IMPACT OF ORAL HEALTH EDUCATION ON DENTAL PLAQUE AMONG 11-12 YEAR OLD PUBLIC SCHOOL CHILDREN IN ELDORET MUNICIPALITY – UASIN-GISHU COUNTY – KENYA

BY

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THIS THESIS IS SUBMITTED TO MOI UNIVERSITY, COLLEGE OF HEALTH SCIENCES, SCHOOL OF PUBLIC HEALTH, DEPARTMENT OF EPIDEMIOLOGY AND NUTRITION IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE IN MASTERS OF PUBLIC HEALTH

In: November 2015

DECLARATION

Declaration by the candidate

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DEDICATION

I dedicate this work to my husband, Dr. Omenge, for his patience and support as I developed my thesis; and to my lovely children, Nathan, Shirlene and Daniella, whose untainted smiles inspired me to carry out this study.

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LIST OF ABBREVIATIONS

1. ADA: American Dental Association
2. ANOVA: Analysis of Variance
3. COHO: Community Oral Health Officer
4. CRCT: Cluster Randomized Controlled Trial
5. D.F.: Degrees of Freedom
6. DEFF: Design Effect
7. DMFT: Decayed, Missing Filled Total
8. GCHP: Global Conference on Health Promotion
9. HPS: Health Promoting Schools
10. ICC: Intra-Cluster Correlation Coefficient
11. IREC: Institutional Research and Ethics Committee
12. KEMRI: Kenya Medical Research Institute
13. MOE: Ministry o Education
14. OHE: Oral Health Education
15. OLS: Ordinary least square
16. PI: Principal investigator
17. Rx: Treatment
18. TV: Television
19. USA: United States of America
20. WHO: World Health Organization

ABSTRACT

TITLE: Impact of oral health education on dental plaque among 11-12 year old public primary school children in Eldoret Municipality – Uasin Gishu county - Kenya

BACKGROUND: Dental plaque is an etiologic factor for development of dental caries and periodontal disease, which are of public health concern. OHE towards good oral hygiene practices to curb the onset and rapid progress of these diseases forms a strategy to reduce thefuture disease burden. WHO encourages health education in schools by development of Health Promoting Schools.

PURPOSE OF STUDY: To establish whether oral health education improved oral health knowledge and oral hygiene.

OBJECTIVES: To assess the oral health knowledge; to describe oral health practices; to measure the dental plaque levels; and to assess the impact of oral health education on oral health knowledge and dental plaque scores among 11-12 year old children.

STUDY AREA: Public primary schools in Eldoret Municipality, Uasin-Gishu County, Kenya.

METHOD:A cluster randomized controlled intervention study among 11-12 public primary school children. Schools were randomized to intervention and control. Interviewer-administered questionnaires were used to assess baseline oral health knowledge and practices. Dental plaque was scored by Green and Vermillion index. Four sessions of OHE were given to the intervention group. After the period of study, data to assess the three parameters above was collected and analyzed by STATA. ANOVA and Chi-square statistics were computed to check for statistically significant difference in the above parameters between baseline and after intervention data.

RESULTS: At baseline, oral health knowledge was generally low (intervention - 41.84%, control - 41.70%). Pupils' gender did not significantly influence a pupil's odds of eating sweet snacks (χ^2 = 0.947, df =3, p = .814). Following oral health education, dental plaque score improved from 2.46$\pm$1.45 to 0.88$\pm$0.98 in intervention, and 2.43$\pm$1.52 to 1.99$\pm$1.44 in control (p=.001; t=3.43) The change being more pronounced in male (69%) than female (66.7%).

CONCLUSION: Oral health education has a positive impact in dental plaque control in this population.

RECOMMENDATIONS: Introduction of a structured school-based OHE program in the country. Long- term studies to assess impact of OHE to the incidence of dental caries and periodontal disease.

CHAPTER 1

1.0. INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Health education comprises consciously constructed opportunities for learning involving some form of communication designed to improve health literacy, including improving knowledge, and developing life skills which are conducive to individual and community health (WHO, 1998). It is not only concerned with communication of information, but also with fostering the motivation, skills and confidence (self-efficacy) necessary to take action to improve health (WHO, 1988). Oral health education (OHE) is aimed at improving oral health through the acquisition of knowledge; and eventually leading to motivation, and finally, to behavioral change according to the health belief model.

Oral health is the absence of oral disease, and the optimum functioning of the mouth and related tissues, in a manner that preserves the highest level of self esteem (WHO, 1999). It describes a state which enables an individual to eat, speak and socialize without disease, discomfort or embarrassment, and which contributes to their general wellbeing (WHO, 2003; Kaimenyi, 2004). Poor oral health can lead to irreversible damage to oral tissues and unnecessary pain, and further result in general health problems, depression, low self-esteem, lose of school and working hours and generally poor quality of life (WHO 2004; ADA, 2003).

Poor oral hygiene leads to accumulation of dental plaque on the dentition and surrounding structures. This leads to dental caries and periodontal disease; and consequential compromise of the above stated functions. Many studies show that

persistent presence of plaque-associated bacteria cause periodontal disease and dental caries, both of which lead to loss of teeth. (Moore, 1987; Kidd and Feferskov, 2010). Dental plaque, which contains acidogenic bacteria, is an etiologic factor for dental caries. Further, longitudinal studies have shown that control of dental plaque reduces the incidence of both periodontal disease and dental caries (Kwan et al, 2005; Axelsson 2004).

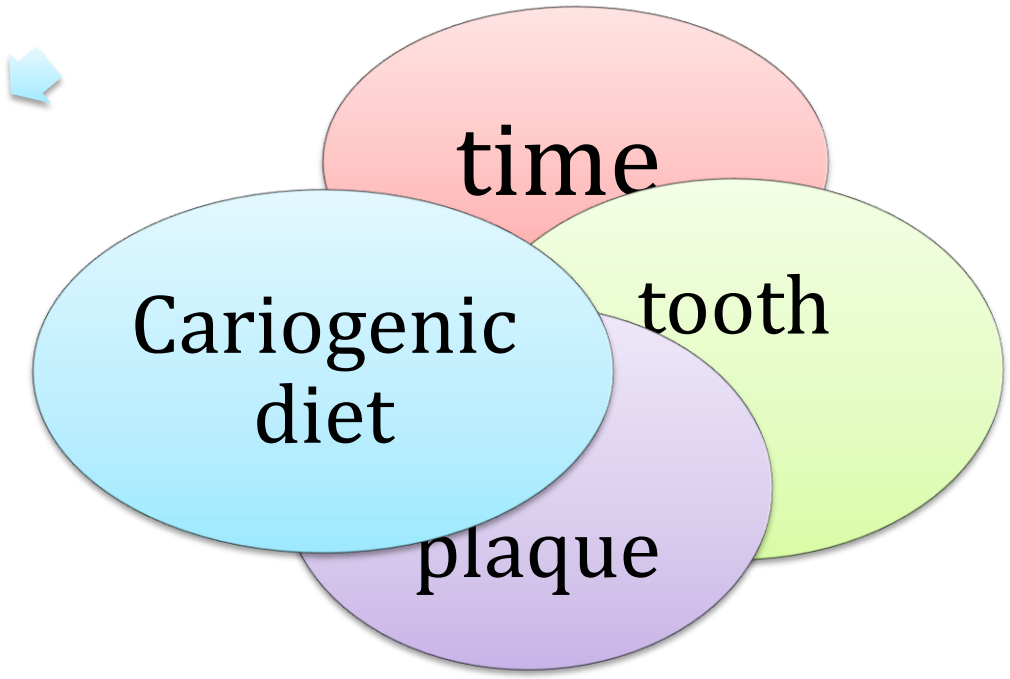
Bacterial dental plaque is a soft deposit that accumulates on the teeth and marginal gingiva. It is a complex microbial community, which consists of more than 400 distinct bacterial species, epithelial cells, leukocytes and macrophages. The cells are held in an extracellular matrix, which is formed from bacterial products and saliva. The matrix is made of protein, polysaccharide and lipids. Inorganic components are also found in this plaque and are primarily derived from saliva and crevicular fluid. These inorganic components are mainly made of phosphorus and calcium. They lead to calcification of the soft dental plaque to a hard and rough material called calculus or tartar. This rough material accumulates on the root and tooth surface and is also easily colonized by bacteria (Carranza, 2002; Kinder, 2011).

