmft score with increase in duration

was, however, not statistically significant (p0.05). The negative binomial regression model is shown in table 17.

Table 17: Relationship between DMFT/dmft score, duration and level of control of T1DM of the children

Parameter		**Hypothesis Test**			**Exp(B) (CI)**
	B	**Wald X^2**	**df**	**p≤0.05**	
(Intercept)	1.054	17.519	1	0.000	2.870(1.752-4.703)
Duration	-0.002	0.225	1	0.635	0.998(.992-1.005)
[Uncontrolled]	0.243	0.666	1	0.414	1.275(.711-2.287)
[Controlled]	0[a]				1
(Scale)	1[b]				
(Negative binomial)	1[b]				

Chapter 4

4.0 Discussion

This current study was a hospital based cross-sectional study aimed at determining the dental caries experience, gingivitis and oral hygiene practices among 3-18 year-old children diagnosed with T1DM and attending KNH paediatric outpatient clinic. Althought children younger than 3 years are seen in the Paediatric Outpatient Clinic they were excluded since the study required the participants to be in full deciduous dentition. The wide age range was also seen as necessary so as to capture the effect of an increase in duration of having T1DM on oral hygiene status, gingivitis and dental caries experience among these patients. The study population and the study area (KNH) were chosen so as to gather the varied socio-demographic characteristics of the study population, some of whom were referred from different parts of the country. As a national referral hospital, the medical records of the patients were relied on to obtain the T1DM data (diagnosis, level of control and the duration since diagnosis). Even though RBS is not the ideal test it was still used in the diagnosis and evaluation of the level of control of T1DM in 45.1% of the participants, the children were being managed properly by paediatric endocrinologists. This minimized the risk of inclusion of non-diabetic children in the study.

Diagnosis of dental caries, gingivitis and oral hygiene status was solely based on clinical examination. Since no radiographic investigation for dental caries was used in this study with probability of underestimation of dental caries as has reported by Lesan[68]. Early presentation of aggressive forms of periodontitis commonly found in the African paediatric population could have also been erroneously scored as gingivitis in the current study. The caregivers'

responses on the oral hygiene practices of especially the younger participants (below 13 years) could have led to over exaggeration of the children's oral hygiene practices. Caregivers' dietary recall bias and possible inadequacy of dietary control of T1DM while the children were at school could not be ruled out. The reported oral hygiene and dietary practices contradicts with the study findings of high dental caries experience, high plaque and gingival scores among the children.

4.1.1 Socio-demographic Characteristics

The mean age of 11.6 years (±4.1 SD) for the children in the current study was similar to that of a study by Alves[69] in Brazil which had a mean age of 11.3 years (± 3.4 SD). The mean age was; however, lower than that of a study done in Sudan which had a mean age of 13 years (± 3.19 SD) [39] and much less than that of Recep[11]of 9 years (± 0.14 SD) from Turkey[11]. The age distribution in the present study was skewed towards the 12-18 years age group probably due to later onset or later diagnosis of T1DM. The fact that 63.4% of the children were accompanied by their mothers, out of whom 26.9% had less than secondary level of education could have affected the awareness of the oral health needs of their children. Furthermore, 19.5% of the caregivers were in the lower age bracket of 21 to 30 years and 26.8% of these caregivers were either unskilled workers or were unemployed. These non-biological determinants of the caregivers could give rival explanation of the oral hygiene status, gingivitis and dental caries outcome of the diabetic children in this study.

4.1.2: Oral Hygiene Status

The oral hygiene status of the study population was generally poor. Mechanical reduction or elimination of dental plaque by tooth brushing is recommended worldwide in the maintenance of oral hygiene. In this study all the children brushed their teeth with a toothbrush and fluoridated toothpaste. This was similar to what was reported by Siudikiene[44] in Lithuania where 99.3% of the diabetic children were reported to have brushed their teeth with a toothpaste containing fluoride. On the other hand, a majority of the children (62.2%) brushed their teeth once a day while 34.1% of them brushed their teeth two or more times a day. A Brazilian study conducted by Alves in 2009 among diabetic children reported that more than half of the children brushed their teeth three times a day. The difference in the frequency of tooth brushing between the current study and that of Alves from Brazil could be attributed to the 63.8% of the diabetic children from Brazil who had been to the dentist in one year against no dental visit for a year among the diabetic children in this study. Furthermore, there was no dental floss use found in the current study while the Brazilian study reported that 30.9% of the diabetic children flossed at least once a day[69]. Although dental plaque formation is accelerated among diabetic children[54, 55], proper oral hygiene practices can lower the high plaque scores found in this study.

