DIETARY HABITS, NUTRITIONAL STATUS AND PREVALENCE OF DENTAL CARIES AMONG 5-YEAR-OLD SCHOOL CHILDREN IN UASIN-GISHU COUNTY, KENYA

WAKHUNGU HILLARY KIPCHUMBA

A THESIS SUBMITTED TO THE SCHOOL OF AGRICULTURE AND BIOTECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE MASTER OF SCIENCE DEGREE IN COMMUNITY NUTRITION, DEPARTMENT OF FAMILY AND CONSUMER SCIENCES

UNIVERSITY OF ELDORET, KENYA

SEPTEMBER, 2019

DECLARATION

DECLARATION BY THE CANDIDATE

This thesis is my original work and has not been submitted for any academic award in any institution; and shall not be reproduced in part or in full, or in any format without prior written permission from the author and/or University of Eldoret.

WAKHUNGU HILLARY KIPCHUMBA

_____ _____

AGR/PGF/010/14 **DATE**

DECLARATION BY THE SUPERVISORS

This thesis has been submitted with our approval as the University supervisors.

_____ _____

DR. GERTRUDE WERE **DATE**

Department of Family and Consumer Sciences,
School of Agriculture and Biotechnology,
University of Eldoret, Kenya

_____ _____

DR. CHARLOTTE SERREM **DATE**

Department of Family and Consumer Sciences,
School of Agriculture and Biotechnology,
University of Eldoret, Kenya

_____ _____

DR. CAROLINE KIBOSIA **DATE**

Department of Pediatric Dentistry and Orthodontics
School of Dentistry,
Moi University, Kenya

DEDICATION

To my daughter, Kelsie Florrie Wakhungu

ABSTRACT

Dental caries affects 60-90% of children globally with the burden in both industrialized and less industrialized countries undergoing nutrition transition. Nutritional deprivation due to difficulty in eating a variety of foods because of pain from dental caries when chewing food translates into prolonged negative effects on physical growth, cognitive development and overall academic performance. The aim was to assess the link between dental caries, dietary habits and nutritional status of 5-year-old school in Uasin-Gishu County. A cross-sectional survey design was used. Multi-stage systematic and simple random sampling procedures were employed in selecting three hundred and eighty-two (382) 5-year-old children and their parents/caregivers who participated in the study. The criteria proposed by WHO for oral health surveys was used to assess dental caries among 5-year-old. Information on demographic and socio-economic and oral health practices was gathered using structured questionnaires. Dietary intake was collected using quantitative food frequency questionnaire and nutritional status of the children assessed using anthropometric measurements. ENA for SMART computer programmes was used analyze the anthropometric and dietary intake data, while Statistical Package for Social Sciences (SPSS) Version 21 (2014) analyzed the rest of the data. The relationship between nutritional status and dft was analyzed using Pearson's with a statistical significance set at $p < 0.05$. Results showed that 39.3% of children had dental caries (mean dft of 1.55). Children from urban areas (228) had the highest mean dft of 1.83±1.37 while those from rural areas (154) had a mean dft score of 1.16±1.13. Nutrient requirements for protein, vitamin C, calcium, and phosphorus was met by the children, but did not meet the requirements for energy, folate, vitamin A, and iron. Children from urban area had higher overweight than rural children at 13.6% and 8.9% respectively. The prevalence of underweight was higher in rural areas at 10.7%, stunting at 14.6% and wasting at 6.8%. Underweight, overweight, obesity and wasting at (9.0%), (13.9%), (4.2%) and (6.7%) respectively had a significant relationship with dft. More children brushed their teeth (52.6%) with 16.5% brushing at least twice each day. Parents/caregivers had sufficient knowledge and a positive attitude towards oral health hygiene of the children where the techniques of brushing teeth and reduction in the rate of intake of cariogenic foods is not well implemented. In conclusion, the prevalence of dental caries is significantly higher among 5-year-old children in urban than rural areas. Parents displayed good knowledge and attitude towards oral health hygiene, however, they did not implement the right oral hygiene techniques. It is recommended that programs targeting alleviation of malnutrition among children be modified to include dental caries mitigation in both rural and urban areas, and that children should be fed on nutrient rich foods and cariogenic foods should be consumed occasionally.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS

CPI	Community Periodontal Index
CI	Confidence Interval
dft	decayed, filled teeth in primary teeth
DMFT	Decayed, Missing and Filled Teeth in permanent teeth
dmft	decayed, missing and filled teeth in primary teeth
ECDE	Early Childhood Development and Education Program
EER	Estimated Energy Requirement
FFQ	Food Frequency Questionnaire
IOM	Institute of Medicine
KNBS	Kenya National Bureau of Statistics
MTRH	Moi Teaching and Referral Hospital
MUAC	Mid-Upper Arm Circumference
NACOSTI	National Commission for Science, Technology and Innovation
OR	Odds Ratio
RDA	Recommended Daily Allowance
SDG	Sustainable Development Goals
SPSS	Statistical Package for the Social Sciences
WAZ	Weight-for-Age Z-scores
WDF	World Dental Federation
WHO	World Health Organization
WHZ	Weight-for-Height Z-scores

DEFINITION OF OPERATION TERMS

Attitude	This is a fairly lasting organization of conviction about an object, issue, or notion, which disposes one to reply in some special way (Shardra, & Shetty, 2008).
Caregiver	Parents/guardians of 5-year-old children/participants in Eldoret Municipality and Merewet Location
Cariogenic	Producing or promoting the development of tooth decay
Cariostatic	Delaying or limiting the development of dental caries
Charcoal	A black residue that remains after burning wood used traditionally to clean teeth (MoH, 2015)
Chewing stick	This is a wooden stick from selected trees that has medicinal value used to clean teeth (Kiwanuka *et al.,* 2004).
Dental caries	A procedure of demineralization of the enamel, leading to damage of enamel and dentine (Fisher *et al.,* 2012)
Diet	Are food or drink an individual eats every day and the psychological and physical conditions associated to consumption
Dietary Intake	Dietary intake refers to foods consumed daily by the 5-year-old children
Enamel	The hard calcified coating that covers the outside or crown of a tooth
Knowledge	This is well-defined as the know-how and expertise developed by a parents/caregivers of the 5-year-old children through

understanding or learning with the capacity to use it for prevention of dental caries (Sharda, & Shetty, 2008).

Nutritional status The biological circumstance of a person that comes from the stability regarding nutrient wants and ingestion and the capacity of the body to consume these nutrient substances (WHO, 2003).

Oral health It is the state of being free from mouth and facial pain, oral and throat cancer, oral infection and sores, periodontal (gum) disease, tooth decay, tooth loss, and other diseases and disorders that limit an individual's capacity in biting, chewing, smiling, speaking, and psychosocial wellbeing (World Health Organization, 2012).

Oral hygiene practice This is an activity undertaken by people in order to protect, promote, or maintain oral health and prevent dental diseases. The practices include tooth brushing and sugar consumption practice among others (Petersen, 2009)

Rural A geographic area that is located outside towns and cities that are sparsely populated and usually characterized with increased agricultural activities (United Nations Statistics Division, 2014).

Urban Areas with high population concentration and with higher structural development compared to the surrounding areas.

ACKNOWLEDGEMENT

I convey my deepest gratitude to Dr. Gertrude Were, Dr. Charlotte Serrem and Dr. Caroline Kibosia for their excellent guidance, positive criticism, caring, monitoring and constant encouragement throughout the learning process.

Special thanks to the Higher Education Loans Board (HELB) Kenya for the postgraduate scholarship and Colgate-Palmolive (EA) Ltd, School Program for their material and logistical support in the study.

I thank the parents and caregivers of children who took part in this research, the administration of Queen of Angels Mission School, Uasin-Gishu, Itigo and Ainabtich Primary Schools for their willingness to allow the study to take place in their schools and the logistical support during they offered. Special appreciation goes to the research assistants who were instrumental in data collection. .

My appreciation goes to my mother-Florence Mutenyo for her prayer and guidance throughout my study period. To my wife Daisy Bett-Wakhungu for her emotional support and cooperation during this study. To my friends: Amos Ronoh, Deborah Slater and Suge Caroline for their academic and professional support and who made my postgraduate experience fulfilling.

Above all, I acknowledge God for the strength, understanding, guidance and good health throughout my study period.

To all, God bless you!

CHAPTER ONE

INTRODUCTION

1.1 Overview

This section entails the contextual information, statement of the problem, objectives, justification, study limitation and scope.

1.2 Background information

Nutrition is critical to the wellbeing of a person, including oral health. It is important from gestation through the end of life, where it influences growth and development as well as the integrity and function of the dentition (Pflipsen & Zenchenko, 2017). A diet that is balanced is crucial to guaranteeing that individuals receive the nutrients they need, whereas an imbalance intake of nutrients needed to support healthy tissues leads to malnutrition (Moshfegh, Kovalchik & Clement, 2016).

Dental caries is a microbial disease that results in destruction of the teeth enamel (Shah, 2009). It negatively affects the functional, psychological, and the social welfare of both children and their families (De-Paula *et al.,* 2015). It is major oral health problem in most developed nations with 60-90% of all children of school going age affected (WHO, 2015). In 2010 alone, nearly 3 billion individuals were affected with severe caries in secondary teeth and another more than 0.5 billion children having their deciduous teeth affected by untreated caries (Kassebaum *et al.,* 2015). In Africa, the prevalence of dental caries varies significantly by region. For example, a study by Olobasi *et al., (*2015) reported a 35.1% prevalence with Decayed, Missing and Filled Teeth (DMFT) of 0.67±2.0 in Nigeria. Subsequently, a baseline survey in Uganda posited a prevalence of 40% in children where dental caries value of 0.7 was

observed (Wandera & Twa-Twa, 2003). Owino, Masinga, Ng'ang'a and Macigo (2010) reported 50.3% caries prevalence in school going children in Kitale Municipality in Kenya.

Diet plays an important part in the development of dental caries. In response, intake of diets deficient in fluoride, calcium and iron leads to the improper enamel formation that prevent the development of caries (Do *et al.*, 2015). Refined carbohydrates, especially disaccharides such as sucrose have also been established in the etiology of dental caries (Arora, Scott, Bhole, Do, Schwarz *et al.*, 2011). Intake of foods rich in Vitamins D, A, $B_{6,}$ K, phosphorous, calcium, fats, and lysine have inhibitory impact on dental caries initiation and progression. Equally, sufficient intake of vegetables and fruits that are rich in ascorbic acid may also decrease the incidences of dental caries (Pitts, Zero, Marsh, Ekstrand, Weintraub *et al.*, 2017). Cariostatic foods such as milk (Armstrong, Freeman, McComb & Speedy, 2008) and cheese (Shah, 2009) protect teeth through neutralizing dietary acids by stimulating the flow of saliva in the mouth and increasing the plaque calcium concentration (Armstrong *et al.*, 2008). An inadequate diet deficient in major nutrients vital for the development of dental enamel has a remarkable impact on the progression of caries and the occurrence of malnutrition especially among children (Koksal, Tekciced, Yalcin, Tugrul, Yalcin *et al.*, 2011).

Distribution and brutality of dental caries varies globally and within the same nation or regionally (WHO, 2015) where the incidences being reported more in the urban areas unlike the rural areas (Perinetti, Varvara & Esposito, 2006). This is attributed to the difference in the socio-economic status, personal and dietary habits and hygiene (Arora *et al.*, 2011). As such, improvements in the oral care habits may lessen the

occurrence of caries (Datta & Datta, 2013). In spite of this, the rate of teeth decay is very higher in children in developed and developing countries (Bagramian, Garcia-Godoy & Volpe, 2009).

Knowledge, attitude and practices are essential pillars in addressing health related issues, with dental caries being no exception. Studies have shown that a direct link exists between mother's/caregiver's level of knowledge, attitude and practices and dental caries in their children (Olobasi *et al.,* 2015; Kassebaum *et al.,* 2015). A study by Liu, Chen, Hsiao & Huang, (2017) pointed out that good knowledge among parents/caregivers on oral hygiene is a crucial aspect for favorable behaviors on the oral health of children and themselves. This has also been suggested by Szatko, Wierzbicka, Dybizbanska, Struzycka & Iwanicka – Frankowska (2004) where they observed that parents/caregivers with knowledge on tooth brushing have higher chances of instilling correct tooth brushing skills to their children, thus lowering the incidences of dental caries. When it comes to parents/caregivers attitude in prevention of dental caries, Chacha (2016) posited that parents' positive attitude concerning their children's oral hygiene stand a chance to protect them from dental caries. This is because parent's/caregiver's attitude control behavior and beliefs on oral health in children (Vania, Parisella, Capasso, Di Tanna, Vestri *et al.,* 2011). The importance of oral hygiene behaviors such as brushing of teeth has been suggested (Ashkanani & Al-Sane, 2013). In Uasin-Gishu, Okemwa, Gatongi and Rotich (2011) indicated that the level of education of the parents play a key role in dental caries reduction in children.

In Kenya, a prevalence of 23.9% in children with the highest dental caries prevalence 5 year olds (46.3%) has been reported with a mean dmft of 1.87 (Ministry of Health

(MoH), 2015). A study by Kibosia (2011) among urban and rural pre-primary school children in Uasin-Gishu reported dmft's of 3.30 and 1.97 for urban and rural children respectively, with over 90% of these dental caries in 5-year-old remaining untreated. In another study, Okemwa *et al.,* (2011) noted a 38.9% dental caries prevalence in rural children attending school in Uasin-Gishu with a caries score of 0.74 and a mean dft score of 0.4. Consequently, a need to identify the reasons behind the increasing incidence of dental caries among 5-year-old is necessary. Therefore, this study aimed at assessing the link between dental caries with dietary habits and nutritional status of 5-year-old school children as well as the attitude, knowledge, and practices of their parents/caregivers on the prevention of dental caries.

1.3 Statement of the problem

Children at this stage of growth phase experiencing rapid growth and development. Nutritional deprivation due to difficulty in eating a variety of foods because of pain when chewing food translates into prolonged negative effects on physical growth, cognitive development and overall academic performance. In spite of a low death rate linked to caries, a significant impact on the eating ability, self-esteem, nutrition wellness and general well-being both in all growth phases has been noted. Dental caries make chewing difficult thus preventing consumption of a variety of diet. This further affects their growth and development and predisposes them to deficiency diseases, poor immunity and cognitive problems. These conditions compromise their future productivity and social interactions. MoH (2015) found that 31% of children in Kenya had a problem biting hard food due to pain in their teeth, 27.8% avoided smiling and 18.9% missed school in the preceding year because of pain in their teeth.

Cariostatic foods have a role in the protection of teeth through neutralizing dietary acids by stimulating the flow of saliva in the mouth and increasing the plaque calcium concentration. However, cariogenic foods that lack vital nutrients for the growth of teeth enamel significantly affects dental caries progression and the occurrence of malnutrition especially among children**.** Dental caries impedes dietary goals achievements especially on the consumption of all kinds of vegetables, fruits thus leading to poor nutritional health. Further, Vitamin D, calcium and protein deficiency is associated with lack of variety in diet (Ronoh & Were, 2015), hence the development of dental caries (Schroth, Levi, Seller, Friel, Kliewer *et al.*, 2013a). Furthermore, to achieve healthy lives and encourage health security in all phases of life (Sustainable Development Goal 3), Vision 2030 of economic development and Agenda 2063 that advocates for healthy life is negative effected by the impacts of dental caries especially on quality of life. Positive attitude, good knowledge, and the correct oral behaviors of the parents/caregivers have been found to play a critical role in the deterrence of caries in children. This study assessed the dietary habits, nutritional wellbeing and the occurrence of dental caries along with the attitude, knowledge, and behaviors of parents in preventing dental caries among 5-year-old children in urban and rural areas of Uasin-Gishu County, Kenya.

1.4 Objectives

1.4.1 Broad Objective

To examine the relationship between dietary habits, nutritional status and dental caries of 5-year-old school children in Uasin-Gishu County, Kenya

1.4.2 Specific Objectives

1. To determine the prevalence of dental caries in 5-year-old school going children in the selected urban and rural areas of Uasin-Gishu County
2. To analyze the dietary intake of the 5-year-old children in selected schools in urban and rural areas of Uasin Gishu County
3. To assess the Nutritional status of the 5-year-old school children in urban and rural areas of Uasin-Gishu County
4. To analyze the knowledge, attitude and practices on dietary habits and dental caries of 5-year-old children and their caregivers in urban and rural areas of Uasin-Gishu County.

1.5 Research questions

1. What is the relationship between dietary intake and prevalence of dental caries among 5-year-old children in selected schools in urban and rural areas of Uasin Gishu County?
2. What is the relationship between nutritional status and prevalence of dental caries among 5-year-old children in selected schools in urban and rural areas of Uasin Gishu County?
3. What is the relationship between nutritional status of the children and their location (rural or urban)?
4. What is the association between parent/caregivers' attitude, knowledge and practices and the occurrence of dental caries in 5-year-old children?

1.6 Significance of the study

The study results are intended to help caregivers by pointing out how diet choices affect the prevalence of caries so that they can choose foods that support healthy teeth development and prevent caries in children. The findings from this study will help in policy formulation at the National and County Government levels through forming the basis of how they can intervene to combat dental caries, formulating health education campaigns material as well as planning and implementation of community intervention projects to alleviate of dental caries. Further, the body of knowledge on nutrition and caries will be built from the findings.

1.7 Scope of the study

This study took place in selected urban area in Eldoret Municipality and rural area in Uasin Gishu County, Kenya. The study population was 5-year-old school going children and their parents in both public and private day schools. Data collection methods were by use of questionnaires and nutrition anthropometry. The results was generalized to 5-year-old school children in urban and rural areas.

1.8 Limitations of the study

Since the respondents were from selected areas in Uasin-Gishu County, Kenya, generalization of the results to 5-year-old children from different locations should be made with caution. Nevertheless, the results might offer important evidence for parents/caregivers and their 5-year-olds with comparable demographic characteristics. Bias from the parents/caregivers by giving false information on dietary intake of their child to suit the researcher was mitigated by researcher through assuring confidentiality and anonymity of the questionnaires by using unique codes instead of names of the respondents.

1.9 Conceptual framework

In this study, a conceptual framework for evaluating the link between dental caries, nutritional wellbeing and parental/caregivers' factors was adopted and modified from the WHO Global Oral Health Conceptual framework as used by Petersen (2003).

The causes of dental caries are multifactorial having a number of interwoven factors that operates simultaneously (Srisilapanan *et al.,* 2017). The causes are categorized as maternal/caregiver's characteristics, environmental and child's individual factors as described by the WHO Global Oral Health Conceptual framework. The causes reflects relationships among oral hygiene factors and its possible impact on the dental caries of the children.

At parental/caregiver's level, children's dental caries are related to level of education, oral health awareness, attitude and behaviors as well as nutritional and standard of living influences. Environmentally, caries prevalence and its progression is affected by the usage of oral health facilities as well as fluoridated toothpaste. At the child's individual factors, dietary behaviors that entails the intake patterns of cariogenic foods and snacks as well as consumption of cariostatic diets, their oral hygiene practices and nutritional wellbeing of the 5-year-olds is considered.