A newly cleaned tooth surface is rapidly covered with a glycoprotein deposit called pellicle. The pellicle is derived from salivary constituents that are selectively adsorbed onto the tooth surface. The formation of the pellicle is the first step in plaque formation. It is on to this pellicle that bacteria and other plaque components attach to form dental plaque (Kinder, 2011).

Accumulation of the dental plaque on the tooth and along the gum margin leads to gingivitis, which may progress to periodontitis. Inter-play between bacterial plaque and cariogenic diet on tooth surfaces cause dental caries. This is well explained in the Keyes triad, which describes the relationship between cariogenic diet, acidogenic bacteria and susceptible tooth surface (Cawson, 1991). It is further described in the

modern theory of dental caries, which incorporates the aspect of time to Keye's triad in the development of dental caries (Sikri, 2008).

Figure 1.1 Modified Keye's triad



Dental caries is the oral disease with the highest prevalence. Its long-term impact is teeth loss (Costa et al, 2009). It is an infective disease. Streptococus *mutans* is one bacterium, which is almost always isolated from dental plaque over small carious lesions. Most carious lesions have >10% S. *mutans* and most non-infected areas are non-carious. Longitudinal studies have also shown that S. *mutans* precedes development of dental caries and the absence of S. *mutans* has been shown to be associated with absence of dental caries (Childers, 2011). It is an acidogenic bacteria found in dental plaque,which ferments carbohydrates on the teeth, with the resulting acid demineralizing the hard tooth tissues. The demineralized tissue, which is already weakened, crumples and forms a cavity. The continuous destruction of tooth structure may progress to involve the pulp of the tooth, and later lead to dental abscesses and consequential loss of such teeth.

Plaque induced periodontal disease is a chronic disease that starts early in life. Its symptoms and effects worsen over time and so does its impact on general health. It is an inflammatory process, which is triggered by plaque bacteria and their products.Developing good oral self-care habits, which maintain dental plaque levels low, can change the course of this disease. Dental caries develops over time too and its impact is felt long after initiation of the disease. Control of plaque levels and good dietary habits are measures that can curb the development and progression of this disease. (Axelsson et al, 2004).

Oral health education is a method of equipping one with knowledge on oral diseases and methods of preventing development of these diseases, or altering their progression, impact and outcome too. Health education towards dental plaque control would thus reduce the burden of dental caries and periodontal disease.

The World Health Organization (WHO) encourages health education through schools. WHO's Global Health Initiative is one of the Organization's primary health promotion efforts. Its general direction is guided by the Ottawa Charter for Health Promotion (1986) and the Declaration of the Fourth International Conference on Health promotion held in Jakarta (1997). It is also guided by the recommendations of the WHO's Expert committee on Comprehensive School Health Education and Promotion (1995). The initiative seeks to mobilize and strengthen health promotion and education activities at the local, national, regional and global levels. Its goal is to increase the number of schools that can truly be termed as "Health Promoting Schools" (WHO 1988).

Since the first WHO Global Conference on Health Promotion (GCHP) that produced the Ottawa Charter for Health Promotion, subsequent GCHPs were held in different

continents. The 7th GCHP was held in Nairobi and its theme was 'Promoting Health and Development: Closing the Implementation Gap'. In this oral health received much attention and at the end of it, the key messages formulated in relation to the preparation of call of action were that:

" Oral health is a human right and essential to general health and quality of life.

Promotion of oral health and prevention of oral diseases must be provided through Primary Health Care and general health promotion. Integrated approaches are the most cost-effective and realistic way to close the gap in implementation of sound interventions for oral health around the globe.

National and community capacity building for promoting oral health and integrated oral disease prevention requires policy and appropriate human and financial resources to reduce the gap between the poor and rich" (Petersen, 2010).

It is in the light of this that this study was done, to provide baseline data that is necessary for planning of health interventions in schools, and also test the impact of oral health education as school based intervention tool in fostering good oral health.

1.2: PROBLEM STATEMENT

Bacterial dental plaque, which accumulates on teeth and surrounding structures,is a known etiologic factor in development of both dental caries and periodontal disease. These two diseases have grown to a level of public health concern due to their significant social and economic impact (Ernisto et al, 2007). They also constitute the major oral diseases that affect mankind (WHO, 1999).

Periodontal disease is an inflammatory disease of the supporting tissues of the teeth caused by specific microorganisms that are found in dental plaque and leads to progressive destruction of the periodontal ligament, alveolar bone and consequential mobility of affected teeth. (Carranza's,2000). Dental caries is an infective disease

resulting from interplay between cariogenic diet, acidogenic bacteria in dental plaque, susceptible tooth surface and time (Cawson, 1991, Sikri, 2008).

Of the two diseases, dental caries has the highest prevalence and its long-term effects are tooth loss (Costa et al, 2009). Second to this is periodontal disease with similar long-term consequences.

In the Kenyan set-up, children in the age group of study are shown not only to be affected by these diseases, but also to suffer a poor quality of life as a result (Gathece et al, 2011). Waweru (2005) in her study conducted in Juja area of Thika – Kenya demonstrated that 39.1% of 12-15 year old children had dental caries, 51.6% had gingivitis and 75% had both gingivitis and calculus.

Other studies in Kenya indicate that plaque induced periodontitis has a high prevalence yet oral health awareness is low, depicted by the fact that 43% of all adults interviewed do not know any cause of dental diseases, and 50% do not know any preventive measure for dental diseases (Kaimenyi, 1993, Kassim et al, 2006).

The picture is not different in other countries as per studies done. In India among 5-15 year old children revealed that 75% of children from high socioeconomic status and 85% of children in low socioeconomic status families had dental caries (Moses et al, 2011). Eke et al (2012) also established that 47% of adults in the USA had periodontal disease.

Plaque induced periodontitis and dental caries are diseases that progress over a long time and take a long period before they cause any noticeable morbidity or even mortality. Most people may opt to utilize their constrained resources to take care of more basic needs like food and shelter before considering spending on dental check-ups and treatment.

There's also limited dental personnel to offer curative services in Kenya (Kaimenyi, 1993) and the picture has not changed much over the years, based on the limited training facilities for dentists in the country, as the country has only two dental schools. The numbers of trained dentists is not sufficient to meet the burden of dental curative services for the forty million Kenyans. This is complicated by the fact that curative dental treatment is a costly venture and unaffordable by many people. This leaves prevention of the diseases as the only intervention which in the long run may reduce the disease burden; and thus ease the pressure on the already strained national health budget.

1.3: JUSTIFICATION

Disease prevention programs are aimed at preventing or reducing the rate of development of a disease condition in a given population. The long-term goal of such programs is to reduce the future disease burden; and so reduce the burden of cost and labor for curative services in that population. Long-term plaque control leads to reduced tooth loss and less morbidity associated with dental diseases. This is demonstrated in a study done by Axelsson et al (2004) where a group of 550 subjects were subjected to strict plaque control measures and over a period of 30 years of the study, a total of 21 teeth were lost to periodontal disease and dental caries combined.

Initiated early in childhood, better results of control and reduction of disease burden may be achieved than when such programs are initiated when the targeted diseases are already established. This study was conducted among 11 to 12 year old school children. These are basically in class 6 in Kenyan set-up, as the class 1 entry age is 6-7 years. At this age, permanent dentition (except the last molars) is just established,

and yet not exposed to the oral environment for long enough to allow development of much damage to the teeth and attachment apparatus due to the above mentioned diseases. Introduced at this early age, preventive interventions aimed at improving a child's oral health practices and attitude may thus yield much.

Twelve years is also one of the recommended age brackets for global monitoring of dental diseases for international comparison (WHO, 1997).

School years are mainly childhood and adolescence stages of life, and this is a time many good habits can be inculcated at this stage of life. Globally, 80% of children attend primary schools up to the age of 12 years (WHO, 1988). This gives a strategic setting to reach many children worldwide, and by extension, families and communities. On this basis, WHO advocates the development of health promoting schools, which includes development of oral health education programs in schools rather than focusing all efforts and resources on curative dentistry (WHO, 1988).

Baseline data on oral health knowledge, practices and oral hygiene; together with how these factors change on an intervention program form a sound basis for policy formulation and implementation. This study aims at developing such baseline data.