Diet, especially the cariogenic type, is an important factor in dental caries experience. In this study population, there was low sugary diet intake reported among the children in this study, and this was similar to what was reported by Siudikiene[44] in Lithuania and Matson in Sweden[70]. This was expected of diabetic children for the glycemic control of T1DM disease. However, in the current management of diabetes diet is less restricted. This could have

contributed to the discordance between low reported sugar intake and the high level of uncontrolled T1DM (72%) among these patients. Another cause of uncontrolled T1DM like low medication compliance could probably have led to the high level of uncontrolled diabetes in this study.

The mean plaque index in this study was 1.6± 0.37 which was almost the same as 1.69± 0.81 reported in a study done in Belgium among 3-16 year-olds with T1DM[38]. Other studies previously conducted have also shown a tendency to increased plaque scores in diabetic patients[25, 54, 69]. In the present study, the Fisher's exact test yielded a statistically significant relationships between age, level of education and type of dentition of the children and the plaque score ($p<0.05$). Despite favourable brushing and dietary practices, the children in this study had a poor oral hygiene with moderate plaque deposit. About 69.5% of the children had moderate plaque deposit, majority of whom (75.4%) had uncontrolled T1DM. Poor oral hygiene status was also reported in Sudan among diabetic children[39.]

In the current study, regression analysis showed higher plaque scores among the children with uncontrolled T1DM ($p<0.05$) which was in agreement with the reported hypothesis of high glucose content in uncontrolled diabetes favouring dental plaque formation[54, 55]. On the other hand, an increase in duration of having T1DM did not lead to significant increase in plaque scores ($p>0.05$).

4.1.3: Gingivitis

There was probably increased gingival inflammation among the children as a result of T1DM. Gingivitis was highly prevalent (100%) in the current study with a mean gingival index score of 1.3 ± 0.28. The mean gingival index scores increased with an increase in age probably due to lower number of younger children in this study. The 3-6 years old were only six compared to 45 children in the 12-18 years age bracket. A Turkish study among diabetic children demonstrated increasing mean gingival score with an increase in age and reported mean gingival index scores of 1.54 ± 0.5 in the 5–9 year-olds and 1.98 ± 0.6 in the 10-14 year-olds[11]. Whereas in the present study all the children had gingivitis, 63.4% had mild gingivitis while 36.6% had moderate gingivitis. The high prevalence of gingivitis had also previously been reported among 2-15 years old children with T1DM in Libya. In the current study, there were differences in the gingival scores in primary, mixed and permanent dentition but the results were not statistically significant (P>0.05). This was contrary to the Libyan study which reported a statistically significant difference in plaque and gingival scores between the groups in the primary, mixed, and permanent dentition[53]. A lower prevalence of gingivitis was reported in a Turkish study among diabetic children where gingival inflammation was 69.7% in the 5 - 9 year-old children and 83.7% in the 10 - 14 year-old children[11]. Probably the high percentage of uncontrolled T1DM (72%) and low regular dental consultations in the present study could have led to vascular changes in the gingiva and hence the higher gingivitis in this current study. Likewise, the high plaque deposits (mild 30.5% and moderate 69.5%) could have led to exaggerated gingival inflammation and hence the poor gingival health in the current study.

There was a statistically significant relationship between level of control of diabetes and gingivitis ($p<0.05$). This contradicted with previous reports that there was a relationship between glycemic control and gingival inflammation but a clinically significant improvement in gingivitis had not been demonstrated[8, 71]. A longitudinal controlled study among diabetic and non-diabetic children from Brazil reported that there was no significant relationship between T1DM and gingivitis[52]. There was no significant relationship between increase in duration of having T1DM and increase in gingival scores ($p>0.05$) among diabetic children in the current study. This was in agreement with the findings of a study by Alves (2009) in Brazil which reported a mean duration of 4.5 years compared to 3.3 years in the current study but still found much lower (27%) level of gingivitis than that of the present study (100%)[69]. The difference in the level of gingivitis could have been brought about by the lack of regular dental visits among the children in this study. There was also lack of flossing among the children in the current study compared to a third of the children in the Alves study who used a dental floss at least once daily.