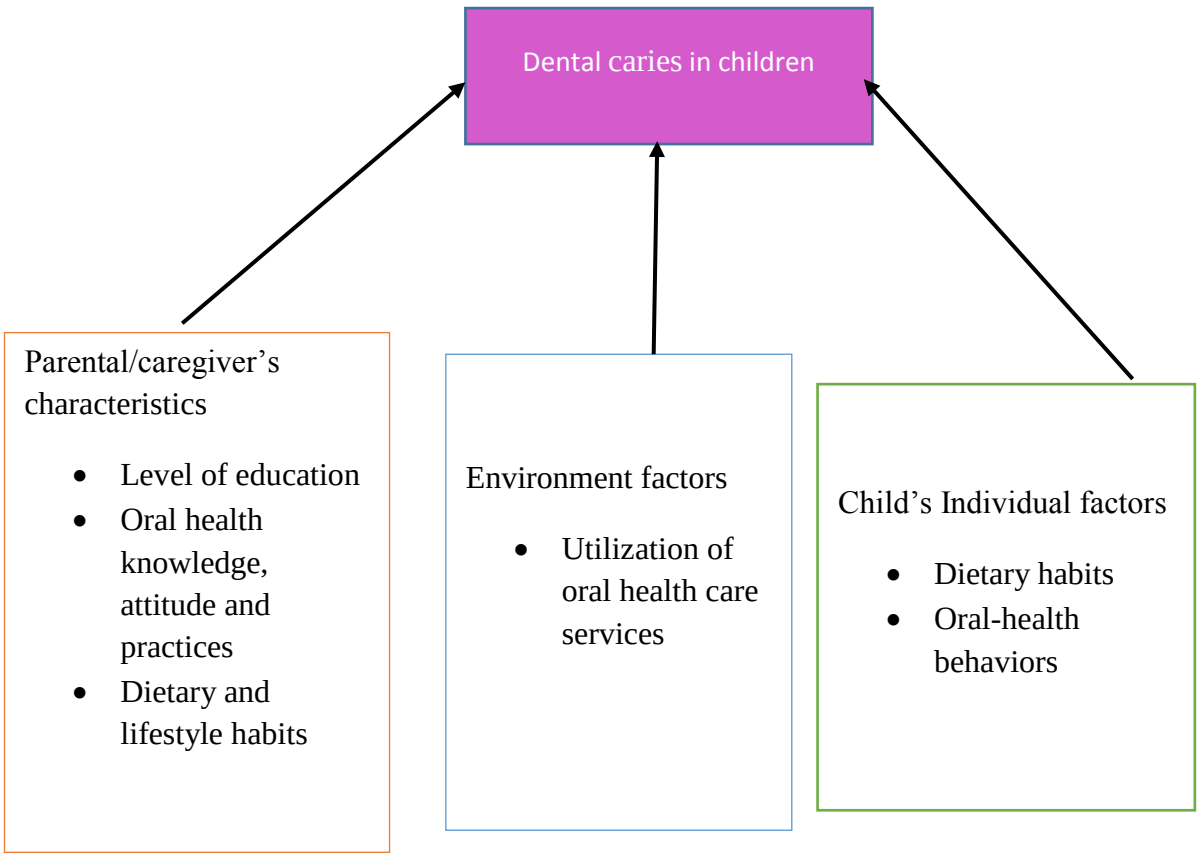


Figure 1.1 Conceptual background on dental caries. Modified from WHO Global Oral Health Conceptual framework (Source: Petersen, 2003)

CHAPTER TWO

LITERATURE REVIEW

2.1 Outline

This section begins with understanding of dental caries, description of DMFT, dmft and df-t in caries determination and the occurrence. It then tackles the pre-disposing issues to dental caries in the subjects. Other areas such as nutrition and dental caries, part of fluoride role in development of dental caries, caries. The relationship of nutrient intake, nutritional wellbeing and prevalence of dental caries in children is highlighted. Further, the review presented the role of attitude, knowledge, and oral hygiene behaviors among children and parents and occurrence dental caries. Finally, summary of literature and gaps in knowledge is presented.

2.2 Dental Caries

Multiple factors that include interaction of bacteria, diet, and host response triggers dental caries development. These factors interact and cause caries initiation and progression (Hurlbutt, Novy & Young, 2010). Dental caries is the localized damage of a vulnerable surface of the tooth through the action of acid that comes from sugar breakdown from the diet people eat over a long period (Datta & Datta, 2013). The first stage is the initial-stage which is seen by the first clinically non-corroded visual changes in surface of the teeth that is seen on clean teeth and any corresponding abrasions seen on x-ray films of the teeth. The second stage is the moderate-stage which is viewed by either a confined enamel interruption or a hidden shadowy image from dentine and the corresponding grazes seen on dental x-ray films. These scratches can be mitigated by more exhaustive preventive managements, whereas others might call for tooth-preserving fillings (WHO, 2012). The final stage is the extensive-stage

in which a separate cavity with noticeable dentine or a widespread discrete cavity with observable dentine connecting nearly half of the teeth surface and the corresponding abrasions can be seen on dental x-ray films (Datta & Datta, 2013).

2.3 Description of DMFT, dmft and df-t

Decayed, Missing, Filled Teeth (DMFT) index is the important determinant of dental caries understanding in dental caries investigation. DMFT score is used in the secondary teeth and is conveyed as the totality of decayed (D) surfaces, M denotes teeth that are missing, and (F) for teeth that are filled in children or adult (WHO, 2015). Lowercase letters are used to show tooth decay in primary dentition especially for a child (Petersen, 2010). Stookey (2008) has pointed out that due to the trouble in differentiating between extracted teeth due to dental caries and natural exfoliation in preschoolers, the missing teeth (m) is usually ignored. In such cases, the df-t index is used to determine dental caries prevalence (Petersen, 2010).

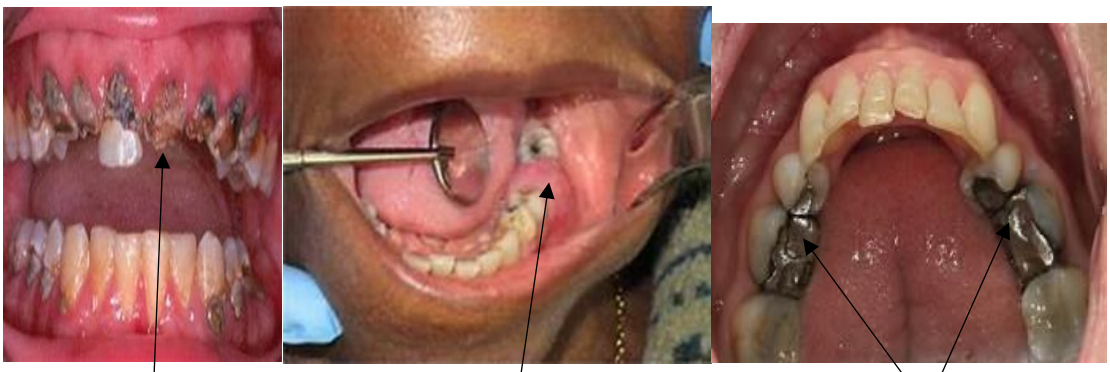


Plate 1: Picture showing the decayed, missing and Filled Teeth

(Source: Kibosia, 2011)

2.4 Prevalence of dental caries

Report by WHO Oral Health information systems (2015), show a marked reduction in dental caries in developed nations. This is credited to a myriad of community health programs, together with shifting way of life and better-quality self-care capacities.

WHO (2015) understands that in spite of the pronounced accomplishments in oral hygiene of people worldwide, complications persist in various societies internationally, with those who are poor in both emerging and advanced countries bearing the dental caries burden. Furthermore, occurrences and brutality of this disease varies among diverse parts of the globe and within the similar nation or region (Wigen & Wang, 2010).

In 2010, caries that were untreated was dominant illness global, affecting nearly 2.5 billion persons, and unattended caries in milk teeth was the most common problem, impacting negatively around 621 million children globally (Kassebaum, Bernabe, Dahiya, Bhandari, Murray *et al.,* 2015). In European countries, there exists variation between different countries. In England, the estimated prevalence of caries in children was 37% (Dye, Hsu & Afful, 2015). In England, nearly 28% children had dental decay with a dmft of 3.38 on average (Davies, Neville, Rooney, Robinson, Jones *et al.,* 2012). In Scotland, tens of thousands of children suffer from dental caries and many of them endure the pain accompanying it (Scottish Dental Clinical Effectiveness Program2 010). In Asia, Sohi *et al.,* (2012) reported higher caries among 5-year-olds children in India at 48.3% (dmft = 1.8 ± 2.1).

In Africa, the prevalence varies significantly in different regions. A study by Awooda, Saeed and Elbasir (2013) in pre-school children in Sudan showed a 64.6% dental

caries prevalence (dmft =3.53). In another study by Elidrissi & Naidoo (2016) among preschool children 3- 5 year-olds in Sudan found a 52.4% prevalence (dmft =2.27). Elsewhere, a prevalence of 35.1% with a DMFT value of 0.67 was reported by Olobasi *et al., (*2015) among children in Nigeria. A baseline survey in Uganda by Wandera and Twa-Twa (2003) showed an occurrence of caries in school children at 40% (mean DMFT=0.7).

In Kenya, 46.3% 5-year olds had dental caries (dmft of 1.87) (MoH, 2015). In the North Rift Region of Kenya, Kibosia (2011) indicated a dmft of 1.97 and dmft of 3.30 among the rural and urban pre-primary school children in Uasin-Gishu respectively. Furthermore, Okemwa *et al.*, (2011) also found a higher prevalence in caries with 38.9% of children in rural Uasin Gishu County reporting a DMFT of 0.74 and a dft of 0.4. Further, Owino *et al* (2015) recorded a prevalence of 50.3% in school going children in Kitale Municipality.

2.5 Factors that predisposes children to dental caries

Children predominantly suffer from dental caries in spite of the reliable scientific evidence that the disease is avoidable. It is a key public health issue, affecting many emerging countries that are undergoing nutrition transition (Sudha, Bhasin & Anegundi., 2005). *Streptococcus mutans* bacteria which is accompanied by changes in the dietary regimes and lifestyles is the main cause of caries, and is occasioned by intake of refined sugars (WHO, 2015). The occurrence of caries in children is influenced by the sex, age, economic status, ethnicity, food intake, that include the pattern of sugar intake as well as oral health behaviors (Pahel, Rozier & Slade., 2007).

Abiola, Eyitope, Sonny and Oyinkan (2009) have reported different values on the occurrence of caries among diverse age groups where young children (5-10 years) have elevated prevalence than older children (11-13 years). This is attributed to the increased level of information in the older children regarding oral hygiene and that permanent teeth, which have developed mostly at this age, are more resilient to the dental decay process than the deciduous teeth (Gathecha, Makokha, Wanzala, Omolo & Smith, 2012).

Studies indicate mixed results on the occurrence of dental caries among sexes. For example, Hilgers, Kinane and Scheetz (2006) found no statistical difference among boys and girls. Elsewhere, Sudha *et al., (*2005) found out that there was increased incidence of caries in boys compared to girls. On the contrary, Shahraki, Shahraki and Mehr (2013) found higher incidence of dental decay in girls than boys.

Socio-economic background has been put forth as a determining criteria of the occurrence of teeth decay in children. Studies by Gibsons & Williams (1999); Sayegh, Dini, Holt and Bedi (2002) and Datta & Datta (2013) found that dental caries were higher in low socio-economic group. The variance in the dental caries scores in terms of the socio-economic status was substantial statistically . The limitation of this variable is that combination of respondents in terms of their socio-economic position includes the influence of schooling, earnings and societal environment. Therefore determining the social level is complex, particularly in emerging countries.

2.6 Dental Caries and cariogenic foods

Dental caries can be well-defined as sugar- modified microbial disease. A diet that is rich in sucrose favors the development of oral microbes and changes the alignment of

the bacterial habitat in a caries-enhancing way (Public Health England, 2012). The high intake of cariogenic foods have been known to cause dental caries for many decades, however reviews indicate that fluoride contact daily, the association between consumption of cariogenic foods and caries prevalence is not consistent (Sudha *et al*., 2005). Nevertheless, evidence has shown that intake of cariogenic foodstuffs does not appear to be a sequence factor for the incidence of dental decay. Nevertheless, for individuals with a blend of compromised dental hygiene, the intake cariogenic foods is predominantly destructive (Vanishree *et al*., 2017). Recurrent ingesting of cariogenic products increase the likelihood of dental caries (WHO, 2015). Guthrie & Morton (2000) indicated that sugared beverages continue to create the main source of harmful sugar in kids' food. This has been extrapolated by Marshall *et al*., (2007) that with the increase in the soda pop consumption is possible to escalation of the caries in preschoolers and adolescents.

Gathecha, *et al., (*2012) noted higher dental caries prevalence in children that ate sugar rich foods than children those who avoided sugary diet. They further found out that those who consumed pastries frequently, had statistically higher tooth decay compared to those who never ate pastries. A study by Cook, Martinez-mier, Dean, Weddel, Sanders *et al., (*2008) found that dental caries is caused by soda intake between meals. Therefore the intake of cariogenic foods poses great risk to dental caries. Therefore there should be a sustained action to endorse good dietary behaviors that are essential for both teeth health and general body wellness (Alm, Wendt, Koch & Birkhed, 2008).

2.7 Fluoride levels and dental caries

According to the Institute of Medicine (IOM), (2000) the recommended fluoride intake 1.0mg/day is recommended for children 4 to 8 year. Fluoride level of 1.5 mg/litre is advocated by the WHO (WHO, 1993). Fluoride critical role in protective action of the teeth from dental caries is well established (Warren & Levy, 2003). Fluoride is the foundation of dental caries avoidance and there are assortment of sources that add to the nutritional ingestion of fluoride. Food sources that are rich in fluoride include: vegetables such spinach, kales, carrots, potatoes, beans; fruits such as grapes, mangoes, oranges, tomatoes, oranges, pears; fluids such as milk, black tea, water and sea foods (Berg, Gerweck, Hujoel, King, Krol *et al*, 2011).

2.8 Food intake and dental caries

In spite of a low death rate linked to dental illnesses, they significantly impact on confidence, consumption capability, nourishment and well-being in all phases of life. According to Naidoo & Myburgh (2007), teeth are vital in allowing intake of a wide-ranging diet and in breaking down the foodstuff ready for assimilation. Dental caries cause considerable pain and discomfort hence making chewing of food difficult (Abiola *et al.,* 2009). Furthermore, dental caries results in dental loss that decreases the capability to eat a diverse diet. Dental caries is linked with eating a diet deficient in vegetables of different kinds and fruits. This denies the growing child enough nutrients that are necessary for growth and development thus resulting into prolonged negative effects on physical growth, cognitive development and overall academic performance (Petersen *et al.,* 2010). Failing to eat a diversified diet has been established as a causal factor in undernutrition where it generally leads to wasting, stunting and underweight (Ronoh & Were, 2015).

2.9 Dental caries and nutritional status

The intake of caffeinated drinks and highly processed foods as well as physical inactivity has been implicated for the increasing number of overweight individuals around the globe (Kopycka-Kedzierawski, Auinger, Billings & Weitzman, 2008). Studies show that children who are overweight are linked to prolonged exposure to carbohydrates (Petersen, 2005). Consumption of refined starches has been recognized to cause of dental caries. Shahraki *et al., (*2013) in a study involving 6-11 year old elementary children (n=513) they found high dental caries in the overweight group than those who had acceptable weights (p=0.001). They further established a significant link between dental caries occurrence and nutritional status (p<0.005). BMI and those that were caries free did not show any statistical significance. This confirms a positive link between being overweight or obese and dft/DMF. The authors recommended that control of overweight and intake of proper diets in children could be a ways of delaying dental caries occurrence. A similar study by Willerhausen, Blenttner and Hohenfellner (2007) involving elementary children (n=590) in Germany confirmed that that there was high weight in children had a significance relationship to dental caries (p=0.0061). Comparable results has been shown by Hilgers, *et al., (*2006) (n=178), Balleul-Forestier, Lopes, Souames, Azoguy-Levy, Frelut *et al., (*2007), and Hilgers, *et al., (*2006) where there was a link between overweight and obesity and prevalence of dental decay.

However, other studies have shown contradictory results. A survey among Iranian children noted that dental caries in children was connected to overweight and obese in the children (Pakshir, 2003). In another cross-sectional survey in Iran (Sadeghi & Alizadeh, 2007) involving 6-11 year old children (n=1003) revealed that even though most of the respondents had higher BMI (16.9% being overweight and 61.7% were

obese respectively), link between overweight and DMFT did not have statically significance. Amongst the subjects, those who had normal nutritional status, at risk overweight or obese at 27.7%, 14% and 37.2% respectively, did not have dental caries. Furthermore, Mojarad and Maybodi (2011) revealed that children who were normal weight had the highest prevalence of DFT. No statistical significance was reported between having overweight and obesity and the prevalence of dental caries in the first and permanent dentitions ($p>0.05$).

2.10 Oral hygiene behaviors and dental caries

Oral cleanness is one of the important mechanisms of preventing dental decay. A study by Shahraki *et al., (*2013) (n=513) confirmed a positive association between the increased brushing of teeth and lesser occurrence of dental caries. Willerhausen *et al., (*2007) found that there was a lower occurrence of dental decay in children that brushed their teeth regularly. In a prevalence study Pita-Fernandez *et al., (*2010) revealed that children who failed to brush present a 40% chance of development of dental caries earlier, compared to 15.3% probability in those who brush. They concluded that the helpful effect of cleaning teeth was beneficial in the deterring progression of caries than the intake of a cariostatic diet. Similar results were found by Datta and Datta (2013).

On the contrary, other studies (Abiola, *et al.,* 2009; King, Wu & Tsai, 2003) found out that no statistical significant exist difference between frequency of brushing and the incidence of tooth decay. In addition, Folayan, Sowole and Kola-Jebutu (2007) found out that even though oral hygiene was recognized as a likely influencing factor for occurrence of dental caries, and that brushing of the teeth alone is insufficient for caries prevention.

2.11 Knowledge and practice of oral hygiene among children

Adequate knowledge on oral hygiene is a key way of preventing dental caries as demonstrated by behavioral studies (Petersen, 2005). It includes the use of frequent brushing of teeth using fluoridated toothpaste, flossing and the periodic change of the toothbrush or the materials used in cleaning teeth. These oral health behaviors are considered the most effective methods for preventing dental caries through controlling bacterial plaque (Jepsen *et al.*, 2017). In turn, neglect of dental treatment through poor oral hygiene behaviors has been documented to increase the chances having dental caries (WHO, 2015). According to Kenya's first Oral Health report, only 47.6% brush once per day (MoH, 2015). Farsi, *et al., (*2004) showed that among the 5-18 year old children in Saudi Arabia, 87.1% knew that brushing teeth helps to prevent periodontal diseases and dental caries. A similar study by Okada, Kawamura, Kaihara and Matsuzaki (2002) in Hiroshima, Japan, revealed that maternal oral health behavior hinders dental caries.

Tooth brushing is one of the mechanical ways of removing the plaques which initiates dental caries development. A study by Datta and Datta (203) among Indian children (n=114) found that the occurrence of tooth decay was lower among young sujects who exhibited oral hygiene behavior and cleaned twice a day as opposed to those who cleaned their teeth once daily or never in some days. A study by Farooqi *et al., (*2015) among 6-9 year old children (n=711) indicate that daily brushing of teeth had leads to prevention of caries in children. Similarly a study by Singh, Kaur, Mengi and Singh (2014) in Indian children (n=322) exhibited that there was 100% likelihood of dental caries among those with poor oral health as compared to 14.3% prevalence in those with decent oral hygiene behaviors.

2.12 Dental caries and Socio-economic position

Improvement in the household's socio-economic among the population around the world has been associated with rural to urban movement, which escalates in the level of education and changes in food consumption patterns (Popkin, Shu & Wen, 2007). Parental socio-economic status has yielded mixed results on the dental caries occurrence.

Ng'ang'a and Valderhaug (1991) found out that the oral hygiene behaviors were poorer in low socioeconomic status children that those from high socioeconomic backgrounds in primary schools in Nairobi, Kenya. A study by Al-Darwish, Walid & Bener (2014) in Qatari children (n=2113) indicated that low dental caries prevalence in children registered in private institutions and had stronger status socio-economically compared to children from lower socio-economic background who attended public schools. Similar results were reported by Datta & Datta (2013) among Indian children. The socio-economic data collected was the monthly household income and the maternal level of education.

2.12 Summary of literature and gaps in knowledge

From the literature, the association between cariogenic foods and the occurrence of caries has been documented by most studies. There are limited studies documenting dental caries status in children in Kenya, particularly in 5-year-olds. Studies assessing the link in nutritional consumption and caries in children in Uasin Gishu County are scanty. There is also limited documentation of how the nutritional status of 5-year-olds is association to dental caries occurrence in children. There is need to assess the link of the nutritional status, dietary intake, and the dental caries in 5-year-old children. These knowledge gaps will be filled by this study.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This section highlights the area of the study, the design used in the research, methods of collecting information and techniques of analyzing employed in the study among others.

3.2 Research Design

Cross-sectional survey design was adopted. The design was found suitable because it collected current data. This design collected information on the prevailing dental caries as determined by the prevailing practices which included the nutritional status, oral health practices, and the diet. Data collection took place in May to July, 2017.

3.3 Study Area

Moiben and Tembelio Wards and in Eldoret Municipality in Uasin-Gishu County formed the study location. Uasin Gishu County is divided into six constituencies namely: Ainabkoi, Moiben, Turbo, Soi, Kapseret and Kesses covering a total area of 3327.8 Km^2. It borders Nandi County, Kericho County, to the South West and South respectively, and Elgeyo Marakwet to the East, Bungoma County to the West, and to the North by Trans Nzoia County. Large scale farming of maize and wheat, dairy livestock keeping, and tourism in sports is the main economic activity of the County. Manufacturing that provide jobs to thousands of its urban population is also important in the County. The chief source of drinking water in Eldoret Municipality and the environs is tap water from Eldoret Water and Sewerage Company (ELDOWAS) (Uasin-Gishu County Integrated Development Plan 2013-2018).