1.4: OBJECTIVES

1.4.1: Broad objective

To determine the impact of oral health education on the oral health knowledge and oral hygiene of primary school children.

1.4.2: Specific objective

1. To measure the oral health knowledge of 11-12 year old school going children in Eldoret Municipality
2. To determine oral health self-care practice among these children
3. To measure the dental plaque levels among these children
4. To assess the short term impact of oral health education on oral health knowledge and dental plaque levels among 11-12 year old school children in Eldoret Municipality

1.5: STUDY HYPOTHESIS

There is no difference in oral hygiene between children who receive oral health education intervention and those who do not.

1.6: LIMITATIONS OF THE STUDY

Examination of students was not done in ideal clinical set up. Lighting was not ideal and positioning of pupils at examination was not at the normal as expected in ideal clinical set up. Pupils were examined in a classroom, sited on an armchair and lighting enhanced using a headlamp. For this reason, some clinical data was possibly missed out.

CHAPTER 2

2.0: LITERATURE REVIEW

2.1: ORAL HEALTH EDUCATION

Oral health education encompasses learning activities directed at promoting individual oral self-care behavioral change, primarily through the acquisition of oral health knowledge (Watt et al, 2001). It is defined as "a planned package of information, learning activities, or experiences that are intended to promote oral health" (Overton, 2005). Oral health literacy emphasizes the availability of skills to obtain, understand, and use information for appropriate oral health decisions (Horowitz & Kleinman, 2008). It is thus a method of equipping one with knowledge on oral diseases and methods of preventing development of these diseases, or altering their progression, impact and outcome.

2.2: IMPACT OF DENTAL PLAQUE ON DENTAL TISSUES

Studies, have revealed that bacteria found in the dental plaque are the primary cause of periodontal disease (Ali et al, 1996) and the bacteria associated to this disease are predominantly gram negative anaerobic and proteolytic. They include*: A. actinomycetomcomitans, P. gingivalis, P. intermedia, B. forsythus, C. rectus, E. nodatum, P. micros. S. intermedius and Treponema sp.* (Lovegrove, 2004)**.** These bacteria work in synergy to lead to periodontal disease (Zhonghua, 2005). These are not bacteria from outside the body, rather microbes that normally inhabit the mouth. They cause the disease directly by invading the periodontium or indirectly by emitting toxins.Some of these bacteria also release proteolytic enzymes. The enzymes destroy the host tissue surrounding them (Gutner et al, 2009). The body's natural response to

these toxins is inflammation. Inflammation is characterised by red swollen gingiva that easily bleed spontaneously or on mild trauma. These are the classical features of gingivitis, which is an early stage of periodontal disease. This causes space between the tooth and the gum (gingival sulcus) to increase in depth, forming periodontal pockets, and creating a good environment for bacteria to breed and cause further damage.

As dental plaque accumulates on the tooth surface and along the gum line and in the depth of the gingival sulcus, it interacts with saliva in the mouth. Some of the inorganic minerals found in saliva are deposited in the plaque and cause the plaque to calcify. Most of the deposits are made of calcium and phosphates. The calcified dental plaque is called tartar or calculus. As it wedges between the gum and the tooth, it mechanically pushes away structures that surround the root of the tooth, and also lead to attachment loss, causing mobility and tooth loss. Classical features of periodontal disease include bleeding gums, dull ache from the gums, and mobile teeth with associated attachment loss (Cawson, 1991).

Dental plaque is also a known etiologic factor in causation of dental caries. Dental caries is an infectious microbiologic disease of the teeth that results in localized dissolution and destruction of the calcified tissue. (Sturdevants,2002). Bacteria found in dental plaque (mainly S. mutans and lactobacillus) break down remains of carbohydrates in the mouth to form an acidic medium. This change in pH in the mouth causes loss of minerals from the hard tooth structure (demineralization) (Cawson, 1991). When the pH returns to normal, minerals are re-deposited to the tooth. Tipping of the net balance between re-mineralization and demineralization towards demineralization followed by breakdown of surrounding connective tissue may lead to cavitation on teeth, which is dental caries.

2.3: ORAL HEALTH KNOWLEDGE AND PRACTICES

Schools have been the main setting for oral health intervention promotion among children (Towner,1993; Watt, 2005). It offers an environment for improving health, self-esteem, behavior and life skills (WHO, 2003). Some countries have embraced school based oral health education programs. Tanzania has a long-standing oral health education program in primary schools as part of their education policy (Nyandindi et al, 1995).

In as much as oral health education is not an integral part of the national education curriculum in Kenya; efforts have been made to foster this aspect of health in schools. The Ministry of Health through its team of community oral health officers strives to promote oral health activities in schools. Giving oral health education sessions to schools within one's district is one of the duties of community oral health officers who work in the government hospitals and this is scored as part of their performance targets. However, no published studies are available to assess the impact of this program on oral health of the school children.

In a descriptive study done in Kapseret Division of Uasin-Gishu district, Kenya among primary school children aged 5-17 years (Okemwa et al, 2010), good toothbrushing habits were reported. 92% of these children brushed their teeth with 48% brushing at least twice daily, and most of these (59%) using a chewing stick. At brushing, 38.9% used toothpaste. However, oral health knowledge was low, with 39.9% having knowledge on the cause of tooth decay and up to 48.2% with knowledge of at least one method of its prevention. For this the researcher recommended planned school based OHE programs to improve on oral hygiene of children. Studies that assess impact of oral hygiene practices on dental plaque

amongst children indicate that plaque levels reduce with increased frequency in tooth brushing. Such a study was done in Mbita District – Kenya (Fuduka et al 2014) where the percentage of children with dental plaque covering 30% or more of the tooth surface was noted to increase with decrease in frequency in tooth brushing.

Prasad et al conducted a study in Burkina Faso in 2006 among 12-15 year old school children. From the study sample, only 30.7% of the children brushed their teeth twice or more times a day, a higher percentage being females, 1.2% brushed once a week and 5% never brushed. However, awareness of the importance of tooth brushing as a way to prevent dental caries was high (57.7%); while24.2% of this group disagreed that tooth brushing prevents dental caries, 17% did not know whether tooth brushing could prevent dental caries. 26.1% of his sample visited the dentist regularly while 36.7% sited fear of the dentist as the reason for irregular dental visits. In a different study done in the same country where oral health awareness and practices were assessed and compared between rural and urban 12 year old children, 81% of urban children and 42% of rural children knew that brushing teeth can prevent tooth decay; those who knew that tooth brushing could prevent gum disease were 67% and 32% respectively ($P<0.001$). 53% of urban children and 12% of rural children brushed at least once a day, while 38% and 87% ($P<0.001$) respectively never brushed at all (Benoit et al, 2006). Another study in Burkina Faso by Vienne et al (2006), which was done among 12-year-old children revealed an oral health knowledge index of 35%. Many other studies have revealed a generally low oral health knowledge among children (Varenne et al, 2010, Study in Burkina Faso, El-Qaderi and Taani 2005, study done in Jaresh District of Jordan, Wyne et al, 2004, study in Saudi Arabia, Mehta and Kaur, 2012, a study done in India).

2.4: ORAL HEALTH EDUCATION IN SCHOOLS AND ITS IMPACT

The Tanzanian Government started an oral health education program in 1982 (Nyandindi et al, 1995), which was aimed at fostering proper oral health behavior among school-age children. It has been implemented by primary school teachers (Nyandindi et al, 1995). A 30 minutes lesson per week is given to the children and the method of communicating the information is by lecture only with no demonstrations or teaching aids. Most of the teachers have no prior training on oral health. However, a review of this health education program has revealed a positive impact in children, revealedby a study done byCarneiro et al, (2011) among Tanzanian secondary school children. The students who participated in this study demonstrated a good level of oral health knowledge. Up to 88.4% demonstrated adequate knowledge on signs and prevention of dental caries. This could be attributed to this long-standing primary school oral health program

Parkash and Duggal (2004) did a study in New Delhi, India, to evaluate an OHE module. It entailed training teachers who were to educate their pupils on good oral health. Teachers in the participating schools were taken through a training session on OHE as they were the ones who were to give OHE to their pupils. A training manual and teaching aids were developed and teachers taught how to use them. Charts to be posted on notice-boards of participating schools were also prepared. Baseline data was collected before commencement of OHE. Intervention by OHE was done by the teachers for one year, with the researcher visiting schools two-weekly to reinforce the program and check performance by teachers. Plaque scores were assessed by Loe and Silness index. Here PI score of 0-0.9 was ranked as good, 1-1.9 as average and 2 as poor oral hygiene. For the junior classes (6-8 years), there were 48.9% children in the good score at baseline, which significantly increased to 79% at final examination. In

the average category, there were 48% children at baseline and 19.1% at final examination, and in the poor oral hygiene there were 2.6% at baseline and 0.9% post intervention. Difference between OH scores at baseline and post intervention were highly significant at P<0.001. In the senior classes (12 – 14 years) 46.2% children had good scores at baseline, and score significantly increased to 79.2% post intervention. In the average category, the change was 48.8% to 19.9%; and 5.0% to 0.9% post intervention, which was a highly significant change at P<0.001. Oral health knowledge was also noted to increase significantly following oral health education.