4.1.4 Dental Caries

The dental caries experience in the study population was 78%. This was similar to an 80% reported in Belgium[38] but slightly higher than 60.3% prevalence in Sudan[39]. The Belgium study attributed the untreated dental caries to low levels of dental visit among those diabetic children[38]. That was also the case in the current study where 62(75.6%) of the children never visited the dentist for a year prior to the data collection time. The poor oral hygiene and uncontrolled T1DM of these children also contributed to the high dental experience.

The mean DMFT/dmft was higher among children aged 12-18 years (3.49±2.93) who were in permanent dentition. This finding was similar to what was reported among 5-14 year-old children with T1DM in Turkey where the caries experience in the permanent dentition was higher in those with uncontrolled T1DM. They also noted that the amount of caries increased with age[11]. The relatively higher DMFT (3.9) in the permanent dentition was also reported by Akpata in Kuwait in a study done among 12-15 year-olds diabetic children[72]. Another study conducted in southern Iran by Alavi (2006) reported higher mean DMFT (9.64 ± 4.64) among 5-18 year-old children with T1DM[73]. However, the Iranian study used bitewing radiographs for the diagnosis of proximal dental caries in the posterior teeth, hence the higher mean DMFT compare to the findings of the current study. In contrast, a study conducted by Siudikiene in Lithuania reported a lower DFS of 23.07 in the permanent dentition compared to the primary and mixed dentitions[44]. The variations in the DMFT scores in the permanent dentition could be attributed to the multifactorial nature of the dental caries occurrence. In terms of gender variation, the male diabetic children had a higher mean of DMFT/dmft scores, higher decayed and missing teeth compared to the females. The differences were, however, not statistically significant ($p>0.05$). Miko (2010) from Hungary also reported higher dental caries burden in the male than in the female diabetic patients and the gender differences in the DMFT/dmft were statistically significant[74]. Probably, the larger sample size in the Hungarian study comprising of 259 diabetic patients compared to the smaller sample size of 82 in the current study could explain the significant findings in the Hungarian study. In addition, a higher age bracket of 14 to 19 years and the smaller age range in the study by Miko (2010) could further the different findings in the two studies. Similarly, Alavi

(2006) reported a higher DMFT scores and higher frequency of decayed teeth in boys than in girls among 5-18 year-old diabetic children from southern Iran[72].

Dental caries experience and T1DM control did not show a significant relationship (P>0.05). However, an increase in DMFT/dmft scores in the present study was seen among the children with poorly controlled diabetes. This was similar to a longitudinal study done in Sweden and a cross-sectional study done in Turkey among children with T1DM. These longitudinal studies reported that the participants with uncontrolled T1DM had slightly more dental caries already present at baseline and that the differences were not statistically significant[11, 43]. Another study done among diabetic children and adolescents in Finland reported that DFS scores were increased in patients with poorly controlled T1DM[8]. However, the study by Siudikiene (2008) conducted among 10-15 year-old diabetic children reported that there was a statistically significant association between level of control of diabetes and high caries experience in the diabetics[44]. In the current study, the regression model of DMFT/dmft in relation to duration since diagnosis of T1DM did not show a statistically significant relationship. This was similar to what was reported by Miko[70]. The emphasis should, therefore, be on maintaining a satisfactory metabolic control and appropriate oral hygiene practices.

4.2 Conclusions

1. The oral hygiene of the children who participated in this study was poor with a high dental caries experience (78%) and gingivitis (100%).
2. Uncontrolled T1DM and an increase in duration of having T1DM were associated with significant increase in dental plaque scores.
3. Gingival scores increased significantly among the children with uncontrolled T1DM while the disease duration did not show any significant change in the severity of gingivitis. On the other hand, the level of control and the duration of T1DM did not have a significant relationship with the dental caries experience of the study participants.

4.3 Recommendations:

1) There is a need to achieve controlled T1DM as this appears to assist in maintaining a better oral hygiene status as well as in the prevention of gingivitis among children with T1DM.
2) There is also a need to conduct a comparative study among children with and those without T1DM to assess differences in oral hygiene status, gingivitis and dental caries experience between the groups.