3.4 Population

Study subjects comprised 5-year-olds attending school their parents/caregivers residing in Uasin-Gishu County. The estimated number of children in this study area is 29,047 (Uasin Gishu CIDP 2013-2018). The five year old children were selected because they experience rapid growth and development, and nutritional deprivation due to difficulty in eating a variety of foods because of pain when chewing food because of dental caries translates to prolonged negative effects on physical growth, cognitive development and overall academic performance (Petersen *et al.,* 2010). Furthermore, children aged 5 years old were selected because this is the ideal age suggested by WHO (2012) for assessing the occurrence of children's dental caries. Moreover, this age is appropriate in investigating caries status in the primary dentition which may display variation over a shorter timespan compared to the permanent teeth at other ages (MoH, 2015).

3.5 Sample Size Determination

This study used Fischer's formula (1997) to determine the size of the sample.

Fischer's Formula

$$n = \frac{Z^2 \times P \times Q}{\sigma^2}$$

Where

n= desired size of the sample

Z= standard numerical deviation responding to 95% confidence interval

σ= Error (0.05)

P= Estimated population of carious children in the study area (46.3%; Kenya National Oral Health Survey, 2015)

Q= 1-p (0.497)

$$\text{Therefore n} = \frac{1.96^2 x 0.463 x 0.497}{0.05^2} = 355 \text{ children}$$

An attrition of 45 children were added to arrive at 400 children.

3.6 Sampling Procedures

Eldoret Municipality was chosen purposefully because there are limited studies carried out on level of caries in 5-year-olds in the area. Eldoret municipality has thirteen (13) administrative units. One administrative unit was randomly sampled from the urban area. Total number of day primary schools with ECD classes in the administrative unit was identified by the researcher. Two primary schools (Queen of Angels and Uasin Gishu Primary Schools) were randomly sampled and the total number of 5-year-old established from the school registers/ birth certificate available in the school records.

On the other hand, Moiben and Tembelio Wards, which represented the rural areas, were sampled using multistage sampling procedure. Uasin-Gishu County has six administrative areas. One administrative area (Moiben Constituency) was randomly selected using simple random sampling and two wards (Moiben and Tembelio) from the area sampled using simple random method. From each ward one school (Itigo Primary school from Moiben ward and Ainabtich Primary school from Tembelio ward) were randomly selected. Data was then collected from children sampled from these schools.

Children selected from each area (Urban and rural) was established on the count of 5-year-old present in that area as a fraction of the entire count of 5-year-old children enrolled in the schools selected multiplied by the sample size.

The enrollment of 5-year-old in both rural and urban schools that were selected was 438 children (250 from urban and 188 from rural) according to the class registers. Using proportionate to size formula:

Urban =250/438 x 400=228

Rural =118/438 x 400=172

Since two schools were selected from urban and rural area, each Primary was represented by the total number of children from that area (as calculated above) shared equally in two portions. Consequently, 144 subjects from each school were selected from each school in Eldoret Municipality and 94 children from each school in rural area. Consent forms were given to all of the 5 year-old children through school administration to take to their parents/guardians for consent and bring them back to school. A list of all 5-year-old with approval from parents/guardians was made following the class registers of middle and top class where most of the respondents belong. Children with consent from their parents/guardians were examined for dental caries and their nutritional status while their parents answered QFFQ questions administered by the researcher.

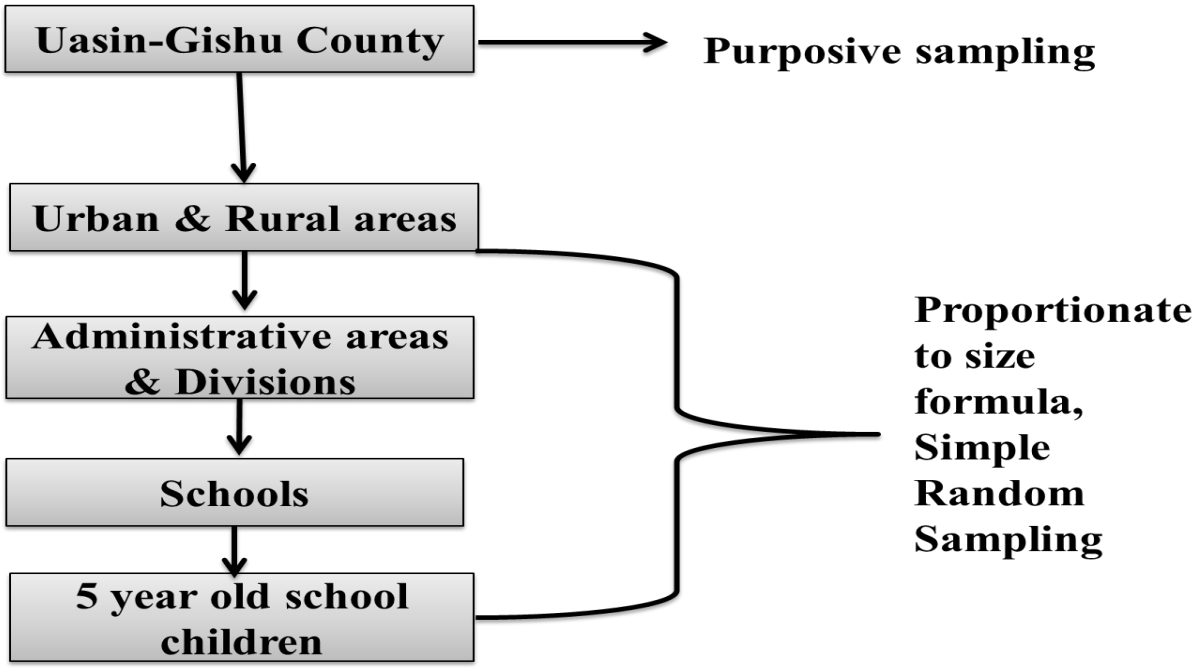


Figure 3.1 Sampling

3.7 Criteria for inclusion and exclusion

Inclusion criteria
Inclusion criteria included:

1. Children who were 5 years ± 6 months as at the beginning of the study (Owino *et al.*, 2010).
2. Those whose parents agreed for them to take part in the study

Exclusion criteria
Exclusion criteria included:

1. Children who were sick at the time of the study
2. Children whose parents did not consent for them to participate in the study

3.8 training of research assistants

Two groups of study assistants were used.

Research assistants for nutritional assessment

Two research assistants were recruited to assist in nutritional assessment of the children. They were conveniently selected from University of Eldoret Food Science and Nutrition third year students. These students had basic knowledge on dietary and anthropometric assessment. Training of research assistants on the objectives of the research and the data collection procedures took three days. During the training, the research assistants were taken learnt aspects in the questionnaire to ensure familiarization with the questions and the clarity of the responses to avoid ambiguity. The study assistants were taken through taking of MUAC, height and weight of the children using the actual measurement tools which were used in this study.

Training of dental research assistants

Three fifth year students from Moi University, School of Dentistry were conveniently recruited to assist in assessing dental caries status in the sampled subjects. The students had basic knowledge to assess dental caries. The students were familiarized with the study requirements.

3.9 Procedures and tools for Data collection

3.9.1 Questionnaire

Data collection was done through used of researcher administered questionnaire. The survey was distributed into four portions. Section A collected information on the socio-economic features of the caregivers; Section B asked questions on attitudes, knowledge and practices on dental caries and nutritional status to be filled by the caregivers. Section C collected food intake data by use of a quantitative food frequency questionnaire (QFFQ). Respondents were asked on the type, frequency and amount of food they provide to their 5-year-olds daily, weekly, monthly or yearly. Lastly, section D comprised questions to the 5-year-old on the foods and snacks they ate away from home, on their way to school and while in school. The research assistants interpreted the questions in this section for the child to be able to answer the questions better.

3.9.2 Dental caries assessment

Oral examinations were performed by three fifth year school of dentistry students who were standardized by a pediatric dentist who used standard procedures as described by World Health Organization for assessment of dental caries in children. The

examinations were performed in a seated position on a school chair in the school-room. Drying of the teeth was done using cotton wool, and normal light of the day was used for appropriate vision. A Community Periodontal Index (CPI) probe and a mouth mirror were used for examination to identify caries as defined by World Health Organization.

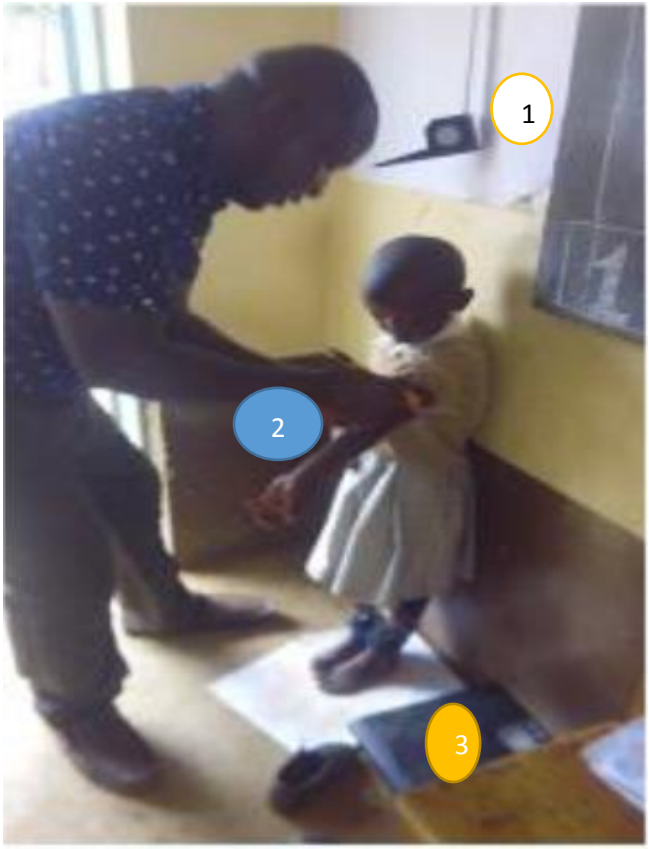
Plate 2: Dentist assessing caries in children in bright sun-light

(Source: Author, 2017)

3.9.3 Socio-demographic features of the subject and Oral sanitation behaviors

Parents or the caregiver of the child were interviewed by the research assistant to determine the socio-demographic status of the children using structured questionnaires. Children were asked “No or Yes” queries related to the incidence of

brushing teeth, knowledge on the use of toothbrush as well as other oral hygiene practices. Guidance was provided by the researcher and the research assistants to make the children understand the questions for appropriate answering.



1. Microtoise for taking the height
2. Taking MUAC using MUAC tape
3. Bathroom scale for taking the weight

Plate 3: Taking anthropometric measurement by the researcher

Source: Researcher, 2017

3.9.4 Dietary Intake

Quantitative Food Frequency Questionnaires (QFFQ)

A QFFQ was adopted and modified from Onyono *et al.*, (2015) and used in this study by changing the food names to be understood by local community and including estimated weights of foods per portion. The questionnaires were prepared in English language but during administration, trained research assistants used local dialect or Kiswahili to communicate if the need arose, to ensure that the questions were well

understood and answered. The questionnaires were pre-tested at University of Eldoret Primary school, which is found in a peri-urban area. Ten Percent of the sample size that is, 40 caregivers and children participated in the pre-testing and adjustments made on the questionnaire before the commencement of actual study.

The questionnaire consisted a list of 79 food items and beverages in total, which was categorized into eleven food groups namely; starchy staples, beverages, legumes, dairy, fruits, vegetables, sugar/sweets, meats, eggs, additives and spreads from which the population source its nutrient intake. The respondents were asked to indicate how many times daily, weekly, monthly or yearly that the children ate the selected foods in order to estimate the usual diet. Standard portion sizes (cups, plates, spoons, bowls, and rulers) commonly used locally by the respondents aided the parents to approximate the correct serving sizes consumed. The respondents describe the size, of each of his or her child's usual serving as small, medium or large relative to these standard servings.

3.9.5 Determination of nutritional status

The anthropometric measurements were carried out using standard anthropometric equipment and procedures as described by de Onis *et al.,* (2004).

3.9.5.1 Weight measurement

Weight was taken using a SECA scale (Vogel and Halke Hamburg, Model 7141014009, Germany, 2008) to the nearest 0.1kg. The weighing scale was placed on a flat surface. It was calibrated using 2kg of sugar as recommended by Kenya National Bureau of Statistics (KNBS) (2008). The calibration exercise was done on every visit before the measurements were made. Heavy clothing and shoes were remove, and children asked to step at the center of the scale facing straight ahead,

arms at the side, looking relaxed but still. Three consecutive readings were then read from the weighing scale and recorded appropriately. The average value of these readings were used for analysis.

3.9.5.2 Height measurement

Height measurement was taken using a portable microtoise to the nearest 0.1 cm. It was stretched to its full length and hooked on a wall using a nail. A child, with shoes removed, stood on a flat cemented surface below the microtoise with the head positioned such that the Frankfurt plane was horizontal; the knees of the child were straight with buttocks, shoulder blades, back of the head and heels in conduct with the wall and arms hanging loosely at the side of their body with the palms facing the thighs. Just before the measurements were taken the subject inhaled deeply, held the breath and maintained erect posture. The microtoise was lowered gently until it touches the crown of the head. Three sets of measurement off the red mark on the microtoise were taken at the eye level and recorded.

3.9.5.3 MUAC

The measurement of MUAC were taken using a non-stretchable arm circumference tape to the nearest 0.1 cm. The posterior aspect of the left arm on the center-point between the shoulder's acromion process and the olecranon process at the elbow was measured. This was done by finding the tip of the shoulder. Olecranon process was located by bending the child's elbow at a right angle. Clothing that may cover the child's arm were removed and the arm relaxed by hanging down side the body. A tape wrapped around the straightened arm at the midpoint. The numbers were read right side up and the tape kept flat around the skin but firmly. The measurements were read

from the window of the tape without pinching the arm or leaving the tape loose. The measurements were taken three (3) times and the average value calculated and used for the analysis.

3.10 Research Variables

3.10.1 Independent variables

Dental caries

3.10.2 Dependent variable

Age, dietary habits, nutritional status, gender, location of the school

3.11 Validity and Reliability

3.11.1 Validity

To ensure validity of the research instruments, the weighing scale used to take measurements in the study was calibrated using known weight. In this case, two kilogram packet of sugar was used.

3.10.2 Reliability

Reliability of the research instruments was ensured by pre-testing at University of Eldoret Primary school, which was not selected to participate in this study. Ten percent (40) children of similar age to those in this study were randomly selected and used in the pilot study. Data from the pilot helped to modify the questionnaires by correcting mistakes made during construction of the instrument.

A pediatric dentist calibrated the students to assist in dental caries assessment for consistency using two children attending dental clinic in school of dentistry, Moi Teaching and Referral Hospital (MTRH). Kappa Coefficient was used to measure the inter-examiner consistency where:-

- First assessor and standard=Kappa coefficient of 0.8 (Good)
- Second assessor and standard=Kappa coefficient of 0.9 (Good)
- Third assessor and standard=Kappa coefficient of 0.7 (Good)

3.12 Data Analysis

Data on collected were entered and analysis carried using the Statistical Package for Social Sciences (SPSS) version 21 (2014). Anthropometric and dietary intake data was analyzed using Nutri-Survey for computer programmes 2007. Nutritional status of children in Z-score was done using ENA for SMART, in which the weight-for-age (WAZ) of <-2 z-score was underweight and severe underweight at <-3 z-score. Height-for-age (HAZ) of <-2 z-score denoted for stunting while weight-for-height (WHZ) > 3 was considered obese or severe overweight. To determine the nutrient intake per day, food portions was multiplied by the number of portions consumed per week and divided by 7 or per month and divided by 30. An estimated daily nutrient intake was arrived at after analysis of the portion sizes per food consumed and then compare it to the RDA.

In order to compute df-t score, total of d+f teeth was calculated and divided by the sampled children. The relationship between nutritional status and df-t was determined using Pearson correlation. A p value of < 0.05 was significant.

3.13 Ethical approvals

The Institutional Research and Ethics Committee (IREC), Moi University granted the ethical approval to conduct this study (Appendix V). Printed assent was issued by the parents and permission from school administration obtained before carrying out the survey (Appendix II). Verbal approval was acquired from the children on their

involvement in the study. Research and professional ethics were maintained throughout the study by the researcher and the research assistants. On the questionnaires, codes were used instead of names to ensure anonymity. The subjects were guaranteed of privacy of the data collected.

CHAPTER FOUR

RESULTS

4.1 Overview

In this section, the link between dietary behaviors, nutritional status and dental caries of 5-year-old school children in Uasin-Gishu County, Kenya was assessed. Three hundred and eighty-two (382) children and their parents/caregivers completed the questionnaire (95.5% response rate). Data collection tools used were piloted and pre-tested at the University of Eldoret Primary school Early Childhood Development and Education (ECDE) located in a peri-urban area. Data collection was done in two urban schools, Queen of Angels Academy and Uasin-Gishu Primary and rural schools, Itigo and Ainabtich Primary.

4.2 Socio-demographic characteristics of the caregivers

4.2.1 Socio-demographic characteristics of the parents/caregivers

Socio-demographic characteristics of the parents/caregivers assessed in this study are shown in Table 4.1. One hundred and sixty-eight (168) out of 382 (43.9%) parents/caregivers attained college/university education. Those who did not complete secondary education were 80 (20.9%) and 44 (11.5%) had completed primary school. With regard to occupation, 125 were civil servants representing (32.8%), and casual labourers were 74 (19.3%). Furthermore, those who practiced farming of crops such as maize, wheat, beans, and vegetables for food and sold the surplus were 63 accounting for 16.6% of the parents/caregivers.

Findings from this study showed that 123 (32.2%) of the households earned a monthly income of Ksh.21, 000-50,000, while 66 (17.2%) earned Ksh.6000-10,000.

Table 4. 1: Socio-demographic characteristics of parents/caregivers of selected school children in urban and rural areas of Uasin-Gishu County, Kenya

Variable	Description	N	Percentage (%)
Level of education	Did not attain primary	12	3.1
	Attained primary	44	11.5
	Incomplete secondary	80	20.9
	Complete secondary	71	18.6
	University & college	168	43.9
	None	7	1.80
Occupation	Farmer	63	16.6
	Civil servant	125	32.8
	Casual laborer	74	19.3
	Self-employed	104	27.1
	Other	16	4.2
Household income	<Ksh. 5000	23	6.0
	Ksh. 6,000-10,000	66	17.2
	Ksh. 11,000-20,000	75	19.6
	Ksh. 21,000-50,000	123	32.2

4.2.2 Socio-demographic characteristics of 5-year-old children in urban and rural areas of Uasin-Gishu County

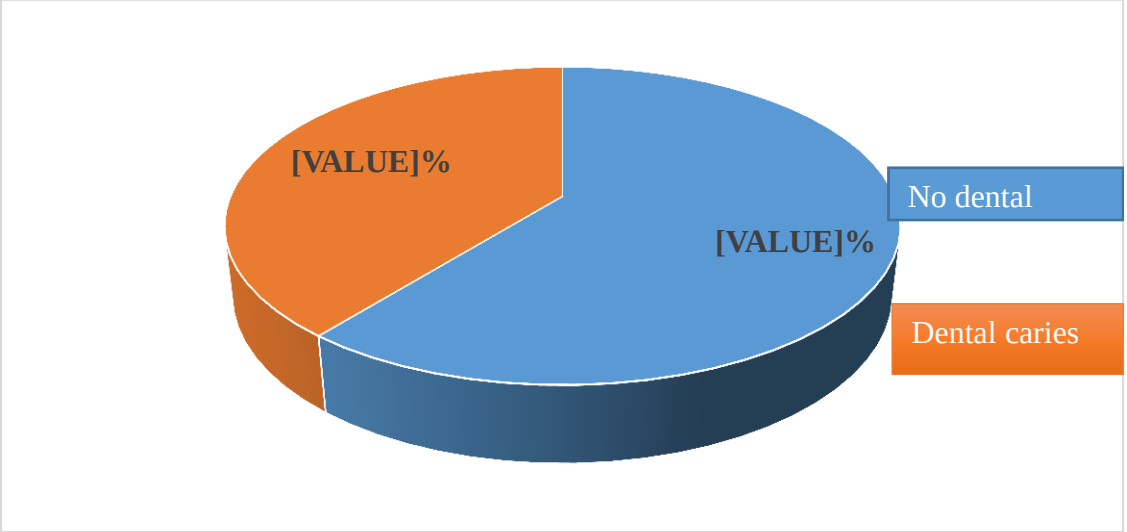
In this study, 228 children (59.6%) were from urban areas whereas rural areas had 154 (40.4%). Of these, 192 were male (50.3%) and 190 female (49.7 %) (Table 4.2).