Another study done in India in 2010 by Shenoy et al stressed the importance of oral health education in children. A 20-minutes interactive session was given to the intervention group every three and six weeks. No education was given to the control arm of the study. Improvement in plaque and gingival score; and oral health knowledge among the intervention groups were all statistically significant among the intervention group as compared to the control group (p>0.05). Similar results were also noted in a study done in United Kingdom in 1999 (Redmond et al, 1999).

This clearly shows that oral health and hygiene of school children improved significantly due to the oral health education imparted to the children; and that school based OHE programs can be an effective method for prevention and control of plaque related dental diseases in developing countries.

In Belgium, the effect of a six-year oral health education program was evaluated in primary schools (Vonobbergen et al, 2004). This program consisted of annual one-hour instructions for children and teachers. The authors found that the program did not result in significant reduction in the caries prevalence; however, it has been effective in improving some of the children's reported oral health behavior. This highlights the importance of the frequency of oral health education sessions.

In England the effectiveness of a dental health programme was tested (Worthington et al, 2001). The pupils were given four 1-hour lessons by the dental nurse in school. Homework involving parental participation was also given. No oral health education sessions were given to the control group. After 7 months the children in the program had significant lower mean plaque scores and greater knowledge than did those in the control group. Again in England, in 1999, Redmond and colleagues investigated the impact of a six months school education program where one lesson and discussion were given per month. Compared to the baseline data collected, the data after six months depicted improvement in knowledge of dental diseases and better oral hygiene. Increase in reported duration of brushing was also noted too.

In 2004, Petersen conducted a study in Wuhan City in China to assess the impact of a three-year school based OHE program, which was based on the WHO Health Promoting School Project. Teachers in the participating schools were taken through a two day training workshop on general health, diet and nutrition, oral anatomy, tooth development, causes and prevention of caries and periodontal disease, oral self care and emergency oral care at school. A one-day follow up training was done a year later into the study. Participating schools were divided into control and intervention groups, and no significant differences in oral health were noted between the two groups at baseline. Three years down the line, there was no statistically significant difference in DMFT between control and intervention groups, while the over-time difference of bleeding scores was lower for experimental children than that for control children (14% against 20% difference between baseline and after 3 years, $p<0.05$). The increase in proportion of children with tooth brushing at least twice a day was 26% for the experimental group and 19% control group ($p<0.05$). Difference in consumption of cariogenic diet was minimal between the control and intervention

groups (5% increment in the control group, and 5% decrease in intervention group at $p<0.01$), which could explain the insignificant changes in DMFT.

In the United States, Bartizek et al (2003) conducted a study among members of a boys and girls club. After taking baseline data on oral health knowledge, gingivitis and levels of dental plaque, oral health education was given for four weeks. Post education, there was 51% reduction in gingivitis, 85% improvement on dental knowledge and 29% reduction in dental plaque all significant at $P<0.001$.

Contrasting this, Francken et al who did a study in Zimbabwe in 2001 found different results. The sample was of some schools whose teachers were sent for a regional OHE workshop formed the intervention group, and those who did not attend the workshop, the control arm of the study. The schoolteachers gave the OHE over a period of 3.5 years after baseline statistics were taken. Analysis of plaque scores and caries between control and intervention groups showed no statistically significant difference in mean plaque scores.

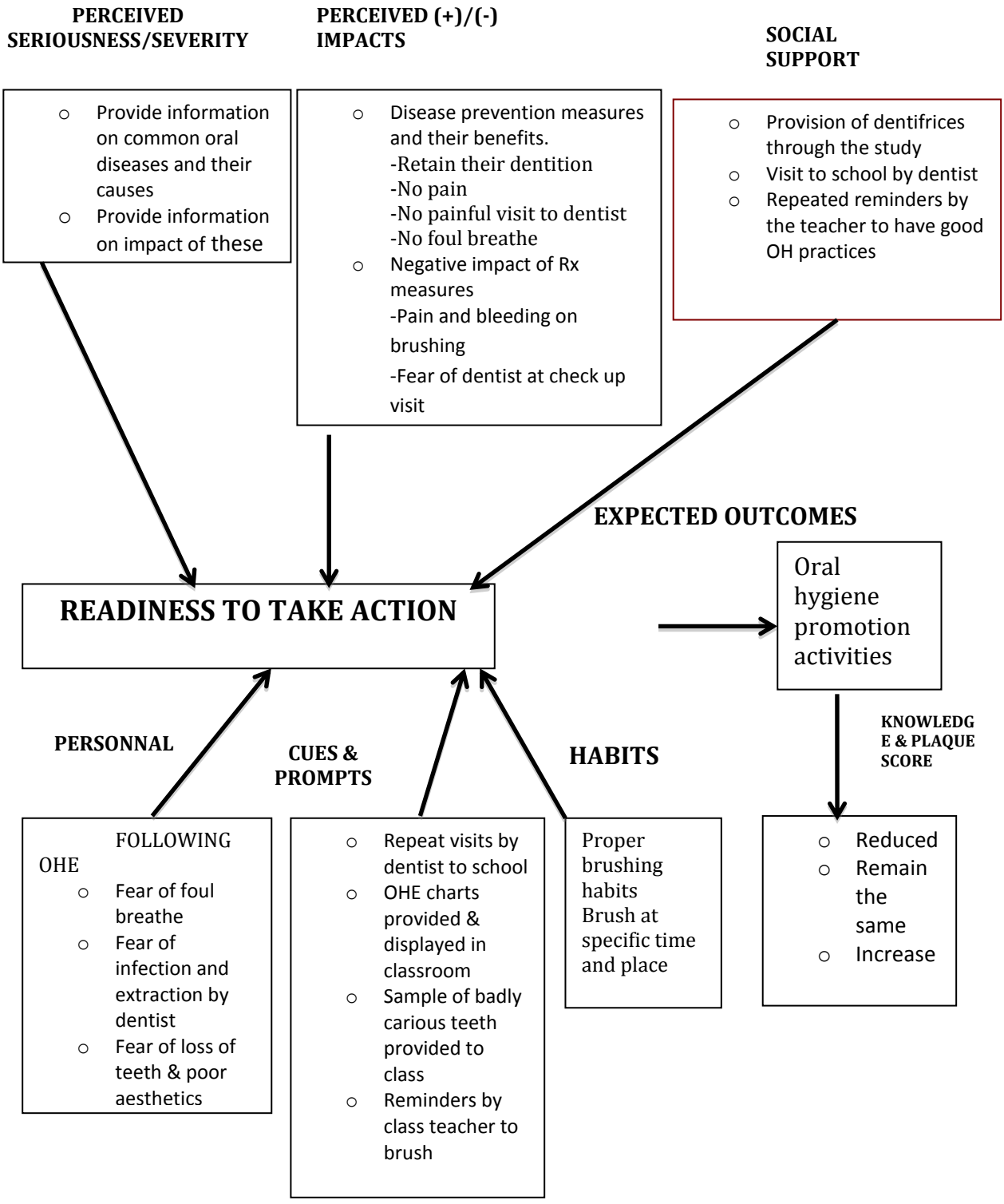
Again, in 2010, Ajithkrishnan et al (2010), in his three-month study in Gujarat state noted different results. The study was to evaluate the impact of OHE on plaque, gingival and caries status. In the study, 12 and 15 year old subjects were examined at baseline and after three months of oral health education where 20-minute sessions were given. Findings were recorded using Loe and Silness Plaque index, Loe and Silness Gingival Index and WHO modified DMFT index. Paired T-test was used to evaluate change between baseline data and after OHE, and significance level was set at $P<0.05$. A total of 372 children were examined. No statistically significant reduction in mean plaque scores of 12-year old subjects before and after OHE was noted. There was a significant reduction on plaque scores of the 15 year olds after the

OHE. No significant reduction was noted in mean gingival scores of the 12 and 15-year old subjects at the baseline and after OHE. There was also no difference in mean caries status for both groups before and after OHE. However, this was quite a short time to assess changes in development of dental caries.