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Appendices

Appendix i: a) Consent Form

Dental Caries, Gingivitis and Oral Health Practices Of 3-18-Year-old Children with Type 1 Diabetes Mellitus Attending the Paediatric Outpatient Clinic in KNH

Introduction

I, Dr. Mohamed A. Sheikh from the University of Nairobi would like to seek your consent for your child's participation in a clinical examination of dental caries and gingivitis among 3-18 years old children with type 1 diabetes mellitus. I would also like to seek your consent for filling a questionnaire about the oral health practices of your child.

Objectives of the study

The general objective of this research is to determine the dental caries status, gingivitis and oral health practices among 3-18 years old children diagnosed with type 1 diabetes mellitus attending the paediatric outpatient clinic at KNH. The information I get is part of my research for a thesis as a partial fulfillment for the degree of master of dental surgery in paediatric dentistry at the University of Nairobi.

Benefits

You as the caregivers and the children will receive free oral health education.

This study will form a baseline for future studies. The results and recommendations of this study could be used to develop strategies on oral health education for the caregivers of children with type 1 diabetes mellitus.

The findings of this research will also partially fulfill the requirements of a Master of Dental Surgery in Paediatric Dentistry at the University of Nairobi.

Risks

No risk is anticipated for participating in the study

Method of conducting the research

You will be asked some questions on the oral health practices of your child. The mouth of your child will be examined and observations made will be recorded. The examinations shall be carried out using clean (sterile) instruments and no invasive procedures shall be performed.

Voluntary participation

Your child's participation in the study is voluntary. You can terminate his/her participation in the study at will without any consequences. Also understand that the participation in the study does not entail any financial benefits.

Confidentiality

The information you provide to me as well as the observations recorded on examining the child's mouth will be kept in strict confidence and only used for the purpose of this research. No information, by which your identity or that of your child can be revealed, will be released or published.

If you are satisfied with my explanation and you are willing to have your child participate, please sign the consent form.

Role of Ethics and Research Committee

This study conforms to international standards of medical research and has received the approval of the Kenyatta National Hospital/University of Nairobi Ethics and Research Committee.

Assent information for the children

My name is Dr. Mohamed A. Sheikh from the University of Nairobi. I would like you to allow me to check your mouth to see if there are any holes (decay) in your teeth or a gum disease. I will use a dental mirror and a probe to examine your teeth and gums and that your caregiver has also allowed me to examine you.

Consent Form

I_____ of_____

Having understood the nature of the study as explained to me by Dr. Mohamed A. Sheikh of The University of Nairobi, I am willing to have my child participate in the study. My child has also assented to participate in the study.

Name _____ Sign _____ Date _____

Caregiver

I confirm that I have explained the nature of the study to the caregiver.

Name _____Sign _____ Date

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Kiambatisho i b): Fomu Ya Idhini

Meno kuoza, kuvimba ufizi na mazoea ya afya ya kinywa kwa watoto kati ya umri wa miaka 3 na 18 ambao wanaugua aina 1 ugonjwa wa kisukari katika kliniki ya watoto ya Kenyatta national hospital.

Utangulizi

Mimi , Dk Mohamed A. Sheikh kutoka Chuo Kikuu cha Nairobi ningependa kuomba idhini yako kwa ajili ya ushiriki wa mtoto wako katika uchunguzi wa meno kuoza na ufizi kuvimba kwa watoto kati ya miaka 3-18 wanaougua aina 1 ugonjwa wa kisukari. Napenda pia kutafuta idhini yako kwa ajili ya kujaza dodoso kuhusu mazoea ya afya ya kinywa kwa mtoto wako.

Malengo ya utafiti

Lengo mkuu wa utafiti huu ni kuamua hadhi ya meno kuoza, ufizi kuvimba na mazoea ya afya ya kinywa miongoni mwa watoto wa umri wa miaka 3-18 wanaougua aina 1 ugonjwa wa kisukari na ambao wanahudhuria kliniki ya watoto hospitali kuu ya Kenyatta. Habari nitazozipata ni sehemu ya utafiti wangu kama kutimiza sehemu kwa ajili ya shahada ya mabwana.

Faida

Wewe kama mlezi na watoto watapata elimu bure afya ya kinywa.

Utafiti huu utakuwa msingi kwa ajili ya tafiti ya baadaye . Matokeo na mapendekezo ya utafiti huu inaweza kutumika kwa kubuni mikakati ya elimu ya afya ya kinywa kwa walezi wa watoto wenye aina 1 ugonjwa wa kisukari.