Table 4. 2: Socio-demographic characteristics of 5-year-old children in urban and rural areas of Uasin-Gishu County

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

4.3 Prevalence of dental caries

From a total sample of 382 children, those with dental caries were 150 (39.3%) with a mean dft of 1.55±1.34 while 232 children (60.8%) had no dental caries (Fig. 4.1).



Figures 4. 1: Dental caries in 5-year-old in rural and urban areas of Uasin-Gishu County

According to location and gender, results showed that children from rural primary schools had a prevalence of 34.4% with a mean dft of 1.16±1.13 while those from the

urban primary schools had 42.5% prevalence with a mean dft of 1.83±1.37 (Table 4.3). In the urban area the prevalence was significantly higher than compared to the rural area (p=0.028). Male children had prevalence of 32.3% with a mean dft of 1.38±1.17 whereas females had 46.3% dental caries prevalence (mean dft of 1.44±1.26) (Table 4.3).

Table 4. 3: dft score of 5-year-old children according location and gender

Variable			N	dft ±SD	Prevalence (%)	p-value
Location	Rural	Yes	53	1.16±1.13	34.4	0.028*
	Urban	Yes	97	1.83±1.37	42.5	
Gender	Male	Yes	62	1.38 ± 1.17	32.3	0.421
	Female	Yes	88	1.44±1.26	46.3	

*significant at p< 0.05 (2 tailed)

4.4 Dietary intake

4.4.1 Nutrient intake of 5-year-old children

World Health Organization guidelines recommend that certain minerals such as phosphorus, calcium, fluoride, iron, and zinc; vitamins A, C, folate as well as protein and energy has a key role in dental caries deterrence and progression (WHO, 2015). Data on nutrient intake was collected using QFFQ and analyzed by Nutri-Survey for Windows (2007) revealed that both urban and rural children met and surpassed the nutrient intake requirements for protein, vitamin C, calcium, and phosphorus, but were unable to meet the requirements for energy, folate, vitamin A, and iron (Table 4.4).

Table 4. 4 Nutrient intake among the 5-year-old in Uasin-Gishu County

Nutrients	Mean intake	RDA[a]/EER[b]	Adequacy of Intake
Energy	1321.87±348.85[b]	1600 Kcal	Lower by 45%
Protein	29.21±5.94[a]	19 g	Higher by 53.7%
Vitamin A	382.30±189.85[a]	400 µg	Lower by 4.43%
Folate	135.82±22.56[a]	400 µg	Lower by 66.1%
Vitamin C	49.82±22.56[a]	25 mg	Higher by 99.3%
Calcium	470.67±113.64[a]	1000 mg	Lower by 53%
Phosphorus	949.32±291.52[a]	500 mg	Higher by 89.9%
Iron	9.29±6.81[a]	10 mg	Lower by 7.4%
Zinc	8.92±2.57[a]	5 mg	Higher by 78.4%

[a] Based on nutrient needs for 4-5-years-olds as endorsed by IOM (2000)

[b] The Estimated Energy Requirement (EER)

4.4.2 Consumption frequency of cariogenic foods among the 5-year-olds

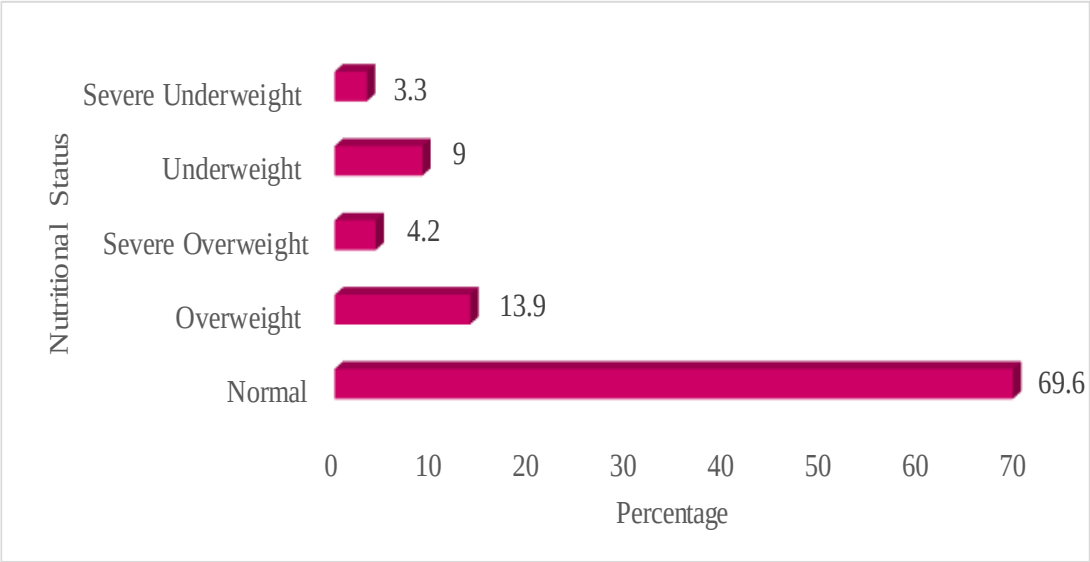
The regularity of intake of cariogenic foods is an important forecaster of children dental caries outcome (Perera *et al.,* 2012). As shown in Table 4.5, children from urban primary schools ate sweets/candies everyday (33.5%), several times a day (28.4%), tea with sugar everyday (58.5%), pastries several times a week (54.6%) and carbonated soft drinks several times a week (44.5%). Children from rural primary schools ate sweets once a week (27.9%), several times a week (43.3%), tea with sugar every day (46.5%), biscuits or queen cakes once a week (43.7%), and carbonated soft drinks once a week (40.6%).

Table 4. 5: Consumption frequency of cariogenic foods among 5-year-olds in Uasin-Gishu

Cariogenic foods	Location	Never (%)	Once a week (%)	Several times a week (%)	Everyday (%)	Several times a day (%)
Sweets/Candy	Urban	0.9	23.1	14.1	33.5	28.4
	Rural	11.6	27.9	43.3	15.3	4.0
Tea with	Urban	0.1	2.4	23.2	58.5	15.9
sugar	Rural	6.5	29.6	10.5	46.5	7.0
Biscuits or	Urban	0.0	17.5	54.6	17.9	10.0
queen cakes	Rural	26.4	43.7	15.8	10.4	3.8
Carbonated	Urban	0.5	24.6	44.5	18.3	12.1
Soft drinks	Rural	24.5	40.6	25.2	6.3	3.5

4.5 Children's nutritional status

Results from this study indicated that the prevalence of overweight in children was 13.9% and obesity at 4.2%. The prevalence of underweight was 9.0% while 3.3% were severely underweight. Children with normal nutritional status were 69.6% (Figure 4.2).



Figures 4. 2: Nutritional status of the 5-year-old children in Uasin-Gishu County

4.5.2 Nutritional status of the children per location

Results showed that nutritional status differed significantly (p=0.02) according to the location of the schools where the occurrence of overweight was greater in children in the urban compared to the rural areas at 13.6% and 9%, respectively (Table 4.6). In rural areas, underweight was higher 10.7% while 8.6% was recorded in urban areas, stunting was 8.5% and 14.6% in urban and rural areas respectively. The prevalence of wasting was 6.8% among rural and 5.6% in urban areas. The prevalence of wasting in the urban and rural children was significantly different (p=0.03).

Table 4. 6: Nutritional status of Uasin-Gishu County's 5-year-old

Nutrition Index	Indicator	Overall prevalence (Rural and Urban) [%]	Rural area prevalence [%]	Urban area prevalence [%]	p-value
Weight for Height (WHZ)	Underweight	8.6	10.7	8.6	P=0.02*
	Overweight	12.0	9.0	13.6	p=0.15
Height for Age (HAZ)	Stunting	9.1	14.6	8.5	p=0.13
Weight for Age (WAZ)	Wasting	6.7	6.8	5.6	p=0.03*

*Significant at p<0.05

4.5.3 Relationship between BMI and dft among the children

From the findings, underweight (9.0%), overweight (13.9%), obesity (4.2%) and wasting (6.7%) had a significant positive relationship with dft (Table 4.7).

Table 4. 7: Relationship between nutritional status and dft of 5-year-old school children in Uasin-Gishu County

Nutritional status	Prevalence (%)	Mean dft	Pearson Coefficient (r)	p-value
Underweight (WAZ <-2 z score)	9.0	1.58	0.67	0.047*
Normal/ healthy weight	69.6	1.24	0	1.31
Overweight (WHZ >2 z score)	13.9	1.77	0.83	0.012*
Obesity (WHZ >3 z score)	4.2	1.83	0.53	0.031*
Stunting (HAZ <-2 z score)	9.1	1.48	0.13	0.732
Wasting (MUAC<11.5 cm)	6.7	1.52	0.16	0.041*

*Correlation significant at P< 0.05

4.6 Parental knowledge, practices and attitude, on dietary behaviors and occurrence of dental caries in children

4.6.1 Knowledge

Results on knowledge on dietary behaviors and preventive measures of caries among the parents/caregivers showed that 4.2% of them strongly disagreed that on the aspect of necessity to brush their children's teeth immediately after breakfast and last thing before going to bed at night. In this group, children had a higher mean dft of 2.3±1.30. On the other hand, those who agreed (49.4%) had their children's mean dft at 1.18±0.82, and those who strongly agreed (37.2%) had a mean dft 1.06±0.45 (Table 4.8).

Rinsing the mouth after meals is regarded as a good practice and hence important in reducing the occurrence of dental caries. In this study, 3.3% of parents/caregivers strongly disagreed that children should rinse their mouth after meals. Results showed that children of parents/caregivers who strongly disagree with rinsing the mouth had a higher mean dft 3.0±1.25) while those who agreed (43.7%) had their children's with a lower mean dft 1.12±0.35, and those who strongly agreed (47%) had their children's mean dft at 1.5±0.05 (Table 4.8).

Knowledge on intake of cariogenic foods and their influence on dental caries was assessed. Parents/caregivers that disagreed strongly that drinks and foods rich in sugar such as sweets, biscuits, and cakes affect children's teeth (7.2%) had their children with a mean dft 1.41±0.36, those who agreed (44.3%) had their children's mean dft at 1.16±0.75 while those who strongly agreed (39.2%) had children with a mean dft of 1.54±0.08 (Table 4.8).

Visiting the dentists for dental clinic yearly is strongly suggested by WHO to reduce the ruthlessness of dental caries. Parents/caregivers in this study that disagreed strongly that there was a need for children to go for the dental health inspection at minimum once a year (6.3%) presented a mean dft of 2.29±0.25, while those who agreed (41.9%) had a mean dft of 0.99±1.23 (Table 4.8).

Knowledge of the importance of brushing, flossing and avoiding sugar as a measure to reduce the risk of developing caries was also assessed in children. Parents/caregivers who disagreed strongly that it is essential to hinder dental caries in children by flossing, brushing their teeth, and shunning refined sugar (8.1%) had children with a mean dft of 1.93±0.36, those who disagreed (8.4%) had a mean dft of 2.02±1.08, while those who agreed (45.2%) had children with a mean dft of 1.46±0.56 (Table 4.8).

Table 4.8: Knowledge of dental health among parents/caregivers of 5-year-old children in Uasin-Gishu County

Variables	Response	Percent (%)	dft[1]	OR (95% CI)
Brushing of teeth after breakfast and last thing at night is necessary	SD	4.2	2.3±1.30	
	D	8.7	1.79±1.12	2.34
	A	49.4	1.18±0.82	
	SA	37.2	1.06 ±0.45	
It is necessary to rinse the children's mouth after each meal	SD	3.3	3.0 ±1.25	0.86
	D	6.0	1.88 ±1.02	
	A	43.7	1.12 ±0.35	
	SA	47.0	1.5 ±0.05	
Food and drinks with sugar affect children's teeth	SD	7.2	1.41 ±0.36	1.33
	D	9.3	1.61 ±0.45	
	A	44.3	1.16 ±0.75	
	SA	39.2	1.54 ±0.08	
A dental clinic is necessary at least yearly for children	SD	6.3	2.29 ±0.25	1.66
	D	11.1	1.46 ±0.93	
	A	41.9	0.99 ±1.23	
	SA	40.7	1.34 ±0.22	
Brushing, flossing and avoiding sugar prevent dental caries in children	SD	8.1	1.93 ±0.36	0.43
	D	8.4	2.02 ±1.08	
	A	45.2	1.46 ±0.56	
	SA	38.3	1.47 ±0.76	

[1]Values are the means±Standard deviation; SD=Strongly Disagree; D=Disagree; A=Agree; SA=Strongly Agree

4.6.2 Attitude

The attitude towards children's preventive actions of dental caries was assessed in the study (Table 4.9). Results indicated that 6.2% of parents/caregivers disagreed strongly that taking care of the child's teeth is as essential as caring for critical organs of the body and had their children's mean dft at 1.31±0.56. Those who agreed (39.2%) had a mean dft at 1.41±0.34 and 38.0% who strongly agreed with their children's mean dft of 1.53±0.62.

Seeing the need by the parents for their children to visit a dental clinic for check-up at least twice a year is advocated to ensure healthy teeth. Children whose parents/caregivers claimed that they visited a dental check-up in the period 0-6 months prior to this study were 12% and had a mean dft of 1.50±0.54. Children who visited between 7-12 months prior to this study (8.7%) had a mean dft of 1.45±0.33 whereas those who had attended more than a year prior to this study (43.1%) had a mean dft of 1.53±0.65. Conversely, results showed that children who never visited the dental clinic preceding this study (36.1%) had a mean dft of 1.57±0.36. Of these, 52.4% claimed that their children visited the dentist for painful tooth/treatment these had a mean dft of 1.73±0.36 while 47.6% visited for check-up/ dental cleaning had a mean dft of 1.62±0.06 (Table 4.9).

Table 4.9 Oral health Attitude of parents/caregivers of 5-year-old children in Uasin-Gishu County

Variables	Response	Percent (%)	dft ±SD	OR (95% CI)
Caring for the child's teeth is as important as caring for other body parts	SD	6.2	1.31 ±0.56	0.421
	D	16.6	0.95 ±0.37	
	A	39.2	1.41 ±0.34	
	SA	38.0	1.53 ±0.62	
When was the last time your child had a dental visit	0-6 months	12.0	1.50 ±0.54	0.210
	7-12 months	8.7	1.45 ±0.33	
	>1 year	43.1	1.53 ±0.65	
	Never	36.1	1.57 ±1.23	
Why did they visit the dentist	Painful tooth/treatment	52.4	1.73 ±0.36	0.254
	Check-up/ Dental cleaning	47.6	1.62 ±0.06	
Brushing after breakfast and before sleeping at night is important	SD	6.6	2.19 ±1.08	0.642
	D	11.1	1.63 ±0.64	
	A	43.1	1.30 ±0.64	
	SA	39.2	1.50 ±0.54	
Eating sweets, candies, cakes, biscuits affect your child's teeth	SD	8.1	1.57 ±0.47	2.13
	D	20.5	1.89 ±0.64	
	A	38.3	1.62 ±0.56	
	SA	33.1	1.52 ±0.34	

SD=Strongly Disagree; D=Disagree; A=Agree; SA=Strongly Agree

4.6.3 Practice of Dental Hygiene

Practices such as regularity of cleaning teeth, washing the mouth after meals, the frequency of consumption of high sugar and sticky snacks were assessed in this study (Table 4.10). Results revealed that children who brushed once a day (21.4%) had a mean dft of 1.58±0.83, children who brushed twice daily(41.6%) had a mean dft of 1.34±0.99, children who brushed sometimes in the week 32.8% had a mean dft of 1.43±0.28 while 4.2% never brushed their teeth and had a mean dft of 1.79±0.74.

The practice of rinsing the mouth to remove food debris is advocated as a measure to reduce dental caries development. Results showed that 18.1% of the children rinsed their mouth with water after meals once a day and had mean dft of 1.53±0.39 while 34.3% rinsed twice a day and had a mean dft of 1.45±0.09, children who never rinsed their mouth accounted for 16.3% and had a mean dft of 1.91±0.77 (Table 4.10).

Brushing with fluoridated toothpaste is recommended to significantly reduce dental caries in children (Sheiham, 2006). In this study, children that used fluoridated toothpaste and a toothbrush for brushing once a day (21.7%) had a mean dft of 1.67±0.67, while 34.9% brushed twice a day and had a mean dft of 1.48±0.24, those who never used a toothbrush and fluoridated toothpaste were7.2% and had a mean dft of 2.25±0.89 (Table 4.10).

Brushing technique is critical in ensuring that debris is effectively removed from the mouth (Petersen, 2010). In this study, the children who brushed using “up-down and sideways” once each day (19.3%) had a mean dft of 1.68±0.78, and 38.9% brushed twice daily in “up-down and sideways” motion and had a mean dft of 1.29±0.09, while 13.9% never brushed using this technique and had a mean dft of 1.43±0.44 (Table 4.10).

Table 4. 10 Practice of oral hygiene among parents/caregivers of the children in Uasin-Gishu County

Variables	Response	Percent (%)	dft ±SD	OR (95% CI)
How often does your child brush their teeth	Once a day	21.4	1.58 ±0.83	2.07
	Twice a day	41.6	1.34 ±0.99	
	Sometimes a week	32.8	1.43 ±0.28	
	Never	4.2	1.79 ±0.74	
The frequency of rinsing children's mouth after meals	Once a day	18.1	1.53 ±0.39	1.320
	Twice a day	34.3	1.45 ±0.09	
	Sometimes a week	31.3	1.55 ±0.25	
	Never	16.3	1.91 ±0.77	
Using toothbrush & fluoride toothpaste for brushing	Once a day	21.7	1.67 ±0.67	0.724
	Twice a day	34.9	1.48 ±0.24	
	Sometimes a week	36.2	1.62 ±0.23	
	Never	7.2	2.25 ±0.89	
Brushing children's teeth by "up-down and sideways" technique	Once a day	19.3	1.68 ±0.78	0.626
	Twice a day	38.9	1.29 ±0.09	
	Sometimes a week	28.0	1.64 ±0.52	
	Never	13.9	1.43 ±0.44	
The frequency of consumption of sugar-rich and sticky snacks	Once a day	24.4	1.53 ±0.35	1.890
	Twice a day	27.1	1.62 ±0.87	
	Sometimes a week	32.2	1.50 ±027	
	Never	16.3	1.42 ±033	

SD=Strongly Disagree; D=Disagree; A=Agree; SA=Strongly Agree

4.6.4 Specific oral hygiene practices for children

Results showed that 201 (52%) pupils brushed their teeth while 42 (1.8%) did not brush their teeth at all and 139 (36.5%) brushed their teeth sometimes, which was significant at P=0.021. Further, 196 (57.7%) brushed once a day, 56 (16.5%) twice a day and those who brushed three times a day were 88 representing 25.88 percent (Table 4.11).

Use of toothbrushes was high among the respondents 265 (69.3%). Additionally, 73 (19.3%) brushed their teeth using a chewing stick, 11 (2.8%) used a piece of charcoal (a piece of burned wood from selected trees) to clean their teeth while 33 (8.7%) used

other devices such as dental floss to clean their teeth. The American Dental Association recommends that toothbrushes should be replaced every 3 months or sooner if the bristles become frayed with use. In this study, 163 (42.6%) of the 5-year-old children changed their toothbrushes after every 3 months while 139 (36.9%) changed after a period of more than 3 months. Furthermore, 80 parents/caregivers (20.9%) did not remember the period taken to change their children's toothbrush (Table 4.11).

Table 4.11 Specific oral health practices among the 5-year-old children

Variables	Description	Sample (n)	Percentage
Children brush their teeth	Yes	201	52.6
	No	42	10.8
	Sometimes	139	36.5
Frequency of brushing	Once a day	196	57.7
	Twice a day	56	16.5
	Three times a day	88	25.9
What they use to brush	Toothbrush	265	69.3
	Chewing stick	73	19.3
	Charcoal	11	2.8
	Other	33	8.7
Time for changing toothbrush	3 months	163	42.6
	>3 months	139	36.4
	Don't know	80	20.9

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This section discusses the core results in the study.