Length of study and interval between oral health education sessions seems to have a bearing on the impact of the OHE programs.

2.5. CONCEPTUAL FRAMEWORK

FIGURE 2.1



Readiness to take action towards prevention of oral diseases may result from a combination of many factors. Provision of oral health education to the pupils enables

them to understand the oral health diseases, their severity, and also modify their perception of impact of these diseases on their general health and aesthetics. Knowledge about these diseases causes development of some personal perception of vulnerability to the adverse effects of the diseases, for instance development of bad breathe and its social impact among peers, fear of loss of teeth and the social, aesthetic and functional impact this may cause; and also the fear of facing the dentist, who in most cases is associated with painful injections and extractions. Repeated visits by the dentist to the schools, provision of dentifrices, reading charts on walls of classrooms, reminders by teachers to brush teeth may contribute to these children developing consistent brushing habits.

All these factors are contributory towards readiness to take action towards good oral health practices, and so reduction in accumulation of dental plaque, one of the main factors in development of both dental caries and periodontal disease.

CHAPTER 3: METHODOLOGY

3.1:STUDY AREA

Eldoret Municipality lies within Uasin-Gishu County, formally Uasin-Gishu District in Kenya. It is an agricultural region growing mainly maize and wheat and lies in the northern part of the Rift Valley. It lies within a longitude of $34^0$50' and $35^0$37' east and latitudes $0^0$03' and ^{0}055' north. It is a highland plateau that lies between altitude 1500m and 2100m above the sea level. Eldoret town is the main town in this county. Its municipality has 42 public primary schools located in five zones. These zones include:

- Kapsoya zone 5 schools
- Kabiyet zone 6 schools
- Pioneer zone 12 schools
- Kiburgen zone 11 schools
- Chepkoilel zone 8 schools

3.2: STUDY POPULATION

The target population for this study is public primary school pupils aged 11-12 years in Eldoret Municipality, Uasin-Gishu County. These were children in class six at the time of study, as the normal enrolment age to class one is six to seven years. There were a total of 4618 pupils, with 2272 boys and 2346 girls. This is as per information obtained from the Eldoret Municipality Ministry of Education office (details in appendix 1).

3.3.STUDY DESIGN

This was cluster randomized controlled intervention study. Clusters of pupils were drawn from the participating public primary schools. Schools from various zones were proportionately and randomly allocated to control and intervention groups, and class 6 pupils in that school formed an intervention or a control cluster based on where their school was randomized to. Baseline data on oral health knowledge and practices was collected using interviewer-administered questionnaires; and dental plaque level scored using a Green and Vermillion plaque index. This was collected for all pupils participating in the study. Standardization was done by provision of toothbrushes and paste for all participating pupils for the period of study. Four sessions of oral health education (one session per week) were given to the clusters in the intervention group and none given to the control group. Afterwards, data on oral health knowledge, practices and plaque scores was collected again for all clusters as described above.

3.4: STUDY DESCRIPTION

As proposed, authority was sought from IREC and from Ministry of Education to carry out this study in public primary schools in Eldoret Municipality (See appendix 8,9). The head teachers of participating schools were approached with the introductory letter from Ministry of Education and IREC and purpose of study explained to them and they too consented to this study. Through the guidance of the class teacher or the science teacher of the selected class in each school, the PI and her assistants met the participating pupils and method and purpose of the study was also explained to them. Their role in this study was explained to them, and participation was encouraged. The consent forms were given to the class teacher for distribution to the pupils. Some schools sent consent forms home through the pupils to have the

parents sign, while some opted to call the parents for a meeting in school where this information about the study was conveyed to them and they gave consent for their children to participate in this study.

On obtaining consent and identifying the pupils who will participate, pupils were then allocated code numbers. The first appointment for commencement of study was fixed for each school based at a time convenient for the school and the investigator.

The room allocated by the school was set up for data collection. Two stations for the administration of questionnaires and one for clinical examination were set up. Questionnaires were administered by two trained research assistants. Questions were asked sequentially as in the questionnaire. Language of communication was English. On completion of both questionnaires (oral health knowledge and oral health practices (Appendix 2,3), the pupil was sent to the clinical examination station where they were examined by the dentist. Here, they were informed that a dental examination would be done as described in the first meeting with them; and that they would rinse their mouth with plaque disclosing solution first for ease of identification of areas of plaque accumulation. Use of plaque disclosing solution was done under supervision by the PrincipalInvestigator. It was followed by a clinical examination. The pupil sat on a chair opposite the PI, and dental examination was done with use of a sterile mouth mirror and enhanced illumination by a headlamp. Findings were recorded on the clinical data form (Appendix 4), which bore the pupil's identification code. Plaque scores were done based on Green and Vermillion plaque index where buccal and palatal/lingual surfaces of three teeth on each arch were scored for dental plaque with scores ranging from 0 to 3 on each surface. (Appendix 7). A mean plaque score was calculated from this and this is what was entered as the pupil's plaque score. After examination, the pupil was then given a new toothbrush and a tube of paste and

encouraged to use the dentifrices to clean their teeth. Pupils were cautioned against sharing of toothbrushes when they went home.

On completion of this exercise, if the school had been marked for intervention, the first session of oral health education and demonstration on oral self-care practices was done. In the classroom of these intervention clusters, oral health education charts were hanged, and flyers that detailed tooth brushing method and importance were issued to each participating pupil.

Subsequent sessions of oral heath education and demonstrations were given in intervals of one week. After the fourth session of OHE, that cluster was ready for post intervention data collection. A repeat of administration of the questionnaires on knowledge, practices, and clinical data collection on dental plaque levels was done.

For schools identified to participate in the control arm, baseline data was collected as above. The pupils were given their toothbrushes and paste and encouraged to use them when got home, and not share their toothbrushes and pastes with any other family member. Risk of transmission of diseases was give as reason not to share toothbrushes. When four weeks elapsed, a repeat data collection of the above parameters was done from the control group too.

3.5. SAMPLE SIZE DETERMINATION

The sample size to compare mean plaque levels in the experimental and control groups was given by the following formula (Sokal and Rohlf, 1981):

$$n = \frac{\left(Z_{1-\alpha/2} + Z_{1-\beta}\right)^2 (\delta_0^2 + \delta_1^2)}{(\mu_0 - \mu_1)^2}$$

Where,

n = sample size for each group

$Z_{1-\alpha/2} + Z_{1-\beta}$ = Values obtained from a standard normal distribution or from a student t-distribution with infinity degrees of freedom (which is identical to a standard normal distribution). For α = .05 and β = .20 (since the power of the study is .80), the values of $Z_{1-\alpha/2}$ and $Z_{1-\beta}$ are 1.96 and 0.84, respectively.

$\delta_0^2 + \delta_1^2$ = The sum of population variance for the experimental group and control group.

$(\mu_0 - \mu_1)^2$ = The difference between the mean plaque values in the experimental and control groups squared (Sokal and Rohlf, 1981).

Thus,

$$n = \frac{(1.96 + .84)^2 (4.7^2 + 4.4^2)}{(12 - 10.5)^2}$$

= 144.4

= 144 pupils in each group

However, this study adopted a cluster randomized controlled trial (CRCT), in which pupils were primarily assigned to treatment and control groups as clusters of classes rather than as individual pupils. This is because individual randomization may be undesirable because of the potential "diffusion of treatments" (Cook and Campbell, 1979), resulting from sharing of experiences within the same class. Lastly, cluster design findings are likely to have more external validity, because, more often, the unit

of policy direction tends to be the cluster rather than the individual (Raudenbush, 1997).

Individuals in a cluster are likely to have the same outcome to an intervention, a phenomenon also called as within-cluster correlation, lack of statistical independence within groups, or within cluster variability (Cummings and Koepsell, Okm 2002). The measure of the degree of similarity of outcomes among members of the same cluster is called the intra-class correlation coefficient (ICC), often denoted as ρ (Coupland and DiGuiseppi, 2012).