Matokeo ya utafiti huu pia yatatimiza sehemu mahitaji ya shahada ya mabwaa Mwalimu katika Chuo Kikuu cha Nairobi.

Hatari

Hakuna hatari inayotarajiwa kwa ajili ya kushiriki katika utafiti huu.

Njia ya kufanya utafiti

Utaulizwa baadhi ya maswali juu ya maarifa na mazoea ya afya ya kinywa ya mtoto. Kinywa cha mtoto wako litaangaliwa na kumbukumbu kuotlewa. Kinywa kitachunguzwa kwa kutumia vyombo safi na hakuna taratibu vamizi litatekelezwa.

Ushiriki wa hiari

Ushiriki kwako na wa mtoto wako katika utafiti ni hiari. Unaweza kusitisha yake / ushiriki wake katika utafiti kwa hiari bila madhara yoyote. Pia elewa kwamba ushiriki katika utafiti haina faida yoyote ya kifedha.

Siri

Habari unazotoa kwangu na pia kumbukumbu juu ya kuchunguza kinywa cha mtoto yatawekwa katika imani kali na kutumika tu kwa madhumuni ya utafiti huu. Hakuna habari, ambayo utambulisho yako au ya mtoto wako inaweza kuwa wazi, itakuwa iliyotolewa au kuchapishwa.

Kama wewe umeridhika na maelezo yangu na wewe ni tayari kuwa na mtoto wako kushiriki, tafadhali sahihi fomu ya idhini.

Wajibu wa Tume ya Maadili na Utafiti

Utafiti huu inajilainisha na viwango vya kimataifa ya utafiti wa matibabu na imepokea idhini ya Kenyatta National Hospital/Chuo Kikuu cha Nairobi Maadili na Kamati ya Utafiti.

Habari kutiwa saini kwa ajili ya watoto

Jina langu ni Dk Mohamed A. Sheikh kutoka Chuo Kikuu cha Nairobi. Ningependa kukuomba niangalie mdomo wako ili kuona kama kuna mashimo yoyote (kuoza) katika meno yako au ugonjwa wa fizi. Mimi nitatumia kioo cha meno na probe kuchunguza meno na ufizi na kwamba mlezi amenikubalia nianglie mdomo wako.

Fomu ya idhini

Mimi_____

Baada ya kufahamu hali ya utafiti vile nilivyoelezwa na Dk Mohamed A. Sheikh wa Chuo Kikuu cha Nairobi, nina nia ya kuwa na mtoto wangu kushiriki katika utafiti

Jina _____ saini _____ Tarehe _____

Mlea Mtoto

Nami nathibitisha kuwa nimemweleza jinsi ya utafiti kwa mgonjwa.

Jina _____ saini _____ Tarehe ____

Mpelelezi mkuu

Kwa habari zaidi, tafadhali wasiliana na:

Mpelelezi Mkuu

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Appendix ii: MODIFIED WHO ORAL HEALTH ASSESSMENT FORM (2005)

Date: …… OP/NO: …….

1. **Plaque Score (Silness and Loe 1964)**

55/16=	52/12=	64/24 =	
84/44=		52/32=	75/36=

Where; 0 = No plaque detected

1 = Plaque covering up to 1/3 of tooth surface.

5 = Plaque covering 1/3 to 2/3 of tooth surface.

6 3 = Plaque covering more than 2/3 of tooth surface.

2. **Gingival index: Loe and Silness 1963**

55/16=	52/12=	64/24 =	
84/44=		52/32=	75/36=

Where:

0: Absence of inflammation

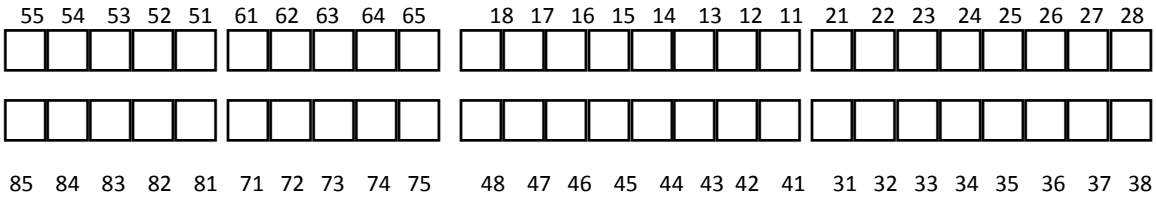
1: Mild inflammation, slight change in colour