5.2 Prevalence of dental caries among5-year-old

5.2.1 Prevalence of dental caries

Prevalence of dental caries was 39% with a mean dft of 1.55. According to the WHO criteria on classification of dft score, a mean dft of 1.55 is considered low prevalence (WHO, 1997). The low dft score in this study may be attributed to frequency of brushing teeth, where more than half of the children (53%) brushed their teeth daily (Table 4.2). Similarly, a low dft score of 1.4 was reported by Lo, Loo and Lee (2009) in Hong Kong preschool children, which was explained by oral health-seeking behaviors such as brushing teeth. In Kenya, the 5-year-old children reported medium dft score of 1.87 among 5-year-olds (MoH, 2015). The variation in prevalence could be attributed to the locations of the studies, where areas sampled for the national survey (Nairobi, Kisumu, and Mombasa) are classified as cities whereas Eldoret which formed the urban sample is a town. Children in the cities are thought to have higher exposure to cariogenic foods than those in developing towns (Zhang, Liu, Lo & Chu, 2014).

In contrast, Elidrissi and Naidoo (2016) in a study among preschoolers in Khartoum, Sudan reported a mean dmft of 2.79. The high dft score was attributed to increased frequency of consumption of candies in addition to poor oral sanitation. Therefore, dental caries prevalence varies among the rural and urban samples as well as between nations.

5.2.2 Dental caries according to location and gender

In this study, higher mean dft score of 1.83 was recorded among the children in urban areas compared to 1.16 in the rural areas. A significant difference (p=0.028) in the occurrence of dental caries among the urban and rural areas. The probable explanation for this difference is that children from urban areas could have had higher access foods high in sugars including biscuits, cakes, and candies that have been implicated in accelerating tooth decay (Elidrissi & Naidoo, 2016). On the other hand, many children from rural areas come from low socio-economic households that may have limited funds to spare for their children to use to buy refined sugar snacks and candies (Srisilapanan Narunsittirat & Roseman, 2017). A study by Kibosia (2011) among preschool children in Uasin-Gishu County reported a mean dmft score of 1.97 for rural areas and 3.30 for urban settlements. The higher mean dft in urban settlement in the study was associated with improvement in the economic status of parents in urban areas and close proximity to high sugar and more refined foods and snacks outlets which was thought to increase the frequency of buying and consumption of sugar-rich foods that accelerate dental caries in this population.

Male children had a lower prevalence at 32.3% with a mean dft of 1.38 compared to female children who had higher prevalence (46.3%) with a mean dft of 1.44. However, no significant difference existed between the gender and the occurrence of dental carries (p=0.421). This can be elucidated from the findings which indicated that female school children have a higher rate of eating sweets and/or snacking that has been found to cause high prevalence of tooth decay (Ferraro & Vieira, 2010). Comparable findings among preschool children were found in a study in Gampaha

District in Sri Lanka which recorded high prevalence in girls (43.6%) compared to 33.7% in boys (Perera *et al*., 2012).

On the contrary, other studies have stated an upper occurrence of dental caries among pre-school boys than girls. Kalita, Choudhury, Sarmah and Saikia (2015) in their study in Guwahati city, India, among preschoolers reported a prevalence of 45.8% in boys and 40.9% in girls with a mean dft value of 5.60 and 5.28 respectively. A study by Al-Malik & Rehbini (2006) on the occurrence of dental caries among Saudi Arabian children also found male to be more affected by dental carries at 50.7% compared to female children at 49.3%. Correspondingly, a higher dmft score of 53% in male pupils and 23% in female pupils have been reported by Nahur (2015). The reason that was given for male children having higher dental caries than girls was that boys generally do not adhere to oral health practices such as brushing teeth like girls (Bafti, Hashemipour, Poureslami & Hoseinian, 2015) and that parents/caregivers place more emphasis on physical appearance and grooming in girls than boys (Nahur, 2015). Therefore, the existing differences of caries experience between locations and genders could be influenced by the socioeconomic differences in the country and variations in oral sanitation behaviors in among the genders.

5.3 Nutrient intake among 5-year-old in Uasin-Gishu County

The intake of nutrients plays a crucial role in the eruption, growth, development, and protection of teeth from decay (Moynihan & Petersen, 2004) with sufficient intake having significant protective roles while insufficient intake accelerates dental erosion leading to dental caries (Arora *et al.,* 2011). Therefore, the current study assessed the intake of recommended minerals such as phosphorus, calcium, fluoride, zinc, and

iron; vitamins A, C, folate as well as protein and energy that play a very a key role in dental health in children (WHO, 2003).

5.3.1 Vitamin C

The mean intake of vitamin C among the subjects this study was met (49.82 mg). The recommended daily allowance (RDA) is 25 mg for this age group. The sufficient intake of vitamin C may be attributed to the consumption of a variety of fruits such as mangoes and oranges as Uasin - Gishu County has a good supply of fruits all-round the year (Uasin Gishu CIDP 2013-2018).Vitamin C is crucial in the synthesis of collagen, which almost exclusively constitutes the protein part of teeth and aids in the basic support over which mineralization of teeth takes place (Bahal & Djemal, 2014). Collagen is necessary for the creation of dentine, pulp, cementum and blood vessels (Moynihan & Petersen, 2004). Based on these functions, vitamin C plays a critical role in reduction of caries development and progression.

5.3.2 Vitamin A

Mean vitamin A intake in this study was 382.30 µg against the RDA of 400 µg of this age group. This means that the children did not meet their requirements for this nutrient by a small percent (4%). This can be attributed to low intake of Vitamin A rich foods such as yellow-fleshed sweet potatoes, carrots and pumpkins as well as dark green vegetables. This is an indicator that a segment of the subjects were at risk of Vitamin A Deficiency (VAD). According to a study by Oyunga, Omondi and Grant (2016), VAD among young children in Western Kenya was attributed to low intake of vitamin A rich foods.

Besides its role in healthy vision, vitamin A is required for the maintenance of the mucosal membranes, salivary glands, teeth and cell integrity (Mobley *et al.,* 2009). Vitamin A plays a part in the care of the mucosal membranes and salivary glands ensuring a healthy oral cavity free from acidic bacteria that are implicated in dental caries progression (Petersen, 2010). The implication of this finding is that a segment of the subjects are in danger of developing and/or faster progression of dental caries due to low intake of vitamin A.

5.3.3 Protein

Protein supply the Essential Amino Acids (EAAs) required for the creation of all body cells and is essential in collagen formation which is needed in the development of dentine, periodontal ligaments, cementum and bones (Pflipsen & Zenchenko, 2017). A deficiency in the protein intake is linked to protein-energy malnutrition, enamel hypoplasia, primary dentition caries and late primary teeth exfoliation (Psoter, Reid & Katz, 2005). The mean protein intake among the children in the current study was 29.21 g. Therefore the children met their daily protein requirement. This could be due to the abundance and consumption of eggs and legumes that provide a significant amount of protein in the diet (Kirui & Nguka, 2017).

5.3.4 Energy

From this study, mean energy intake of the 5-year-old children was 1321.87 Kcal, which was lower than the EER recommendation of 1600 Kcal (Institute of Medicine (IOM), 2000). This may be attributed to the low intake of oil/fat in the diet which has the highest output of energy (9 calories per gram) compared to carbohydrate and protein which offer the body 4 calories per gram each (Austin, Ogden & Hill, 2011). A study in Western Kenya among pre-school children also found that children did not

meet their energy requirement due to inadequate consumption of carbohydrate, proteins and fats that are the chief source of energy in the diet (Ekesa, Walingo & Abukusa-Onyango, 2009). Optimum energy, especially from carbohydrates, consumed at the right proportions benefit an individual by providing the necessary fuel to support daily activities as well as protein sparing mechanism that allow the protein consumed to be used for dental structure formation and protection. A study by Okemwa *et al., (*2011) on intake of cariogenic foods among school children in Uasin-Gishu, Kenya observed that excessive energy from intake of cariogenic foods provides excessive calories which tilts the balance towards the bacterial uses of energy production. This occurrence support the growth of microorganisms that metabolize carbohydrates to produce acidic metabolites causing demineralization of teeth. The implication of the unmet energy consumption in these children is that prolonged energy deficiency will lead to utilization of protein for energy production, leaving little protein for dental development and repair and thus increase the chances of dental caries.

5.3.5 Folate

In this study, mean folate intake of 135.82 µg among the pre-school children was below the recommended RDA of 400 µg for this age group by 66%. This may be attributed to the low consumption of dark green vegetables such as spinach and unsuitable food preparation methods such as boiling. Allen (2008) reported that folate deficiency among preschool children is prevalent among children who have a low consumption of green leafy vegetables. Folate plays a major role in the prevention of dental decay by reducing gums inflammation thus making the gums more resilient to dental caries and anaerobic bacteria that causes dental demineralization (Katz, 2013).

A study by Esaki *et al., (*2010) on the relation of folate intake and dental diseases in Japan reported that low serum folate level as a result of insufficient nutrition is linked to the deterioration of dental health and thus the development of dental caries. The inadequate folate intake in this study could be a pointer that children are at risk of dental demineralization.

5.3.6 Calcium and phosphorus

In the present study, the mean calcium intake of children was 470.67 mg which was according to the RDA less by 53% for 5-years-old children. Low calcium consumption might have been due to milk commercialization by most of the households in Uasin-Gishu instead of feeding it to the children. Kirui and Nguka (2017) in a survey on the influence of milk consumption among preschool children in Uasin-Gishu County established that a smaller percentage of the households (32%) fed their children with a mean amount of 250 ml of milk in a week. In Japan, Tanaka, Miyake and Sasaki (2010) established that daily milk consumption was considerably connected to a lesser risk of dental caries in children.

The RDA for Phosphorus among 5-year-old children is 500mg, thus the children in this study met their daily intake. This may be attributed to presence of phosphorus in a variety of foods of both animal and plant sources. Phosphorus is a mineral that helps in building strong bones and teeth enamel thus protecting the teeth against dental caries (Yoshihara, Watanabe, Hanada & Miyazaki, 2009). Similarly, a study by Lin, Lin, Hu, Kuo and Yang (2014) among school children reported phosphorus intake of 1135.96 to 1035.05 mg. Phosphorus plays an important part in the balance between demineralization and remineralization of enamel thus protecting from dental caries (Dror & Allen, 2014).

Calcium and phosphorus are essential in the mineralization of the protein matrix, therefore providing the bones and teeth with their comprehensive firmness (Subedi, Shakya, Jnawali, Paudyal, Acharya *et al.,* 2011). A study on the relationship between diet and dental caries in Japan demonstrated that relatively high calcium and Phosphorus intake results in lower dental caries experience in children (Yoshihara *et al.,* 2009). Inadequate intake of calcium and phosphorus-rich diet not only leads to premature tooth loss but is also linked with severe caries (Moshfegh *et al.,* 2016). Implication in low intake of calcium and high intake of phosphorus is that it may tilt the synergistic balance of calcium and phosphorus thus placing a section of the children in danger of dental caries.

5.3.7 Iron and Zinc

The RDA for 5-year-olds is 10 mg of Iron and 5 mg of Zinc. In this study, mean iron and zinc intake among the 5-year-old children was 9.29 mg and 8.92 mg, respectively. Therefore, the children met the Zinc requirements but failed to meet the Iron requirements. This could have been caused by little intake of food such as meat, and dark green vegetables such as spinach that is high in Iron. This suggests that some children in this study may have suffered from iron deficiency anemia. Buzalaf *et al., (*2006) in a study on the role of iron on inhibition of acid demineralization found out that iron plays a critical role of inhibiting acid demineralization of the enamel by directly affecting mineral dissolution. Therefore, iron deficiency directly leads to dental caries by exposing the teeth to acid demineralization. A study by Tang, Huang and Huang (2013) on the relationship of dental caries and anemia amongst children in China reported a strong link of anemia from iron deficiency with dental caries.

Zinc plays a crucial role in inhibiting the growth of bacteria proliferation in the mouth which in turn leads to reduction in dental caries in children (Lelli, Putignano, Marchetti, Foltran, Mangani *et al.,* 2014). A study by Sejdini, Begzati, Salihu, Krasniqi, Berisha *et al., (*2018) on the role of zinc on dental caries found that zinc concentration is significantly linked to a decrease in caries in preschoolers and it is also found to play a critical role in mineralization and maturation of hard tooth tissue that protect the teeth against decay. Were, Ohiokpehai, Okeyo-Owuor, Mbagaya, Kimiywe *et al., (*2010) in a study on zinc status in children in Suba District recommended that important improvement in zinc status of the children and nutrition education can increase zinc status of undernourished children. Therefore, adequate supply of zinc and iron in the diet can go a long way in supporting other measures employed in lowering and even eradicating dental caries in children.

5.4 Consumption frequency of cariogenic foods

Dietary factors directly associated with the occurrence and severity of dental caries is linked to the intake of high amounts of sugary foods (Harris *et al.,* 2004). In the present study, tea with sugar was the most commonly consumed food item on a daily basis at 58.5% in urban and 46.5% in rural areas. These findings corroborate those reported by the MoH (2015) where the majority of pre-school children (60.9%) drunk tea with sugar every day. In this study, 28.4% of the children living in urban areas ate sweets and biscuits several times a day. The sucrose added to candies and processed foods might have led to high dental caries in the urban sample.

In a similar study by Elidrissi & Naidoo (2016) among children in Khartoum Sudan, the most consumed food items among children in urban settlements included sweets, candies, chocolate, cakes, biscuits and carbonated soft drinks. In contrast, a study by

Wigen & Wang (2010) reported a low likelihood of dental caries in children who had frequent sugar intake. The implication of this finding is that children in urban area who have higher consumption of cariogenic foods are at increased risk of dental caries.

5.5 Nutritional status of the children

From the results of the present study, the prevalence of underweight was at 9%, stunting at 9.1% and wasting at 6.7% (MUAC <11.5 cm). The prevalence for underweight and wasting were higher when compared to a study by Imbumi, McMullin, Keding, Njogu, Wekesa *et al., (*2013) in Rural Western Kenya which reported a prevalence of 6% underweight, and 2% wasting in children. However, stunting in the current study (9.1%) was lower than the 23% reported by Imbumi *et al., (*2013) for Western Kenya. This might be brought about by failure to receive adequate nutrition (Table 4.4) which is synonymous with the sustained insufficient consumption of food as well as disease episodes that result in low weight for age.

5.6 Nutritional status of the children according to location

In the present study nutritional status according to the location was differed significantly (p=0.02) with higher overweight cases among the urban population (13.6%) compared to the rural population (8.96%). High cases of underweight were prevalent among the rural population 10.7%, stunting at 14.6% and wasting at 6.8% (Table 4.6). Wasting was higher significantly in rural than in urban children (p=0.03). This could be caused by inadequate energy dietary intake as well as episodes of sickness such as diarrhea which is prone to preschool children. Were *et al., (*2010) linked malnutrition in children to underlying factors such as deepening food insecurity in the households, recurrent infections, low parental education

accomplishment and scarcity. Prevalence of underweight among the rural population was close to the national value of 11% (KNBS & ICF Macro, 2015).

Similarly, Ronoh, Were, Wakhu-Wamunga and Wamunga (2017) reported underweight rate of 10.8% in preschool children in Western Kenya. Underweight is associated with decreased food and nutrient intake or illness that lead to loss of body mass thus causing a reduction in body weight (Ronoh *et al.*, 2017). The implication of wasting being significantly higher in rural children is that there will be a vicious cycle of wasting and dental caries thus compromising the life quality. Underweight and Wasting in these children suggest that undernutrition begins at an early age and thus there is the need for nutritional efforts as well as dental caries control to be focused at an early age.

5.7 Relationship between BMI and dft

From the results of the current study, there was a positive relationship that was significant between underweight, overweight, obesity and wasting and the occurrence of dental caries ($p<0.05$). Therefore, a positive association between the BMI score and dental caries among the children. This means that when BMI rises, the rate of dental caries also increases. This might be explained by the fact that the causes of BMI increase such as consumption of refined and high sugar diet have also been seen to exacerbate the development and progression of dental caries. These findings are supported by Vanishree, Narayan, Naveen, Anushri, Vignesh *et al.*, *(*2017) who studied preschool children in India and established a significant positive association between dental caries experience WAZ and BMI-for-Age (BAZ) in children. Gaur

and Nayak (2011) in a study on the association of dental caries with nutrition among children in India also reported a relationship in BMI and dental caries.

Results indicated a positive relationship between dft score and underweight. This implies that the more undernourished the children were, the higher the dft score. This may have been a result of insufficient intake of critical nutrients that support healthy teeth development such as vitamin A, Folate, Iron and Energy as shown on Table 4.4.

Underweight children have poor growth and development patterns due to the deprivation of essential nutrients mentioned earlier. Poor nutrition increases vulnerability to dental caries because of changed saliva composition and altered secretion (Hara & Zero, 2010), and a relationship between undernourishment, enamel corrosion, dental caries, and exfoliation of the teeth exists (Mishu, Hobdell, Khan, Hubbard & Sabbah, 2013). Bafti *et al., (*2015) in a study among 3–6-year-old children in Iran found that the association of being malnourished and dental decay is because preschoolers who are malnourished are more vulnerable to communicable diseases due to the compromised immune system. Yen and Hu (2013) in a study of Taiwan children presented that a higher dental caries score is associated with lower BMI because lower BMI can be caused by other factors such as frequency of consumption of sweets which may not necessarily lead to gain in weight.

Elsewhere, other studies have reported no statistically significant association between the prevalence of dental caries and BMI. For instance, a study by Jong-Lenters, Dommelen, Schuller, and Verrips (2015) among 5 to 8-year-olds in the Netherlands concluded that having active dental caries is not an indicator of being overweight or vice-versa. The probable reason for lack of link between BMI and prevalence of

dental caries was that caries score sums the existence of caries in every teeth throughout the lifespan whereas BMI in pre-school children change rapidly at this phase and thus over nutrition is apparent in a small period of time. In addition, Yen and Hu (2013) observed that obesity and being overweight can be attributed to consumption of high fats in the diet and not high sugar snacks and foods which is implicated to cause dental caries.

Therefore, the relationship between a child's growth and the prevalence of dental caries is multifaceted and differs depending on a myriad of factors, including gender, age, race, as well as other social factors (Vanishree *et al.,* 2017). The prevalence of dental caries could also be linked to influences such as ethnicity (Xavier *et al.*, 2013), low parental education, poverty/lower socioeconomic and higher socioeconomic status level (Yao, Ren, Song, He, Jin, *et al.,* 2014), skipping breakfast and eating lesser fruit and vegetables serving daily (Begum *et al.,* 2014). Furthermore, other studies have reported that attending public school, school absenteeism (Sadeghi & Roberts, 2016) and high intake of soft drink and little health attitude is positively linked with caries(Vanishree *et al.,* 2017). Consequently, the high occurrence of dental caries in pre-school children which continue to be a grave health issue and should be examined further to fully understand the link between obesity and dental caries.

5.8 Knowledge, attitude, and practices on dietary behaviors and dental caries of children and their parents/caregivers

5.8.1 Knowledge

Enhanced knowledge on oral health among caregivers is a pre-requisite for favorable behaviors on the oral hygiene of children and themselves (Liu *et al.,* 2017). In this study, parents/caregivers who strongly disagreed that brushing children's teeth after breakfast and before going to bed had their children experiencing a higher mean dft of 2.3 compared to those who strongly agreed (mean dft=1.18). This implies that the parents/caregivers with knowledge on tooth brushing have higher chances of instilling correct tooth brushing skills in their families, thus lowering the incidences of dental caries (Szatko *et al.,* 2004). In assessing knowledge of parents/caregivers on food and dental caries, 83.5% of the respondents were able to associate food and cariogenicity, and their children had lower dft scores (dft 1.16 and 1.54). Ashkanani and Al-Sane (2013) reported a very high percentage (91.3%) intake of high sugar foods and snacks. In the present study, parent/caregivers who strongly agreed with the fact that refined sugar foods and snacks cause dental caries had a fairly higher dft score of 1.54. This can be attributed to their children buying and consuming candies and sugar-rich snacks instead of healthy snacking in school.

It was observed that 82. 6% of the parents/caregivers had knowledge on the need of ensuring that children honor a dentist appointment at least once annually, and low dft score was observed in their children (dft-0.99) compared to those who lacked knowledge on the importance of dental checks at least once a year for their children (6.3%) and their children had higher dft score of 2.29. Brushing of teeth and

periodically visiting a dentist is linked to low levels of dental decay in children (Njoroge, Kemoli & Hussein, 2007).