Because of the lack of statistical independence within groups, CRCT designs are less efficient (that is, have less statistical power) compared to their individual randomized counterparts (Cummings and Koepsell, 2002). The measure of this inefficiency is called the design effect (DEFF), also called, the Inflation factor, which is given by:

$$DEFF = 1 + (m - 1)\,\rho$$

Where, m is the number of individuals per cluster and ρ is the ICC. Thus, in CRCT designs, this sample size needed to be inflated by a factor of DEEF to recoup the lost power.

This study adopted ρ value of 0.1, obtained from a similar study conducted by KEMRI in 2010 on the efficacy of malaria-prevention education given to pupils in class one to five among primary schools in western Kenya. Taking the average number of pupils in a cluster to be 40, DEFF for this study becomes:

DEFF = 1 + (40 – 1)0 .1

= 4.9

Thus, the sample size required in each of the experimental and control groups, was:

4.9 x 144 = 705

Thus, 705/40 = 17 clusters/schools for each group were required.

On top of these 40 children, 5 children were added per class to take care of any loss to follow up due to various reasons.

The number of public schools in the municipality is 42.

3.6: SAMPLING

Multi-stage random sampling was used with the selected clusters randomized to intervention and control arms of the study.

Out of the 42 schools, one school could not participate in the study since it had received oral health education in that year. This school was also used to pilot the data collection. Forty-one schools were thus legible to participate in the study. Of these, two schools had a population of less than forty pupils enrolled in class six by the time of collection of information on class 6 enrollments from the Ministry of Education – Eldoret Municipality Office and so they were also excluded during sampling. Schools were proportionately picked from the zones. Four schools were randomly picked from Kapsoya Zone, six from Kiburgen, 10 from Pioneer, 8 from Chepkoilel and 6 from Kabiyemit. To do this, names of the school were written on pieces of

paper, folded and mixed and put together in a box. Of these, a number of papers equivalent to the number of schools allocated to participate in the study per zone were picked. After that, these papers bearing the selected names of schools were put together in a box and randomly picked and allocated to intervention and control arms of the study.

In schools with one stream in class six, 40 children were randomly selected to represent their school and this formed a cluster. Five more children were selected to add onto the forty to cater for attrition during the study. If the class had less than 50 children, the whole class was allowed to participate in the study. This was because it would be unfair to bar a handful of children from a class from participating in the study, as they would possibly interpret this as discrimination. In schools, which had more than one stream in class six, one stream was selected to represent the school in this study. Here, pieces of paper indicated 'Yes or No' were put in a tin and the class prefects told to pick one. The one that picked a "Yes" is the one that participated in the study.

3.7: MODE OF ORAL HEALTH EDUCATION

For the intervention group, an interactive oral health education session was done once a week. This was done by a research assistant who had been trained by a dentist (Principal investigator) on how to carry out oral health education. It was done in a classroom set up where an oral health talk was given and reinforced with use of visual aids. Dentoforms and toothbrushes were used to demonstrate how to brush one's teeth. Health education charts were also placed on the walls of the classrooms and children encouraged to keep referring to them.

During the education sessions information on structure and function of teeth, types of dentition and their significance, number and types of teeth present in each dentition, dietary components and their effects on oral tissues; importance of a balanced diet; etiology, clinical manifestations and treatment modalities, and prevention of dental caries and periodontal disease, the influence of oral health to general health, importance of brushing teeth twice daily, use of mouth rinses, proper tooth brushing technique (Modified Bass method) and the importance of regular dental check-ups was conveyed. The instructor used a dentoform and toothbrush to demonstrate brushing and children role-played the demonstration to a certain whether they grasped the correct skills. This was done repeatedly for the four weeks of the intervention period.

All participants in the study who were in the control arm were given a session of oral health education after the second session of data collection.

Toothbrushes that were lost in the course of the study were reported to the PI in subsequent visit and replaced immediately. This was on very rare occasion.

3.8. DATA COLLECTION

3.8.1: ETHICAL CONSIDERATIONS

3.8.1.1 ***Authority to carry out the study***

Approval was sought from the Institutional Research and Ethics Committee (IREC) of Moi Teaching and Referral Hospital/Moi University College of Health Sciences.. The Ministry of education through the Eldoret Municipal Education Office was informed of intent to carry out the study in public schools in this municipality and it

gave approval for this study too. An introductory letter to head teachers in these schools authorizing this study to be carried out was issued from the MOE office. (Appendix 9).

Consent for the pupils to participate in this study was sought from their parents and guardians. Participating pupils were issued with consent forms which had a part of it detailing the purpose of the study and the role of the pupils to take to their parents, which they signed on consenting. These forms were returned to the class teacher and collected by the PI before the commencement of the study.

During the examination, pupils who were noted to require urgent dental carewere given a written note to take to their parents. The note detailed the clinical problem diagnosed. They were referred to Uasin-Gishu District Hospital and Moi University School of Dentistry clinic for dental care.

3.8.1.2 *voluntary participation*:

An explanation of what the study entailed was given to the pupils, and they were informed of what was expected of them. They were informed that participation was out of free will and that they were allowed to withdraw from the study at any time without any negative consequences.

3.8.1.3 confidentiality:

Only the PI and her research assistants who helped in administration of questionnaires handled raw information. A code number was allocated to each pupil. This was used during data entry and analysis instead of names. All questionnaires and clinical data forms were kept in a locked cabinet and locked room until data entry and analysis was done. Extracted data was stored in a password-protected computer, whose password only the PI had access to.

3.8.1.4 Equal opportunity for participation

Every class 6 pupils in participating schools was given equal opportunity to participate in the study through random sampling. All children in the participating class benefited from free oral health education, as free oral health education was given to the control arm of the study too after data collection. Each participant also benefited from free toothbrush and paste for the period of study.

3.8.2: QUESTIONNAIRE AND CLINICAL DATA COLLECTION

Two research assistants were trained on the purpose of this study and how to administer the questionnaire. They helped in administration of the questionnaires during the study. The PI, whose basic training is dentistry, examined all pupils and collected all the clinical data. The questionnaire on oral health knowledge sought for information on dental caries and periodontal disease, their signs, how they come about and how to prevent them. A separate questionnaire was used to assess oral health practices. This addressed tooth brushing habits, dietary habits and oral health seeking behaviors. Language of communication during data collection was English. Data collection was done in a separate room provided by the school. Questionnaires were administered at one end of the room and clinical examination at the other end.

During oral examination, the pupils were given plaque disclosing solution and explained to on how to use it. Examination was done as the pupil sat on an armchair opposite the PI. Sterile mouth mirrors were used for this exercise. The levels of dental plaque were scored by Green and Vermillion plaque score index. For privacy, one pupil was examined at a time. At examination, the examiner wore a mask and a headlamp was used to enhance visibility.

After use, instruments were washed in soapy water and rinsed in clean water; then soaked in Steranios 2% solution (gluteraldehyde buffered at pH 6 in the presence of surface effects catalyst) for one hour and later autoclaved by pressure steam autoclave.

3.8.3: DATA PREPARATION

Several steps were undertaken to ensure the veracity of the data that was used in the final analysis. These included checking the questionnaires for completeness, compliance with instructions at answering questions, coding, transcribing, and cleaning of the data.

The questionnaires with missing pages or missing biographical information of the respondents was discarded and not used in the analysis. However, questionnaires with complete biographical information and most questions answered were included in the analysis, with the unanswered questions treated as missing data.

The data was coded by assigning alpha or numeric codes to answers, which allowed them to be subjected to statistical techniques.

The data was transcribed into a computer spreadsheet and then exported into a statistical program, STATA. To ensure the accuracy of the transcribed data, this data was later on compared with randomly selected questionnaires.

3.9: DATA ANALYSIS

Several analytical tools, described in the following section, were employed in the study.

3.9.1: DESCRIPTIVE STATISTICS

Descriptive statistics were used to describe, summarize, and organize the data. Three sets of these methods were used: frequency distributions, measures of central tendency and measures of dispersion. Frequency distributions, ordered arrangement of all variables, showing the number of occurrences in each category was used to summarize data, which was then displayed in tables. Average values of the data were given by the central tendency measures of the mean. Dispersion (variability) of data was given by the standard deviation.