2: Moderate inflammation; bleeding on probing

3: Severe inflammation; tendency towards spontaneous bleeding

DENTAL CARIES (WHO ASSESSMENT 2005)

For Deciduous Teeth **For Permanent Teeth**



Tooth Status	Code for deciduous teeth	Code for permanent teeth
Sound	A	0
Decayed	B	1
Filled with decay	C	2
Filled no decay	D	3
Missing as a result of caries	E	4

Appendix iii: Modified WHO Questionnaire

Medical details from the patient's file and treatment sheets

1) Diagnosis_____confirmatory diagnostic test_____

2) Date when first diagnosed with T1DM_____

3) Existing other chronic disease_____

Kindly tick the right choice in the box next to the question.

1. Patient identification _____Residence_____.
2. Age of child _____Child's level of education_____
3. Sex of child: male _____ Female_____
4. What is your relationship with the child?
   i. Mother ☐
   ii. Father ☐
   iii. Aunt/uncle ☐
   iv. Other (specify)……

7 Parent's occupation

   i. Unemployed ☐
   ii. Unskilled worker ☐
   iii. Skilled worker ☐
   iv. Businessman ☐
   v. Other (please specify) ……

6. Age of the parent/guardian (in years) ……

7. How would you describe the health of your child's teeth and gums?

	Teeth	**Gums**
Excellent	☐	☐
Very good	☐	☐
Good	☐	☐
Average	☐	☐
Poor	☐	☐
Very poor	☐	☐
Don't know	☐	☐

8. How often during the past 12 months did your child have a toothache or feel discomfort on account of his/her teeth?

Often	☐
Occasionally	☐
Rarely	☐
Never	☐
Don't know	☐

9. How often did the child go to the dentist during the last 12 months?

Once	☐
Twice	☐
Three times	☐
Four times	☐

More than four times ☐

I had no visit to dentist during the last 12 months ☐

I have never received dental care/visited a dentist ☐

I don't know/don't remember ☐

If you did not visit the dentist during the last 12 months, go on to question 11

10. What was the reason of the child's visit to the dentist?

Pain or trouble with teeth, gums or mouth ☐

Treatment/follow-up treatment ☐

Routine check-up of teeth/treatment ☐

I don't know/don't remember ☐

11. How often does the child clean his teeth? (One answer only)

Never ☐

Several times a month (2-3 times) ☐

Once a week ☐

Several times a week (2-6 times) ☐

Once a day ☐

2 or more times a day ☐

12. Does the child use any of the following to clean your child's teeth or gums?

	Yes	**No**
Toothbrush	☐	☐
Wooden toothpicks	☐	☐
Plastic toothpicks	☐	☐
Thread (dental floss)	☐	☐
Charcoal	☐	☐
Chewing stick/Miswak	☐	☐
Other	☐	☐

Please specify……

13. a) Do you use toothpaste to clean the child's teeth?

b) Does the toothpaste contain fluoride? ☐ ☐

Don't know .....

14. Because of the state of your child's teeth and mouth, did your child experience any of the following problems during the past year?

	Yes	No	Don't know
a) The child is not satisfied with the appearance of his teeth.	☐	☐	☐
b) The child often avoids smiling and laughing because of his/her teeth	☐	☐	☐
c) Other children make fun of his/her teeth	☐	☐	☐
d) Toothache or discomfort caused by his her teeth forced him/her to miss classes at school or for whole days	☐	☐	☐
e) The child has difficulty chewing hard foods	☐	☐	☐
f) The child has difficulty in chewing	☐	☐	☐

15. What level of education did the child's father and mother complete?

	Father	Mother
No formal schooling	☐	☐
Less than primary school	☐	☐
Primary school completed	☐	☐
Secondary school completed	☐	☐
High school completed	☐	☐

Don't know ……

16. How often does your child eat or drink any of the following foods, even in small quantities? (Read each item)

Foods	Several times a day	Every day	Several times a week	Once a week	Several times a month	Never
Fresh fruit						
Snack						
Fizzy drinks						
Jam/honey						
Chewing gum containing sugar						
Sweets/candy						
Milk with sugar						
Tea with sugar						
Coffee with sugar						

That completes our questionnaire

Thank you very much for your cooperation!

Appendix iv: Ethical approval