5.8.2 Attitude of Parents/caregivers

The role of the attitude of parents/caregivers and the prevalence of dental caries in their children in known (Okemwa *et al.,* 2011). Chacha (2016) pointed out that parents who have a positive attitude towards oral hygiene of their children stand a chance to protect their children from dental caries. Vania, Parisella, Capasso, Di Tanna, Vestri *et al., (*2011) observed that attitude control behavior and beliefs on oral health in children. In the present study, 77.2% of parents/caregivers agreed that caring for children's teeth is important, yet only 8.7% of them visited a dental clinic for the dental check-up with their children between 7-12 months prior to the study. This findings are similar to those reported by Njoroge *et al., (*2007) in a study on dental caries among preschool children in Kiambaa Division, Kenya where 84.7% of caregivers agreed that deciduous dentition was important. On the other hand, following a study on dental caries among 2-5-year-old immigrant Latino children, 76% of the parents thought that baby teeth were important (Watson, Horowitz, Garcia & Canto, 1999). Contrary findings were reported in a study in Poland among three-year-olds which established that 66% of the mothers agreed that milk teeth need not be looked after because they eventually fall off (Szatko *et al.,* 2004). The implication of this finding is that although the parents/caregivers value the dental health of their children, they do little to protect their children from dental caries. Therefore, young children have a higher risk of dental caries as a result of lack of initiative from their parents to start dental caries check-up on time.

Seeking dental services is positively influenced by the attitudes of the caregivers (Gathecha *et al.,* 2012). In the current study, only 12% of the parents/caregivers visited a dental clinic 0-6 months with their children, another 8.7% visited between 7-12 months prior to this study and their children's dft scores were 1.50 and 1.45, respectively. This was lower than those who had visited more than a year ago (43.1%, dft=1.53) and those that never visited dental clinic at all (36.1%, dft=1.57). However, slightly more than half (52.4%) parents/caregivers visited the dentist because of the painful tooth and another 47.6% visited for dental checkup/treatment upon realizing that their children's teeth had caries. This indicates that even those who thought that visiting a dental clinic at least once every year did not do so for the check-up but only resorted to visiting the dentist when the child was already experiencing pain in the tooth due to caries. These findings corroborate those by Njoroge *et al., (*2007) who reported that although a majority of the caregivers (88.2%) agreed with the importance of regular dental checkups, the carious lesions in the children remained mostly untreated, reflecting a gap between what the caregivers knew and what they actually practiced.

Furthermore, the study by Kibosia (2011) found that preschoolers in both rural and urban areas of Uasin-Gishu County had high unmet dental caries treatment needs (over 90%) and this supports the finding that parents'/caregivers' attitude towards dental visits is still poor in the study area. Similarly, Gathecha *et al., (*2012) established that kids who attended a dental clinic once yearly had high dental prevalence of dental caries compared to those that visited the dentist. These results are similar to KNOHS findings (MoH, 2015) and may be elucidated by the circumstance that children tend to go to a dentist when a dental problem manifests

instead of periodic examinations. Therefore, motives for visiting a dentist were remedial instead of deterrent measures.

5.8.3 Oral Health Practices

Importance of oral hygiene practices including tooth brushing in the removal of plaque, are important in prevention of dental cariesd (Ashkanani & Al-Sane, 2013). In this study, 21.4% of the children brushed once daily, 41.6% twice daily while 32.8% brushed sometimes a week with those who never brushed at all 4.2%. Those who never brushed at all had a mean dft score of 1.79. A higher percentage than the present study was reported by Njoroge *et al., (*2007) where 63% and 31.2% of the children brushed once and twice daily respectively. Elidrissi & Naidoo (2016) in a study among preschoolers in Khartoum reported a very high percentage of brushing where 83% of them brushed once daily. However, those brushing twice a day (15.1%) were lower than the 41.6% reported in this study. Despite the widespread practice of tooth brushing in the study children, the level of dental caries was relatively high (dft=1.83). This finding could be credited based on the realization that 80.7% of the children used incorrect brushing technique with 19.3% brushing using the recommended "up-down and sideways" method once daily. Further, the multifactorial etiology of caries may suggest that other factors such as sugar consumption which was high in the present study among the urban sample, and time for initiation of oral hygiene practices in children by the parents/caregivers. The current study did not determine the time for initiation of tooth brushing among the children.

Sheiham (2006) in a study on dental caries in pre-school children observed that brushing with fluoridated toothpaste is recommended to significantly reduce dental caries in 5-year-old children. In the present study, children who used fluoride

toothpaste a toothbrush in brushing twice daily (34.9%) had a lower mean dft of 1.48 compared to those who never used a toothbrush and fluoridated toothpaste (7.2%) with a higher mean dft of 2.25. Ngatia, Imungi, Muita and Ng'ang'a (2001) in a study preschool children in Nairobi reported that toothbrush and toothpaste were used by the majority of the pre-school children (93%). In Uganda, Kiwanuka, Astrom & Trovik (2004) reported toothpaste use in 99% of the preschoolers. The improved use of toothbrush and fluoridated toothpaste in the current study sample may be attributed to the fairly good household income and high level of education of parents/caregivers experienced in this study.

Additionally, increased advertisement of the importance of tooth brushing using a toothbrush and fluoridated toothpaste in the print media (Njoroge *et al.,* 2007) radio and television (Gathecha *et al., (*2012) may have influenced the brushing practices in the study population. Therefore, the practice of using a toothbrush and fluoridated toothpaste is embraced by many children. However, a very low number of children used the recommended up-down and sideways motions in this study which might have contributed to dental caries.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

From the findings in this study, it is concluded that:

1. The prevalence of dental caries is significantly higher among 5-year-old children in the urban than rural areas
2. There is inadequate consumption of Vitamin A, Energy and Iron in the diet consumed by the 5-year-old both in the urban and rural areas of Uasin – Gishu County, Kenya
3. Underweight is higher in rural than urban areas, while overweight and obesity is greater in urban areas than in rural of Uasin–Gishu County, Kenya. A significant relationship between obesity, underweight and prevalence of dental caries
4. Parents/caregivers have sufficient knowledge and an encouraging attitude concerning oral health hygiene of the 5-year-old children, however the techniques of brushing teeth and reduction in frequency of intake of foods and snacks with refined sugar is not well implemented

6.2 Recommendations

Recommendations from the study includes:

1. **Recommendation for policy**

It is recommended that programs targeting alleviation of malnutrition (underweight, overweight and obesity) among children be modified to include dental caries mitigation in both rural and urban areas by the MoH.

Recommendation for practice

To reduce the dental caries in 5-year-old in Uasin-Gishu County, parents should ensure that children are fed on nutrient rich foods and cariogenic foods should be consumed occasionally

2. **Recommendation for education/training**

Ministry of education should equip the teachers with skills to educate the children on the implications of cariogenic foods on their dental health. Also, proper technique of brushing teeth should be inculcated in the children by their parents at home and teachers when at school.

Further research

There is the need for more research to determine the link between dietary habits, nutritional status and dental caries in children above 5 years in Kenya

REFERENCES

Abiola, A. A., Eyitope, O. O., Sonny, O. J., & Oyinkan, O. S. (2009). Dental caries occurrence and associated oral hygiene practices among rural and urban Nigerian pre-school children. *Journal of Dentistry and Oral Hygiene*, 1(5), 64-70.

Al-Darwish, M., Walid El Ansari, W & Bener, A. (2014). Prevalence of dental caries among 5–14 year old children in Qatar. *The Saudi Dental Journal*; 26, 115–55

Allen, L. H. (2008). Causes of vitamin B_{12} and folate deficiency. *Food and nutrition bulletin*, 29(2_suppl1), S20-S34.

Alm A, Wendt LK, Koch G, Birkhed D (2008).Oral hygiene and parent-related factors during early childhood in relation to approximal caries at 15 years of age. *Journal of Caries Research*; 42:28-36.

Al-Malik, M. I., & Rehbini, Y. A. (2006). Prevalence of dental caries, severity, and pattern in age 6 to 7-year-old children in a selected community in Saudi Arabia. *Journal of Contemporary Dental Practice*, 7(2), 46-54.

Armstrong, A., Freeman, R., McComb, A. &Speedy, P. (2008*). Nutrition and dental health. Guidelines for professionals on Dental caries*

Arora, A., Scott, J. A., Bhole, S., Do, L., Schwarz, E., & Blinkhorn, A. S. (2011). Early childhood feeding practices and dental caries in preschool children: a multi-centre birth cohort study. *BMC Public Health*, 11(1), 28.

Ashkanani, F., & Al-Sane, M. (2013). Knowledge, attitudes and practices of caregivers in relation to oral health of preschool children. *Medical Principles and Practice*, 22(2), 167-172.

Austin, G. L., Ogden, L. G. & Hill, J. O. (2011). Trends in carbohydrate, fat, and protein intakes and association with energy intake in normal-weight, overweight, and obese individuals: 1971–2006–. *The American journal of clinical nutrition*, 93(4), 836-843.

Awooda E.M, Saeed, S.M, Elbasir E.I. (2013). Caries prevalence among 3-5 years old children in Khartoum State-Sudan. *Innovative Journal of Medical and Health Science*; 3: 42-44.

Bafti, L. S., Hashemipour, M. A., Poureslami, H., & Hoseinian, Z. (2015). Relationship between body mass index and tooth decay in a population of 3–6-year-old children in Iran. *International journal of dentistry*, 2015.

Bagramian, R.A., Garcia-Godoy, F. & R, V.A., (2009).The global increase in dental caries. A pending public health crisis. *American Journal of Dentistry*, 22, pp.3–8

Bahal, P., & Djemal, S. (2014). Dental erosion from an excess of vitamin C. *Case reports in dentistry*, 2014.

Bailleul-Forestier, I., Lopes, K., Souames, M., Azoguy-Levy, S., Frelut, M. L. & Boy-Lefevre, M. L (2007). Caries experience in a severely obese adolescent population. *International Journal Paediatric Dentistry*; 17:358-63

Begum, M. Z., Nagamalleshwari, M., Srinivas, P., Gadagi, J. S., Gadde, P., & Jyothirmai, K. (2014). Is body mass index truly related to dental caries? Survey on predisposing factors for overweight among Indian school children. *Dental Hypotheses*, 5(4), 150.

Berg, J., Gerweck, C., Hujoel, P.P., King, R., Krol, D.M., Kumar, J. (2011). American Dental Association Council on Scientific Affairs Expert Panel on Fluoride Intake. From infant formula and fluorosis. Evidence-based clinical recommendations regarding fluoride intake from reconstituted infant formula and enamel fluorosis: a report of the American Dental Association Council on Scientific Affairs. *Journal of American Dental Association*. 142(1):79-87. PMID: 21243832 www.ncbi.nlm.nih.gov/pubmed/21243832

Burt, B.A. & Satishchandra, P. (2001). Sugar consumption and caries risk: a systematic Review. *Journal of Dental Education;* 65, 1017-23

Buzalaf, M. A. R., de Moraes Italiani, F., Kato, M. T., Martinhon, C. C. R., & Magalhães, A. C. (2006). Effect of iron on inhibition of acid demineralisation of bovine dental enamel in vitro. Archives of oral biology, 51(10), 844-848.

Chacha, G (2016). *Are Parents Failing Children in Upholding Proper Dental Hygiene*? The Standard-Special Feature, pp. 6-7

Chepsiror, E. (2013).The Challenges of Housing Development for the Low Income Population in Kenya; A Case of Eldoret Town. University of Nairobi. *Thesis*

Cook, S. L., Martinez-mier, E. A., Dean, J. A., Weddel, J. A., Sanders, B. J., Eggertsson, H., Ofner, S. and Yoder, K. (2008). Dental caries experience and association to risk indicators of remote rural populations. *International Journal of Paediatric Dentistry*, 18: 275–283

Datta, P, & Datta, P. P. (2013). Prevalence of Dental Caries among School Children in Sundarban, India. *Epidemiol* 3: 135. doi:10.4172/2161-1165.1000135

Davies, G. M., Neville, J. S., Rooney, E., Robinson, M., Jones, A., & Perkins, C. National Dental Epidemiology Programme for England: oral health survey of five-year-old children 2012: *A report on the prevalence and severity of dental decay*. 2013.

de Onis, M., Onyango, A. W., Van den Broeck, J., Chumlea, C. W. & Martorell, R. (2004). Measurement and standardization protocols for anthropometry used in the construction of a new international growth reference. *Food and nutrition bulletin*, 25(1_suppl1), S27-S36.

De Paula, J.S., Sarracini, K.L., Meneghim, M.C., Pereira, A.C., Ortega, E.M., Martins, N.S., & Mialhe, F. L. (2015).Longitudinal evaluation of the impact of dental caries treatment on oral health-related quality of life among school children. *European Journal of Oral Science*. 53(3):173-8

de Onis, M., Onyango, A. W., Van den Broeck, J., Chumlea, W. C., & Martorell, R. (2004). Measurement and standardization protocols for anthropometry used in the construction of a new international growth reference. Food and nutrition bulletin, 25(1_suppl_1), S27-S36.

Do, L.G., Ha, D. H. & Spencer, A. J. (2015). Factors attributable for the prevalence of dental caries in Queensland children. *Community Dent Oral Epidemiol 2015*. John Wiley & Sons A/S. Published by John Wiley & Sons Ltd

dos Santos Souza, E. S., Bezerra, A. C. B., de Amorim, R. F. S. G., & Leme, T. D. P. (2015). Caries diagnosis in the mixed dentition using ICDAS II. Pesquisa Brasileira em Odontopediatria e Clínica Integrada, 15(1), 13-21.

Dror, D. K., & Allen, L. H. (2014). Dairy product intake in children and adolescents in developed countries: trends, nutritional contribution, and a review of association with health outcomes. *Nutrition reviews*, 72(2), 68-81.

Dye, B. A., Hsu, K. L. C., & Afful, J. (2015). Prevalence and measurement of dental caries in young children. *Pediatric dentistry*, *37*(3), 200-216.

Ekesa, B. N., Walingo, M. K., & Abukutsa-Onyango, M. (2009). Dietary diversity, nutrition status and morbidity of pre-school children in Matungu division, Western Kenya. *International Journal of Food Safety, Nutrition and Public Health*, 2(2), 131-144.

Ekesa, B., Walingo, M., & Onyango, M. O. A. (2008). Role of agricultural biodiversity on dietary intake and nutrition status of preschool children in Matungu Division, Western Kenya. *African Journal of Food Science*, 2, 26-32.

Elidrissi, S. M., & Naidoo, S. (2016). Prevalence of dental caries and tooth brushing habits among preschool children in Khartoum State, Sudan. *International dental journal*, 66(4), 215-220.

Esaki, M., Morita, M., Akhter, R., Akino, K., & Honda, O. (2010). Relationship between folic acid intake and gingival health in non- smoking adults in Japan. Oral diseases, 16(1), 96-101.

Farsi, J. M. A., Farghaly, M. M., & Farsi, N. (2004). Oral health knowledge, attitude and behaviour among Saudi school students in Jeddah city. *Journal of dentistry*, *32*(1), 47-53.

Farooqi, F. A., Khabeer, A., Moheet, I. A., Khan, S. Q., & Farooq, I. (2015). Prevalence of dental caries in primary and permanent teeth and its relation with tooth brushing habits among schoolchildren in Eastern Saudi Arabia. Saudi medical journal, 36(6), 737.

Featherstone, J.D.B. (2000). The science and practice of caries prevention. *Journal of the American Dental Association* 131, 887–899

Ferraro, M., & Vieira, A. R. (2010). Explaining gender differences in caries: a multifactorial approach to a multifactorial disease. *International journal of dentistry*, 2010. Assessment. National Academy Press, Washington, DC, pp. 73-105.

Ferro, R., Besostri, A., Meneghetti, B. & Stellini, E. (2007). Prevalence and severity of dental caries in 5- and 12-year old children in the Veneto Region (Italy). *Community Dental Health.* 24: 88-92.

Folayan, M., Sowole, A., Kola-Jebutu, A. (2007).Risk factors for caries in children from South-Western Nigeria. *Journal of Clinical Pediatric Dentistry*. 32(2):

Fisher, J., Glick, M., & FDI World Dental Federation Science Committee. (2012). A new model for caries classification and management: the FDI World Dental Federation caries matrix.

Gathecha, G., Makokha, A., Wanzala, P., Omolo, J., & Smith, P. (2012). Dental caries and oral health practices among 12 year old children in Nairobi West and Mathira West Districts, Kenya. *Pan African Medical Journal*, 12(1).

Gaur, S., & Nayak, R. (2011). Underweight in low socioeconomic status preschool children with severe early childhood caries. *Journal of Indian Society of Pedodontics and Preventive Dentistry*, 29(4), 305.

Gibson, S. & Williams, S. (1999). Dental caries in preschool children: Associations with social class, tooth brushing habit and consumption of sugars and sugar containing foods. *Caries Research*. 33: 101-113.

Guthrie, J. F. and Morton, J. F. (2000). Food sources of added sweeteners in the diets of Americans. *Journal of American and Dietetic Association*; 100(1):43-51

Hara, A. T., & Zero, D. T. (2010). The caries environment: saliva, pellicle, diet, and hard tissue ultrastructure. *Dental Clinics*, 54(3), 455-467.

Harris, R, Nicoll, A.D., Adair, P.M. & Pine, C.M. (2004). Risk factors for dental caries in young children: a systematic review of the literature. *Community of Dental Health*; 21(1 Suppl):71–85.

Hilgers, K.K., Kinane, D.E. & Scheetz, J.P. (2006). Association between childhood obesity andsmooth-surface caries in posterior teeth: a preliminary study. *Pediatric Dentistry*; 28:23-8

Hurlbutt, M., Novy, B. & Young, D. (2010). Dental Caries: A pH-mediated disease. Canadian Dental Hygienists' Association. Winter.

Imbumi, M., McMullin, S., Keding, G., Njogu, K., Wekesa, B., Jamnadass, R., & Kehlenbeck, K. (2013). Fruit intake and nutritional status of young children and their mothers/caregivers in rural Western Kenya. *Journal of Food Science*; 24 (6), pp.23-28

Institute of Medicine (IOM), (2000). Dietary Reference Intakes: Application in Dietary Assessment. National Academy Press, Washington, DC, pp. 73-105.

Jarman, M., Fisk, C. M., Ntani, G., Crozier, S. R., Godfrey, K. M., Inskip, H. M & Southampton Women's Survey Study Group. (2014). Assessing diets of 3-year-old children: evaluation of an FFQ. Public health nutrition, 17(5), 1069-1077.

Jepsen, S., Blanco, J., Buchalla, W., Carvalho, J. C., Dietrich, T., Dörfer, C & Higham, S. M. (2017). Prevention and control of dental caries and periodontal diseases at individual and population level: consensus report of group 3 of joint EFP/ORCA workshop on the boundaries between caries and periodontal diseases. *Journal of clinical periodontology*, *44*, S85-S93.

Jong-Lenters, M., Dommelen, P., Schuller, A. A. & Verrips, E. H. (2015). Body mass index and dental caries in children aged 5 to 8 years attending a dental Paediatric referral practice in the Netherlands. *BMC research notes*, 8(1), 738.

Kalita, C., Choudhury, B., Sarmah, P. C., & Saikia, A. K. (2015). Caries prevalence of school going boys and girls according to sweet taking frequency among different age groups in and around Guwahati city. *Journal of Pediatric Dentistry*, 3(3), 82.

Kassebaum, N.J., Bernabé, E., Dahiya, M., Bhandari, B., Murray, C.J&Marcenes, W. (2015). Global burden of untreated caries: a systematic review and metare - gression. *Journal of Dental Research*. 94(5):650–658

Katz, H. (2013), Keep Your Mouth Healthy With Folic Acid. Retrieved from: http://www.therabreath.com/articles/oral-care-tips-and-advice/keep-your-mouth-healthy-with-folic-acid-20163/

Kenya National Bureau of Statistics (KNBS) and Ministry of Public Health and Sanitation (MoPHS) (2008). *Guidelines for Nutritional assessments in Kenya*. Ministry State Planning and National Development and Vision 2030 and Ministry of Public Health and Sanitation. 1st Edition. Nairobi, Kenya.