3.9.2: CALCULATION OF THE PUPILS' ORAL HEALTH KNOWLEDGE INDEX

Nine questions (Appendix 2) provided on the questionnaire tested the pupils' oral health knowledge before and after oral health education intervention. The index was computed by summing up each pupil's correct answers to health knowledge questions, and expressing the value as a percentage. For a student scoring all the questions correct, the index was calculated as (9/9 x 100 = 100%). For a pupil who failed to obtain a single correct answer, the index was: 0/9 x 100 = 0%).

3.9.3: CHI – SQUARE TESTS, T – TESTS AND ANALYSIS OF VARIANCE (ANOVA)

Chi-square (χ^2) tests of independence were used to test if significant differences existed between different categories. This was used to determine if the percentage of pupils engaging in a particular oral practice was significantly different among the categories of gender (male or female) and different arms of the study. Means in the study were compared using either t – tests or Analysis of variance (ANOVA). T – tests were used when the groups being compared were just two, for instance, the mean knowledge index between pupils in the Intervention and Control groups.

3.9.4: DEALING WITH CLUSTER DATA

The study was a CRCT (Cluster Randomized Controlled Trial), in which the primary sampling unit was the school (cluster) rather than individual pupils. Since individuals in a cluster are likely to have the same outcome, observations in a cluster tend to be correlated. Secondly, there is increased variance, resulting from two sources (within- and between clusters) unlike individual randomized studies whose only variation arises from individual differences (Coupland and DiGuiseppi, 2012). The increased variance widens standard errors and confidence intervals, reducing the power of the study. To recoup the lost power and maintain statistical power at 80%, the study inflated the sample size for individual randomized study by a DEFF of 4.9 as discussed in Section 3.5 above.

During analysis, it was also important to determine the variation resulting from cluster differences. This is because failing to account for clustering would have resulted in confidence intervals that were falsely narrow and p-values that were falsely low, increasing the risk of false-positive errors (Wears, 2002; Coupland and DiGuiseppi, 2012.

In this study, a combination of calculating design effect to adjust standard errors and the use of mixed linear models were used at analysis. The former allowed the ICC and the design effect to be known while the latter could simultaneously model the variation from both the clusters and individual pupils. In addition, the mixed model was also versatile as it could allow the analysis of before and after measurements.

The ICC used to adjust the standard errors was estimated by the Loneway Procedure available in STATA, which calculates ICC according to the following formula (Marchenko, 2006):

$$ICC\ (\rho) = \frac{MSB - MSW}{MSB + (M-1)MSW} \quad (3.1)$$

Where,

MSB = Mean square between

MSW = Mean square within j

M = average size of the cluster

The calculated ICC was then used to estimate the design effect (DEFF) or Variance Inflation Factor (VIF), according to the following formula (Marchenko, 2006).

$$VIF\ = 1 + (M-1)\rho \quad 3.2$$

Where,

M = Average cluster size

ρ = ICC

The DEFF was then used to correct the t statistic estimated in the usual way (assuming that the individual was the primary sampling unit). Since the denominator of the t statistic is the square root of the variance, the value for t was divided by the square root of the VIF and the revised statistic referred to the appropriate number of degrees of freedom based on the number of clusters, and not on the total sample size (Wears, 2002).

To determine the impact of oral health education on pupils' oral health knowledge and plaque levels, a hierarchical mixed linear model was used, which could simultaneously deal with both cluster and panel data (before and after data). First, a random effects ANOVA was estimated to determine whether the variance due to cross-school (clusters) differences was large enough relative to individual differences

to warrant the mixed approach. The model is represented in Equation 3.3 (Marchenko, 2006).

$$Y_{ij} = \beta_0 + \mu_{0i} + \varepsilon_{ij} \qquad 3.3$$

Where β_0 is the intercept, μ_{0i} is the random effect, in this case, the cluster, and ε_{ij} is the residual random error.

After running the random effects ANOVA in STATA using the XTMIXED procedure, the ICC for the cluster variation was calculated according to the following formula:

$$ICC = \frac{\sigma_k^2}{\sigma_k^2 + \sigma_e^2} \qquad 3.4$$

Where σ^2_k is the variance between clusters and σ^2_e is the variance between individuals.

If ICC was more than 10%, then it implied that the variance resulting from cross-cluster differences was considerable and therefore a mixed approach was used (Marchenko, 2006). The mixed model tested in the study was as follows:

$$Y_{ij} = \beta_0 + \beta_1 X_{1ij} + \beta_2 X_{2ij} + \beta_3 X_{1ij} X_{2ij} + \beta_4 X_{4ij} + \beta_5 X_{5ij} + \mu_{0i} + \varepsilon_{ij} \qquad 3.5$$

Where,

Y_{ij}= The response variable (knowledge index or plaque level) for i^{th}individual measured at time t_{ij}

β_1 to β_6 = Coefficients for Respondent's type (whether Intervention or Control group), Time (before or after), Interaction between respondent type and time, location of school and gender of pupils, respectively,

X_{1ij} to X_{5ij} = Respondent's type (Intervention group = 1 or Control group =0), Time (Before =0; After = 1), Interaction between respondent type and time (Product of time and respondent type), location of school (Urban = 0, Peri-urban = 1) and gender of pupil (Female = 0, Male =1), respectively

μ_{0i} = The random effect, in this case, the cluster,

ε_{ij} = residual random error.

β_0 = The intercept

If the ICC estimated from the random effects ANOVA was less than 10%, then it implied that the variance resulting from cross-cluster differences was minimal, and an Ordinary Least Squares (OLS) regression, rather than a mixed approach, was adopted (Marchenko, 2006). In this case, the same model (Equation 3.5) was estimated but without the random effect (μ_{0i}).

The study took measurements on pupils before and after oral health intervention and therefore, during analysis, a time variable, (Before and After) was incorporated. Hence, there were two main effects, Respondent type and Time, and an interaction variable of Respondent type and Time. In addition, a covariate, (pupils' sex) was also included in the model, because it could be a confounding variable. The main effect of Respondent type represented the difference in the mean between Intervention and Control groups, regardless of the time, and hence was of little value. Similarly, the main effect of Time merely shows the difference in means Before and After treatment, regardless of the treatment group, and hence was also of marginal value, as it could have represented the effects of natural progression unrelated to the impact.

The most important term was the interaction term because the interaction term measured the treatment effect as follows:

$$\text{Treatment Effect} = (Y - X) - (Z - A) \qquad 3.6$$

Where,

Y and X= Level of phenomenon after and before treatment, respectively, in the intervention group.

Z and A = Level of phenomenon after and before treatment, respectively, in the Control group.

All statistical tests were performed with the aid of STATA statistical package, version 12. All the above tests were two – tailed. Significant levels were measured at 95% confidence level with significant differences recorded at $p < .05$.

CHAPTER FOUR: RESULTS

4.1 INTRODUCTION

Out of 1 410 pupils in 34 primary schools targeted for sampling in the study, 1500 (106.38%) in all the targeted schools participated in the study. This was because some schools had standard six class sizes containing more than the projected 40,yet less than 50 pupils, and up to 5 pupils were added to each cluster of 40 pupils to take care attrition during the study. The study was conducted in public primary school, and according to the Ministry of Education policy in relation to free primary school education, enrollment into school is a continuous process, and no child should be denied entry. For this reason, the number of children registered in schools at development of proposal for this study increased over time with new enrollment into school. A list of participating schools is presented in the Appendix 6.

4.2 DEMOGRAPHIC PROFILE OF RESPONDENTS

The data from this section gives biographical information of the pupils and the clusters (schools) in the study in order to understand their profile. The information sought included the pupils' gender and cluster zones. This information is presented in Table 4.1.