Kibosia, C. (2011). Relating Prevalence of Dental Caries to Unmet Treatment Needs Amongst Urban and Rural 5-Year Old Children, Uasin-Gishu, Kenya. *Kenya Journal of Health Sciences*, Vol. 1, No. 1: Pp 5-9

King, N.M., Wu, I.I. & Tsai, J.S. (2003). Caries prevalence and distribution, and oral health habits of zero to four year old children in Macau, China. *Journal of Dentistry in Children* (Chic) 70(3): 243-249

Kirui, E. & Nguka, G. (2017). Factors that negatively influence consumption of traditionally fermented milk (Mursik) among preschool children (1-5 years old) in Kapseret location-Uasin Gishu County, Kenya. *African Journal of Food, Agriculture, Nutrition and Development*, 17(3), 12295-12310.

Kiwanuka, S. N., Åstrøm, A. N. & Trovik, T. A. (2004). Dental caries experience and its relationship to social and behavioural factors among 3–5- year- old children in Uganda. *International journal of Paediatric dentistry*, 14(5), 336-346.

Koksal, E., Tekcicek, M., Yalcin, S.S., Tugrul, B., Yalcin, S. & Pekcan, G. (2011). Association between anthropometric measurements and dental caries in Turkish school children. *Central European Journal of Public Health*; 19(3):147–51

König, K.G. (2000). Diet and oral health. *International Dental Journal* 50, 162–174

Kopycka-Kedzierawski DT, Auinger P, Billings RJ, Weitzman M. (2008). Caries status and overweight in 2- to 18-year-old US children: findings from national surveys. *Community Dental Oral Epidemiol*; 36(2):157–67.

Kunzel, W. & Fischer, T. (1997).Rise and fall of caries prevalence in German towns with different Fluoride concentrations in drinking water. *Journal of* Caries Research; 31(63): 166-73.

Lelli, M., Putignano, A., Marchetti, M., Foltran, I., Mangani, F., Procaccini, M & Orsini, G. (2014). Remineralization and repair of enamel surface by biomimetic Zn-carbonate hydroxyapatite containing toothpaste: a comparative in vivo study. *Frontiers in physiology*, 5, 333.

Lin, H. S., Lin, J. R., Hu, S. W., Kuo, H. C., & Yang, Y. H. (2014). Association of dietary calcium, phosphorus, and magnesium intake with caries status among schoolchildren. *The Kaohsiung journal of medical sciences*, 30(4), 206-212.

Liu, H. Y., Chen, J. R., Hsiao, S. Y., & Huang, S. T. (2017). Caregivers' oral health knowledge, attitude and behavior toward their children with disabilities. *Journal of Dental Sciences*, 12(4), 388-395.

Lo, E., Loo, E. & Lee, C. (2009). Dental health status of Hong Kong preschool children. *Hong Kong Dental Journal,* 6: 6–12.

Marriott, L.D., Inskip, H.M. & Borland, S.E. (2009). What do babies eat? Evaluation of a food frequency questionnaire to assess the diets of infants aged 12 months. *Public Health Nutrition* 12, 967–972.

Marshall, T. A., Eichenberger-Gilmore, J. M., Broffitt, B. A., Warren, J. J & Levy, S. M. (2007). Dental caries and childhood obesity: roles of diet and socioeconomic status. *Community Dental of Oral Epidemiology* 35:449-58.

Ministry of Health (MoH) (2015). *Kenya National Oral Health Survey Report 2015*, Ministry of Health: Republic of Kenya

Mishu, M. P., Hobdell, M., Khan, M. H., Hubbard, R. M., & Sabbah, W. (2013). Relationship between untreated dental caries and weight and height of 6-to 12-year-old primary school children in Bangladesh. *International journal of dentistry*, 2013.

Mobley, C., Marshall, T. A., Milgrom, P., & Coldwell, S. E. (2009). The contribution of dietary factors to dental caries and disparities in caries. *Academic pediatrics*, 9(6), 410-414.

Mobley, C.C. (2003). Nutrition and dental caries. Dental Clinics of North America 47, 319-336

Mojarad, F., & Maybodi, M. H. (2011). Association between dental caries and body mass index among Hamedan elementary school children in 2009. *Journal of Dentistry (Tehran*).**8**(4):170–7

Moshfegh, A., Kovalchik, A.F. & Clement, J.C. (2016). Phosphorus Intake of Americans. What We Eat in America, NHANES 2011-2012. *Food Survey Research Group Dietary Data Brief;* No. 15.

Moynihan, P., & Petersen, P. E. (2004). Diet, nutrition and the prevention of dental diseases. *Public health nutrition*, 7(1a), 201-226.

Mugenda & Mugenda (2003). *Research Methods*: Acts Press, Nairobi

Nahur, S. (2015). Prevalence of Dental Caries among Slum School Children: a Cross Sectional Observational Study. *European Academic Research*, Vol. 2(12)

Naidoo S. & Myburgh N. (2007). Nutrition, oral health and the young child. *Maternal and Child Nutrition* 3, 35-321

Ng'ang'a, P. & Valderhaug, J. (1991). Oral hygiene practices and periodontal health in Primary school children in Nairobi, Kenya. *Journal of Acta Odontologica Scandinavica*, Vol. 49, No. 5 pp. 303-309

Ngatia, E. M., Imungi, J.K., Muita, J.W & Nganga, P.M. (2001). Dietary patterns and dental caries in nursery school children in Nairobi, Kenya. *East African journal of Medicine*; 78(12):673-7.

Ngatia, E.M. (1999). A Study of Dietary Patterns, Nutritional Status and Dental Caries in Pres-School Children in Nairobi, Kenya, *Thesis*. University of Nairobi, Kenya.

Njoroge, N.W., Kemoli, A. & Hussein, A. (2007). *Early Childhood Caries Among 3-5 Year Olds and their Caregivers' Oral Health Knowledge, Attitude and Practice In Kiambaa Division, Kenya*. *Thesis.* Kenyatta University, Kenya.

Okada, M., Kawamura, M., Kaihara, Y & Matsuzaki, Y. (2002). Influence of parents' oral health behaviour on oral health status of their school children: an exploratory study employing a casual modelling technique. *International Journal Paediatric Dentistry*.; 5:101-106.

Okemwa, K.A., Gatongi, P.M & Rotich, J.K. (2011). The Prevalence of Dental Caries and the Consumption of Cariogenic Foods in Primary School Going Children in Rural Areas of Uasin-Gishu District-Kenya. *Kenya Journal of Health Sciences*, Vol. 1, No. 1: Pp 22-25

Olobasi, A. A., Udo, U. A., Ehimen, U.G., Bashuru, B.O., Ghenga, O.O, & Adenyini, A.O (2015). Prevalence of dental caries and oral hygiene status of a screened population in Port Harcourt, Rivers State, Nigeria. *Journal of International Social Prevention and Community Dentistry*, 5(1):59–63.

Onyono, E. K., Serrem, C & Serem, D. (2015). Food Consumption Patterns and Nutritional Status of Children 2-5 years Living in High Banana Production Areas of Kenyenya and Keumbu in Kisii County, Kenya. *Thesis*

Owino, R.O., Masiga, M., Ng'ang'a, P., & Macigo, F.G (2010). *Dental Caries and Gingivitis Among 5- Year-Old Children in Peri-Urban Kitale, Trans-Nzoia District, Kenya*. *Unpublished Thesis.* University of Nairobi, Kenya.

Oyunga, M. A., Omondi, D. O., & Grant, F. K. E. (2016). Awareness in the Context of Prevalence of Vitamin A Deficiency Among Households in Western Kenya Using a Cross-Sectional Study. *Journal of Food and Nutrition Sciences*, 4(3), 55-64.

Pahel, B.T., Rozier, R.G. & Slade, G.D., (2007). Parental perceptions of children's oral health: the Early Childhood Oral Health Impact Scale (ECOHIS). *Health and Quality of Life Outcomes*, 5(1), p.6.

Pakshir, H. R. (2003). Dental education and dentistry system in Iran. *Journal of Medical Principle and Practice*.**5** Suppl **1**:56–60.

Perera, P. J., Abeyweera, N. T., Fernando, M. P., Warnakulasuriya, T. D., & Ranathunga, N. (2012). Prevalence of dental caries among a cohort of preschool children living in Gampaha district, Sri Lanka: a descriptive cross sectional study. *BMC Oral Health*, 12(1), 49.

Perinetti, G., Varvara, G and Esposito, P. (2006). Prevalence of dental caries in schoolchildren living in rural and urban areas: results from the first region-wide Italian survey. *Oral Health Prevention in Dentistry*. 4(3): 199-207.

Petersen, P.E. (2005). Socio-behavioural risk factors in dental caries - international perspectives. *Journal Community Dental and Oral Epidemiology*; 33 (4):274–9.

Petersen, E. P (2010). Oral health in the developing world. World Health Organization. Global Oral Health Programme, Chronic Disease and Health Promotion. Geneva: Switzerland.

Petersen, P. E. (2009). Global policy for improvement of oral health in the 21st century–implications to oral health research of World Health Assembly 2007, World Health Organization. *Community dentistry and oral epidemiology*, *37*(1), 1-8.

Pflipsen, M., & Zenchenko, Y. (2017). Nutrition for oral health and oral manifestations of poor nutrition and unhealthy habits. *General dentistry*.

Pita-Fernandez, S., Pombo-Sanchez, A., Suarez-Quintanilla, J., Novio- Mallon, S., Rivas-Mundina, B. & Pertega-Diaz, S. (2010). Clinical relevance of tooth brushing in relation to dental caries. *AtenPrimaria*. 42(7):372–9

Pitts, N. B., Zero, D. T., Marsh, P. D., Ekstrand, K., Weintraub, J. A., Ramos-Gomez, F, & Ismail, A. (2017). Dental caries. *Nature reviews Disease primers*, 3, 17030.

Popkin, B., Shu, P., & Wen, N.G (2007). "The Nutrition Transition in High and Low-Income Countries: What Are the Policy Lessons?" *Journal of Agricultural Economics* 37(s1): 199-211.

Psoter W.J, Reid B.C. & Katz R.V. (2005). Malnutrition and dental caries: A review of the literature. *Caries Research.* 39(6):441-447.

Public Health England (2012). National Dental Epidemiology Programme for England: oral health survey of five-year-old children 2012. A report on the prevalence and severity of dental decay. Retrieved from: www.gov.uk/phe

Ronoh, A.K. & Were, G.M. (2015). Diet Diversity of Complementary Foods. A Case Study of Mulot Division, Narok County, Kenya. *Journal of Education Science and Technology*, Vol.2, No. 2 pp. 1-12

Ronoh, A.K., Were, G.M., Wakhu-Wamunga, F. and Wamunga, J.B. (2017) Food Consumption Patterns among Pre-School Children 3 - 5 Years Old in Mateka, Western Kenya. *Food and Nutrition Sciences*, 8, 801-811. https://doi.org/10.4236/fns.2017.88057

Sadeghi, M., & Alizadeh, F. (2007). Association between dental caries and body mass index-for-age among 6-11-year-old children in Isfahan in 2007. *Journal of dental research, dental clinics, dental prospects*, 1(3), 119.

Sadeghi, M. & Roberts, M. W. (2016). The Relationship between BMI-for-age (BMI-%) and dmft Index of 6-year-Old Children in Rafsanjan, Iran. *International Journal Dental Oral Health*, 2(2), 51.

Sayegh, A., Dini, E.L., Holt, R.D. & Bedi, R. (2002). Food and drink consumption, sociodemographic factors and dental caries in 4-5-year-old children in Amman, Jordan. *International Dental Journal*. 52: 87- 93.

Schroth, R. J., Levi, J., Kliewer, E., Friel, J., & Moffatt, M. E. (2013). Association between iron status, iron deficiency anaemia, and severe early childhood caries: a case–control study. *BMC pediatrics*, 13(1), 22.

Schroth, R.J., Levi, J.A., Sellers, E.A., Friel, J., Kliewer, E. & Moffatt, M.E.K., (2013). Vitamin D status of children with severe early childhood caries: a case-control study. *BMC pediatrics*, 13(1), p.174.

Sejdini, M., Begzati, A., Salihu, S., Krasniqi, S., Berisha, N., & Aliu, N. (2018). The Role and Impact of Salivary Zn Levels on Dental Caries. *International Journal of Dentistry*, 2018.

Shah, N. (2009). Oral and dental diseases: Causes, prevention and treatment strategies. *International Journal of Dentistry*, 14 (4)

Shahraki, T., Shahraki, M., and Mehr, O.S. (2013).Association between Body Mass Index and Caries among Zehedan elementary children. *International Journal of High Risk Behavior Addiction*. 2(3):52-5

Sharda, A. J., & Shetty, S. (2008). A comparative study of oral health knowledge, attitude

and behavior of fist and final year dental students of Udaipur city, Rajastan. *Journal of Oral Health Community Dentistry*, *2*(3), 46-54.

Sheiham, A. (2006). Dental caries affects body weight, growth and quality of life in pre-school children. *British Dental Journal*, 201(10), 625-626.

Singh, G, Kaur, G., Mengi, V & Singh, B (2014).A Study of Dental Caries Among School Children in Rural Area of Jammu**.** *Annals of Dental Specialty*; 2 (1)

Sohi, R. K., Gambhir, R. S., Veeresha, K. L., Randhawa, A. K., & Singh, G. (2012). Assessment of prevalence of dental caries among 5 and 12-year-old schoolchildren in Chandigarh (UT), India. *Archives of Oral Research*, *8*(1).

Srisilapanan, P., Nirunsittirat, A. & Roseman, J. (2017). Trends over Time in Dental Caries status in Urban and Rural Thai Children. *Journal of clinical and experimental dentistry*, 9(10), e1201.

Stecksen-Blicks, C., & Holm, A.K. (1995). Dental caries, tooth trauma, malocclusion, fluoride usage, tooth brushing and dietary habits in 4-year-old Swedish children: changes between 1967 and 1992. *International Journal of Paediatric Dentistry* 5, 143–148

Stookey, G. K. (2008). The effect of saliva on dental caries. *The Journal of the American Dental Association*, 139, 11S-17S.

Subedi, B., Shakya, P. K. C. U., Kc, U., Jnawali, M., Paudyal, B. D., Acharya, A & Singh, A. (2011). Prevalence of dental caries in 5-6 years and 12-13 years age group of school children of Kathmandu valley. *Journal of the Nepal Medical Association*, 51(184).

Sudha, P., Bhasin, S. & Anegundi, R.T. (2005). Prevalence of dental caries among 5-13 year old children of Mangalore City. Journal of Indian Society on Paedodontics Prevention; pp. 74-79

Szatko, F., Wierzbicka, M., Dybizbanska, E., Struzycka, I. & Iwanicka – Frankowska, E. (2004). Oral health of Polish three-year-olds and mothers' oral health related knowledge. *Community Dental Health*; 21 (2):175-80.

Tanaka, K., Miyake, Y. & Sasaki, S. (2010). Intake of dairy products and the prevalence of dental caries in young children. Journal of dentistry, 38(7), 579-583.

Tang, R. S., Huang, M. C., & Huang, S. T. (2013). Relationship between dental caries status and anemia in children with severe early childhood caries. *The Kaohsiung journal of medical sciences*, 29(6), 330-336.

Uasin Gishu County Integrated Development Plan 2013-2018. (2013). *Uasin Gishu County*. Retrieved from: https://cog.go.ke/images/stories/CIDPs/UasinGishu.pdf

United Nations Statistics Division (2014). *Population density and urbanization*. Retrieved from: http://unstats.un.org/unsd/demographic/sconcerns/densurb/densurbmethods.htm

Vania, A., Parisella, V., Capasso, F., Di Tanna, G. L., Vestri, A., Ferrari, M., & Polimeni, A. (2011). Early childhood caries underweight or overweight that is the question. European *Journal of Paediatric Dentistry*, 12(4), 231.

Vanishree, N., Narayan, R. R., Naveen, N., Anushri, M., Vignesh, D., & MP, N. R. (2017). Relationship of dental caries and BMI among pre-school children of Bangalore city, India: a cross sectional study. *International Journal of Community Medicine and Public Health*, 4(3), 814-819.

Wandera, M & Twa-Twa J. (2003). Baseline Survey of oral Health of Primary and Secondary Schools in Uganda. *Journal of African Health Science*; 3(1):19-22

Warren, J. J., & Levy, S. M. (2003). Current and future role of fluoride in nutrition. *Journal of Dental Clinic in North America*; 47, 225-244

Watson, M.R, Horowitz, A.M, Garcia, I & Canto, M.T. (1999). Caries conditions among 2-5 year-old immigrant Latino children related to parents' oral health knowledge, opinions and practices. Community Dent. *Oral Epidemiology*; 27(1): 8-15 1.

Were, G. M., Ohiokpehai, O., Okeyo-Owuor, J. B., Mbagaya, G. M., Kimiywe, J., Mbithe, D., & Okello, M. M. (2010). Soybean (Glycine max) complementation and the zinc status of HIV and AIDS affected children in Suba District, Kenya. *African Journal of Food, Agriculture, Nutrition and Development*, 10(3).

WHO (2015). *What is the burden of oral disease*? Accessed on 11th July, 2015 from http://www.who.int/oral_health/disease_burden/global/en/

WHO (2003). *World Health Organization) Nutrition.* World Health Organization Geneva, Switzerland

Wigen, T. I., & Wang, N. J. (2010). Caries and background factors in Norwegian and immigrant 5- year- old children. *Community dentistry and oral epidemiology*, 38(1), 19-28.

Willerhausen, B., Blettner, M., Kasaj, A. & Hohenfellner, K. (2007). Association between body mass index and dental health in 1,290 children of elementary schools in a German city. *Journal of Clinical and Oral Investigation; 11*(3):195–200.

Willerhausen, B., Blenttner, M. & Hohenfellner, K. (2007). Association between body mass index and dental health in 1,290 children of elementary schools in a German city. *Clinical Oral Investigations*, Vol. 11 (3). pp. 195-200

World Health Organization (1997). *Oral Health Surveys*, 4th edition, WHO Publication: Geneva; pp 21-46.

World Health Organization. (1993): *Guidelines for drinking water quality*. Vol 1 Recommendations. 2nd; Geneva: World Health Organization

World Health Organization. (2012). *Oral Health. Fact sheets no 318*. Available at: www.who.int/mediacentre/factsheets/fs318/en/index.htm.

Xavier, A. F. C., Moura, E. F., Azevedo, W. F., Vieira, F. F., Abreu, M. H., & Cavalcanti, A. L. (2013). Erosive and cariogenicity potential of pediatric drugs: Study of physicochemical parameters. *BMC Oral Health*, 13(1), 71.

Yao, Y., Ren, X., Song, X., He, L., Jin, Y. & Chen, Y. (2014). The relationship between dental caries and obesity among primary school children aged 5–14 years. *Nutrition Hospitality*; 30(1):60–5.

Yen, C.E. & Hu, S.W. (2013). Association between dental caries and obesity in preschool children. *European Journal of Paediatric Dentistry*; 14(3):185-9.

Yoshihara, A., Watanabe, R., Hanada, N., & Miyazaki, H. (2009). A longitudinal study of the relationship between diet intake and dental caries and periodontal disease in elderly Japanese subjects. *Gerodontology*, 26(2), 130-136.

Zhang, S., Liu, J., Lo, E. C., & Chu, C. H. (2014). Dental caries status of Bulang preschool children in Southwest China. *BMC Oral Health*, 14(1), 16.

APPENDICES

APPENDIX I: LETTER OF INTRODUCTION

Hello, My Name is Wakhungu Hillary, and I am a masters student at the University of Eldoret. I am conducting a study on the association of dietary habits and nutritional status on the occurrence of dental caries among 5-year-old school children in urban and rural areas of Uasin-Gishu County, Kenya.

My research assistants and I will ask you questions on your household demographics; frequency and amount of foods that you feed your child on daily basis, weekly or monthly. We will also measure the weight, height and the mid-upper arm circumference of the child. The questions will take around 20-30 minutes to complete. Your child will also be assessed for dental caries presence by trained community health officers. The exercise will be undertaken with the highest standards of hygiene using sterile mouth mirror and probe only by dental specialists. The examination will be painless and non-invasive. The information which will be collected from you and your child will be treated with confidentiality and will not be shown to any other persons. Participation in this study is voluntary and you can choose not to answer any individual questions or all of the questions.

Address: University of Eldoret,

Department of Family and Consumer Sciences

P.O Box 1125-30100, Eldoret**Cell phone: 0725422213**

APPENDIX II: CONSENT FORM

Dear Parent/ Guardian

I am a master's student at the University of Eldoret, pursuing a masters degree in Community Nutrition. I wish to request for your permission for your child to participate in a study that will form part of my degree work.

Purpose of study: The aim of this study is to assess association of dental caries with dietary habits and nutritional status of 5-year-old school children in urban and rural areas of Uasin-Gishu County.

Procedure: You and your child will answer questions relating to food consumption habits, oral hygiene and dental health care. The questions to the children will be simplified and the research assistants will help them to interpret the questions for them to give appropriate answers as much as possible. Your child will be checked for teeth decay by trained assistants under high standards of hygiene. The examination will be painless and non-invasive.

Risks: There will be no dental procedures performed on your child during the study therefore there are no risks involved. Your child will not be given any form of medication but should any problems be detected, they will be referred to a dentist with a referral note.

Benefits: Are there benefits to the child for participating in this study?

During this study there will be no direct benefits for the child participating. However, the child will have their teeth checked by qualified personnel and dental caries case that needs attention will be referred to the school of dentistry, Moi University or MTRH. There will also be oral health education. The findings from this study will

contribute to the body of knowledge to help in formulation of policies to improve the nutritional status and dental health status of pre-school children in Uasin-Gishu County.

Confidentiality: All information regarding your child will be kept strictly confidential and used for this research purpose only. Participation of your child in this study will be voluntary and your child will be allowed to drop out of the study on his/her own wishes at any time if they need to.

Please sign accordingly below.

I agree to have my child participate in this study

Name of parent/ guardian _____ Signature Date

_

I do not agree to have my child participate in this study

Name of parent/ guardian _____ Signature Date

APPENDIX III: QUESTIONNAIRE

Questionnaire to the parent/Guardian

Questionnaire number ……Date …….

SECTION A: DEMOGRAOHIC INFORMATION

Sex

MALE	FEMALE

(a) Your highest level of education

1. Incomplete Primary 2. Completed primary school 3. Incomplete Secondary

4.Completed secondary 5. College 6. University 7. None

(b) Occupation of the parent / guardian

1. Farmer 2. Civil servant 3. Casual laborer 4. Self-employed 5. Others

(c) Size of family land

1. 1/8 acre 2. ¼ acre 3. 1acre 4. > 1 acre 5. None

(d) What is the size of the house you live in?

1. One roomed 2. Two roomed 3. Three roomed 4. More than three rooms

(e) Livestock kept at home

1. Cow **2**. Sheep and goats 3. Chicken 4. None

(f) How much does your family earn per month in Ksh.

1. <5,000 **2**. 5,000<10,000 **3**. 10,000<20,000 **4**. 20,000<50,000 **5**. >50,000 **6**. I don't know

B) KNOWLEDGE , ATTITUDE AND PRACTICES

1) Where do you get the source of information on dental care?

1. During visit to health facility/dentist or medical doctor during treatment
2. TV/Radio/Newsprint/ Magazines advertisement
3. Family/ friends/ relatives/ Church/ Mosque
4. Others, Specify…….

2) What is dental caries?

1. Discoloration of teeth 2. Painful gum 3. Tooth decay 4. I don't know

3) What do you think causes dental caries?

1. Sugary foods 2. Bacteria 3. Cold weather 4. Bacteria and sugary foods 5. I don't know

4) Which food support healthy teeth?

1. Fruits/vegetables 2. Milk 3. Cakes 4. I don't know
Others list…….

5) How can a person prevent tooth decay?

1. Brushing Teeth 2. Visiting a dentist 3. Eating fruits/vegetables 4. I don't know

6) Have you ever had any dental caries/decay

YES NO

Diet Characteristics

In this section you are required to fill in the amount of foods eaten by the children. For each food in the categories outlined, tick the frequency to which the food item is consumed. The quantities are reported either in cup (c); teaspoon (t); tablespoon (T); serving spoon (SP): medium (med)

	Food	Description	Quantity (g/ml)	Amount eaten (HHM)	Amount eaten (g)	Times eaten				
						Per day	Per wk	Per mnth	Per yr	never
PORRIDGE	Ugali	White	1c stiff = 250 g 1T = 75g							
		Brown								
	Porridge (Uji)	White (maize meal)								
		Brown (Wimbi)								
		With milk	little =30g med =60g much =125g							
	Is sugar added to porridge? If YES, specify	None	1t = 6g							
		White/brown								
		Honey	1t= 15g							
CEREALS	Cereals	Cerelac	1t = 2g 1T = 8g ½c = 20g							
		Weetabix								
		Cornflakes								
		Cerevita								
		White								

		Oats								
	Githeri (Maize and beans)		1T = 50g 1SP = 125g							
	Banan as	Boiled with skin	S/s = 60g; m/s = 90g							
		Mashed	1T=50g; 1SP = 115g;							
		Processed								

Food	Description	Quantity (g/ml)	Amount eaten (HHM)	Amount eaten (g)	Times eaten Per day	Per wk	Per month	Per yr	Never
STARCHES	Rice	White	1T = 25g; 1SP = 60g;						
		Brown							
	Potatoes	Mashed	1T=50g; 1SP = 115g;						
		Boiled	S/s = 60g; m/s = 90g						
	Sweet potatoes	Boiled	1T = 50g; 1SP = 110g;						
	Chapatti	White	Medium = 90g						
		Brown							
	Pastas	Macaroni	1T = 35g; 1SP = 70g;						
		Spaghetti							
		Spaghetti and Tomato Sauce	1T =45g; 1SP =80g;						
		Other: Specify							
SPREADS	Bread	White	1S/s = 15g 1M/s = 28g 1L/s = 40g						
		Brown							
	Spreads	Margarine	Thin= 5g Med= 7g Thick= 10g						

	Food	Description	Quantity (g/ml)	Amount eaten (HHM)	Amount eaten (g)	Times eaten				
						Per day	Per wk	Per month	Per yr	Never
VEGETABLES	Cabbage	Fried	1T = 30g 1SP = 55g							
		Boiled								
	Spinach	Boiled/ fried	1T=40g; 1SP=105g;							
	Managu									
	Sagaa									
	Terere									
	Bean leaves									
	Pumpkin leaves									
	Sukuma									
	Nderema									
	Kunde									
	Pumpkin (Specify Type	Boiled	1T = 45g; 1SP = 85g							
	Carrots	Raw, salad	1T = 25g							
	Corn/green maize on Cob	Boiled	SmalL=75 g; Med= 135g; Large=150 g							
	Potatoes	Boiled/Baked with Skin	S/s = 60g; m/s = 90g							
		Mashed	1T=50g; 1SP= 115g							
		Roasted	1 med = 70g							
		French fries	½ c = 50g; med = 80g							
		Salad	1T = 45g; 1SP= 105g							
	Egg plant	Fried in oil	1 slice =)+ batter=30g							
		Stew (onion, tomato,	1T=50g; 1SP=100g;							

		oil)								
	Mushroom		1T=30g; 1SP = 65g;							
	Onions	Sautéed in oil	1T = 50g							
	Salad Vegetables	Raw Tomato	Med=120g slice = 15g							

	Food	Description	Quantity (g/ml)	Amount eaten (HHM)	Amount eaten (g)	Times eaten				
						Per day	Per wk	Per month	Per year	Never
DRINKS	Fruit Juice (squash)		1c = 250ml							
	Fizzy Drinks (e.g. Coke, Fanta)		S/s bottle = 300ml L/s bottle = 500ml							
SWEET	Sweets									
	Biscuits		4g							
	Cake	1 Wedge	75g							
	Queen cake	Small	20g							
		Med	30g							
		Large	35g							
	Groundnut	¼c	40g							
		⅛c	80g							
	Chocolates									

	Food	Description	Quantity (g/ml)	Amount eaten (HHM)	Amount eaten (g)	Times eaten				
						Per day	Per wk	Per month	Per yr	Never
	Doughnut	60mm diameter	45g							
		Small	7g							
	Mandazi	Med	20g							
		Large	30g							
	Kangumu		30g							
	Pizza	Med wedge	40g							
		Large wedge	160g							
	Hotdogs	Bread	40g							
		Frankfurter	28g							
	Samosa	Small	42g							
		Large	150g							
PROTEINS	Chicken	Boiled with skin	Breast + skin = 125g							
		Boiled without skin	Thigh = 80g							
		Fried coated	Drumstick = 42g							
		Fried not coated	Foot = 30g							
		Roasted/grilled with skin	Wing = 30g							
		Roasted/grilled without skin	Offal (matumbo) = 20g							
			Liver = 30g							
		Pie	Med = 150g							
	Chicken stew	With vegetables	1SP = 90g							
		With tomato and onion	½c = 125g							
	Beef/ mutto	Stewed/boiled with	1SP = 105g							

	n/ goat	vegetables								
		Mince with tomato and onion	1T = 40g 1SP = 85g							
	sausage	Fried	Thin= 45g Thick = 90g							

In the table below, list the foods commonly consumed by the child more than once per week that have not been included in the previous sections.

Food	Description	`

	Food	Description	Quantity (g/ml)	Amount eaten (HHM)	Amount eaten (g)	Times eaten				
						Per day	Per wk	Per month	Per yr	Never
FRUITS	Apples		1T=60g; ½c=120g 1 med = 150g							
	Pears		1med =165g							
	Oranges		Med = 180g							
		1 med	75g							
		Large	90g							
	Sweet bananas	1 piece	25g							
	Mangoes		small = 90g							
			Med= 200 g							
			Large= 350g							
	Pawpaw	Wedge 165 x 26 x 27	=90g							
	Pineapple	1 slice (85 x 10mm)	40g							
	Guavas (mapera)	Med(6 cm)	95g							
		Small	50g							
	Water Melon		Wedge= 110g							
	Other fruits;									
DRINKS	Tea		Teacup =180ml; mug= 250ml							
	Sugar Per Cup of Tea/ coffee	White	1t sugar (heaped) = 6g (level) = 4g							
		Brown								
	Milk per Cup of Tea	Fresh	20ml – tea in cup							
	Drinking Chocolate		1t = 5g							

c) QUESTIONNAIRE FOR 5 YEARS OLD

Public	Private	Name of the school ……

a) School

b) Study Location……

c) Sex

Female	Male

1) Do you buy sweets (candies/ lollipop) on your way to/from school?

1. YES 2. NO

2) If yes in 1 above, do you share your sweet with your friends?

1. YES 2. NO

3. What do you use to clean your teeth?

1. Chewing stick 2. Brush 3. None

4) How often do you parents change your tooth brush?

1. Every three months. **2**. After 6 months **3**. Every 1 year **4**. Never

5) How many times do you brush your teeth?

1. Once a day 2. Two times a day 3. Three times a day 4. Never

5) What do you use while brushing?

1. Salt 2. Toothpaste 3. Charcoal 4. No

6) **Have you ever visited a dentist?**

1. Yes 2. No

7) If yes what was the reason for visiting?

1. My tooth was aching 2. My gums were bleeding 3. For a check up
4. My teeth were growing badly 5. Others specify……..

C) <u>ANTHROPOMETRIC MEASUREMENT</u>

Weight of child of child ----------Kilograms

2. Height/ Length

1st ----------

2nd ----------

3rd---------

Average ---------centimeters

Mid Upper Arm Circumference----------Centimeters

B) DENTAL CARIES DETERMINATION

df-t tool

Key: d=decayed/f=filled/t= tooth

	16	55	54	53	52	51/11

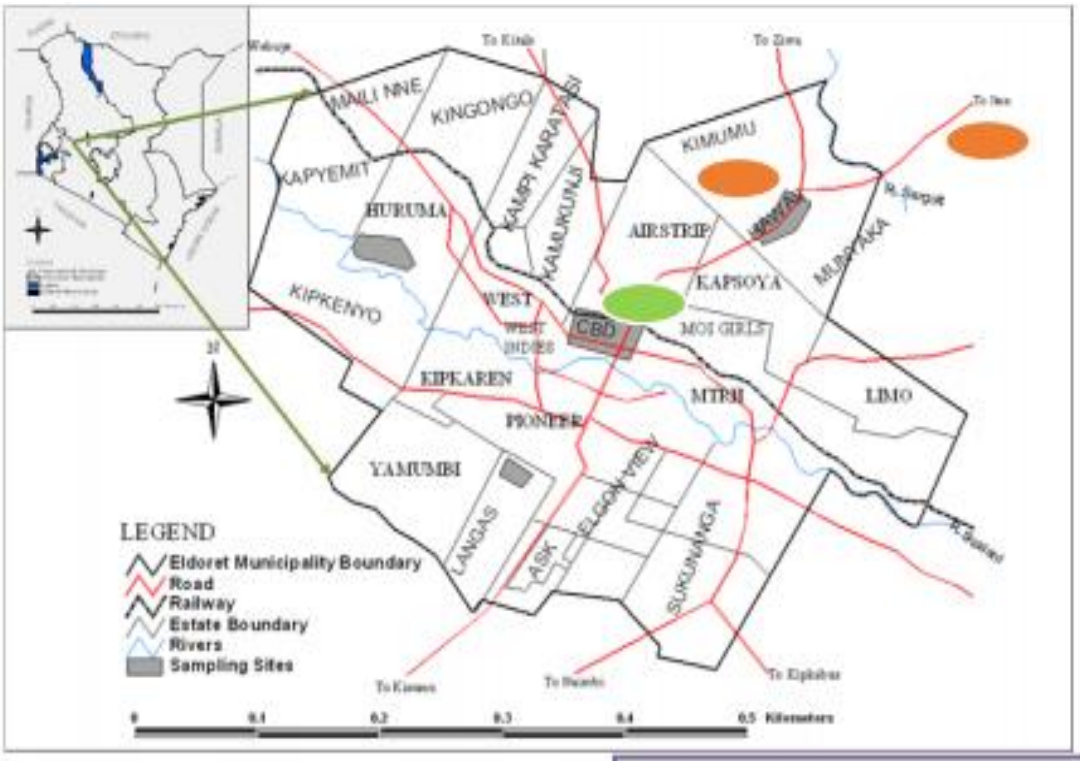
61/21	62	63	64	65	26	

	46	85	84	83	82/42	81/41

71/31	72/32	73	74	75	36	

Total df-t=

APPENDIX IV: MAP OF THE STUDY AREA



SOURCE: Chepsiror (2013)

APPENDIX V: RESEARCH PERMIT

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471//2/3

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET

Reference: IREC/2017/28
Approval Number: 0001888

8th June, 2017

Wakhungu Hillary Kipchumba,
University of Eldoret,
Department of Family and Consumer Sciences,
P.O. Box 1125-30100,
ELDORET-KENYA.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
08 JUN 2017
APPROVED
P.O. Box 4606-30100 ELDORET

Dear Mr. Wakhungu,

RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee has reviewed your research proposal titled:-

"Dietary Habits Nutritional Status and Dental Caries of 5 Year Old School Children in Uasin Gishu County".

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 1888*** on 8th June, 2017. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 7th June, 2018. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

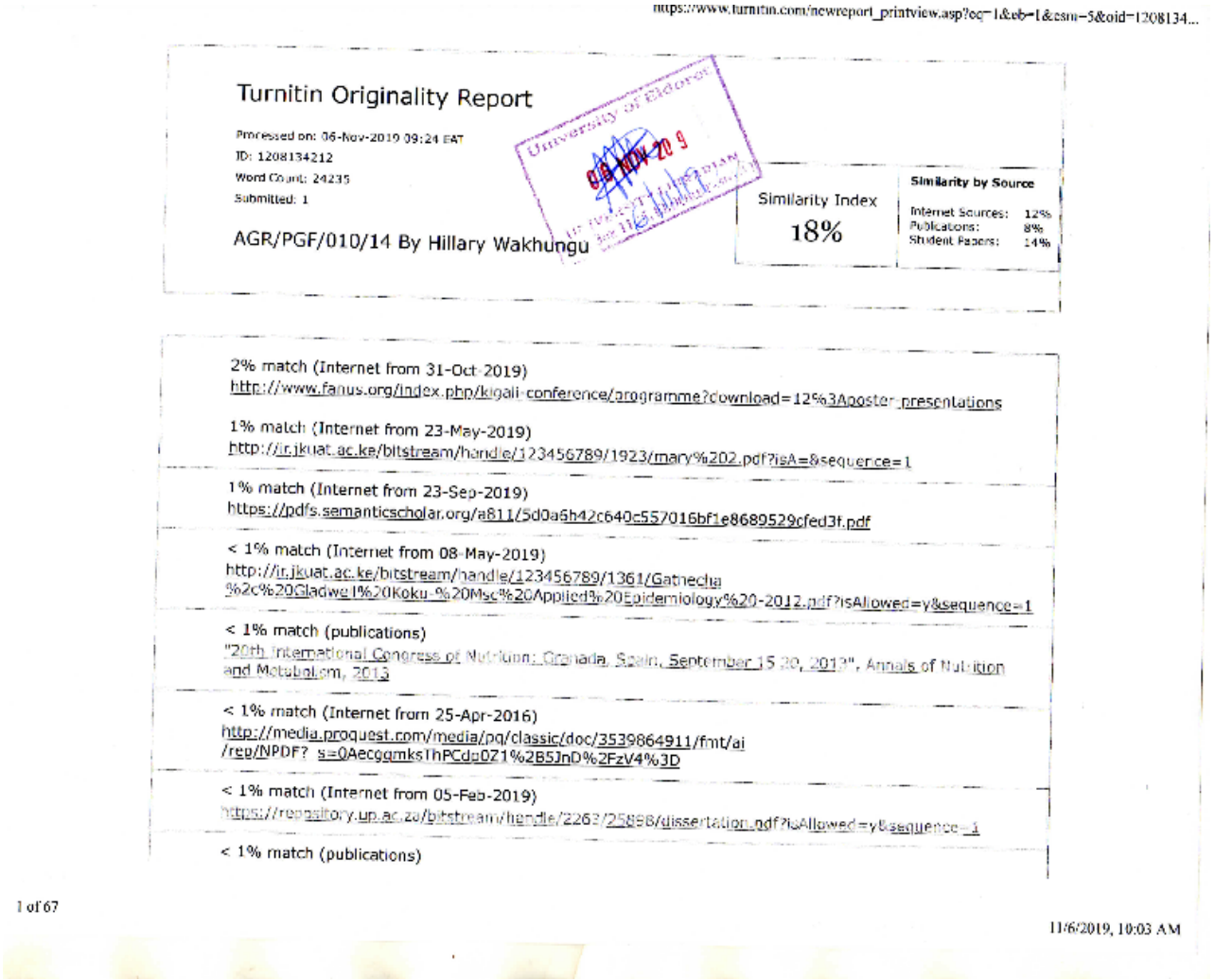
You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

DR. S. NYABERA
DEPUTY-CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc CEO - MTRH Dean - SOP Dean - SOM
Principal - CHS Dean - SON Dean - SOD

APPENDIX VI: Similarity Index/Anti-Plagiarism Report



https://www.turnitin.com/newreport_printview.asp?eq=1&eb=1&esm=5&oid=1208134...

Turnitin Originality Report

Processed on: 06-Nov-2019 09:24 EAT
ID: 1208134212
Word Count: 24235
Submitted: 1

AGR/PGF/010/14 By Hillary Wakhungu

University of Eldoret
06 NOV 2019
P.O. Box 1125-30100 ELDORET

Similarity Index
18%

Similarity by Source
Internet Sources: 12%
Publications: 8%
Student Papers: 14%

2% match (Internet from 31-Oct-2019)
http://www.fanus.org/index.php/kigali-conference/programme?download=12%3Aposter-presentations

1% match (Internet from 23-May-2019)
http://ir.jkuat.ac.ke/bitstream/handle/123456789/1923/mary%202.pdf?isA=&sequence=1

1% match (Internet from 23-Sep-2019)
https://pdfs.semanticscholar.org/a811/5d0a6b42c640c557016bf1e8689529cfed3f.pdf

< 1% match (Internet from 08-May-2019)
http://ir.jkuat.ac.ke/bitstream/handle/123456789/1361/Gatnechia%2c%20Gladwell%20Koku%20Msc%20Applied%20Epidemiology%20-2012.pdf?isAllowed=y&sequence=1

< 1% match (publications)
"20th International Congress of Nutrition: Granada, Spain, September 15-20, 2013", Annals of Nutrition and Metabolism, 2013

< 1% match (Internet from 25-Apr-2016)
http://media.proquest.com/media/pq/classic/doc/3539864911/fmt/ai/rep/NPDF?_s=0AecggmksThPCdp0Z1%2B5JnD%2FzV4%3D

< 1% match (Internet from 05-Feb-2019)
https://repository.up.ac.za/bitstream/handle/2263/25898/dissertation.pdf?isAllowed=y&sequence=1

< 1% match (publications)

1 of 67

11/6/2019, 10:03 AM