Table 4.1: Demographic information

Bio-graphic information	Intervention group	Control group	Total
A. Pupil (Individual) factors			
Number (%)	777 (51.8)	723 (48.2)	1500(100)
Pupils' gender			
1. Female (%)	395 (50.8)	383 (49.2)	778 (100)
2. Male (%)	382 (52.9)	340 (47.1)	722 (100)
B. Cluster (School) factors			
Number (%)	17 (50)	17 (50)	34 (100)
Cluster zone			
1. Pioneer	5 (50.0)	5 (50.0)	10 (100)
2. Kapsoya	2 (50.0)	2 (50.0)	4 (100)
3. Chepkoilel	4 (50.0)	4 (80.0)	8 (100)
4. Kibulgen	3 (50%)	3 (50%)	6 (100)
5. Kabiyemit	3 (50%)	3 (50%)	6 (100)

Results in Table 4.1 indicates that 723 (48.2%) and 777 (51.8%) pupils from control and intervention schools, respectively, participated in the study, which more than satisfied the sample size requirement of 705 pupils, from each group. Thus, statistical tests to be conducted on this data will contain enough power to be able to reject false null hypotheses. The number of girls in the study (n=778, 51.9%) were roughly equal to boys (n=722, 48.1%), suggesting the absence of gender bias in the study. Out of the possible 42 public schools in the municipality, 34 schools participated in the study. Of these ten, four, eight, six, and six clusters were selected from Pioneer, Kapsoya, Chepkoilel, Kibulgen and Kabiyemit zones. The number of participating schools,

their distribution and distribution in terms of gender gives these results a sense of external validity.

4.3. ORAL HEALTH KNOWLEDGE OF PUPILS IN ELDORET MUNICIPALITY

Results from the questionnaire on oral health knowledge indicated that less than half of the pupils in this population knew the two common diseases of the mouth, with only 45.3% and 41.0% of them being knowledgeable about gum diseases and dental cariesrespectively. Nine percent of the pupils (203 pupils) did not know a single disease of the mouth. For the causes of gum disease, 43.3%, 28.2% and 16.6% of the pupils knew that it was caused by failure to brush teeth, accumulation of dental plaque on teeth and poor oral hygiene habits, respectively. A sizeable percentage of pupils (12%) were found to be oblivious of the causes of gum disease.

Knowledge on the signs of gum disease was also found to be low among the pupils, with only 41.6% of the pupils correctly identifying bleeding gums as one of the signs. Other signs of gum disease were poorly known, with reddish swollen gums, foul mouth smell and shaky teeth that easily fall being correctly mentioned by only 16.4%, 24.2%, and 8.7%, respectively, of the pupils.

Only 44.5%, 31.8% and 13.9% of the pupils understood that brushing teeth regularly, visiting the dentist regularly for check up and using mouthwash to keep the mouth clean could prevent gum diseases, respectively.

Pupils' knowledge about the causes, signs and prevention of dental caries was found to be equally poor. Whereas 51.9% of the pupils knew that eating too many sweet

foods causes dental caries, a mere 19.8% and 17.4% comprehended that lack of regular brushing and poor brushing technique, respectively, could also contribute to development of this disease. Only 18% of all pupils interviewed could identify the earliest sign of dental caries – sensitivity on eating hot, cold and sweet foods; while 34.9% and 33.6% identified pain and cavities as signs of the disease respectively. These are late signs of the disease development and by the time one presents with these signs, the disease is at an advanced level. 12.8% of the pupils had no idea of the symptoms that one probably has dental caries, pointing to the fact that with all factors held constant, this group will have the disease take a natural course unabated.

Brushing regularly, reducing intake of sweet foods and visiting the dentist regularly for check –ups were correctly mentioned by 30.3%, 32.3%, and 26.2%, respectively, of the pupils as measures to prevent dental caries. However, 11.2% of the pupils in the study could not identify any preventive methods for the disease.

Only 34.9% of the pupils understood that one should visit a dentist for check – up twice a year while a relatively higher proportion (69.7%) of the pupils correctly comprehended that when a tooth aches, one should visit a dentist for him or her to establish the cause of the pain and administer the necessary treatment.

These findings were computed to form the pupils' oral health knowledge index so as to easily do a comparison of knowledge in different groups. The index was computed by summing up each pupil's correct answers to oral health knowledge questions, and this value expressed as a percentage. The possible maximum score was 100% while the minimum was 0%. Table 4.3 presents the indices according to the pupils' group, gender, and zone.

Table 4.2:Pupils' oral health knowledge indices

Variable	Categories	Mean (%)	n	Std. Dev. (%)	Min. (%)	Max. (%)
Pupils' group	Intervention	41.84	777	20.63	0.00	95.83
	Control	41.70	723	21.05	0.00	95.83
	ALL	41.77	1500	20.83	0.00	95.83
Pupil's gender						
	Female	41.30	778	20.79	0.00	95.83
	Male	42.28	722	20.87	0.00	95.83
	ALL	41.77	1500	20.83	0.00	95.83
School's zone						
	Pioneer	39.50	484	18.11	0.00	91.67
	Kapsoya	41.06	145	21.50	0.00	95.83
	Chepkoilel	42.92	361	22.02	0.00	95.83
	Kibulgen	45.02	257	21.69	0.00	95.83
	Kabiyemit	41.58	253	22.21	0.00	95.83
	ALL	41.77	1500	20.83	0.00	95.83

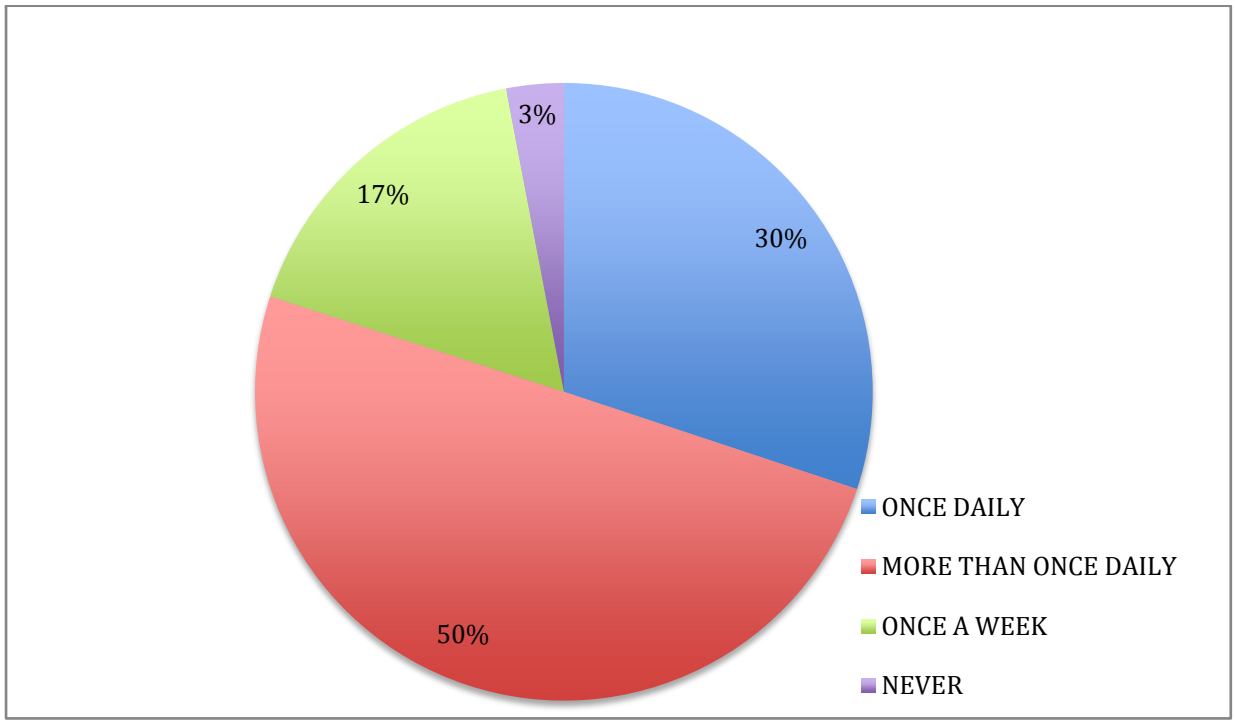
At baseline, the pupils' oral health knowledge index was found to be low in both the intervention (41.84%) and control (41.70%) groups. The indices for both intervention and control groups were similar, suggesting that the process of randomizing the schools to either group was successful. The oral health knowledge indices for pupil's gender and zone were all low (minimum mean=39.50 and maximum mean=45.02), which indicated that pupils in all these groups had a poor discernment of oral health issues at the beginning of study. The minimum oral index of some pupils in the study was found to be 0.00, indicating that some of them were totally ignorant of oral health matters.

4.4. ORAL HEALTH PRACTICES OF PUPILS IN ELDORET MUNICIPALITY

Eleven questions tested the pupils' oral health practices, (Appendix 3) and the outcomes are as discussed below.

4.4.1 FREQUENCY OF BRUSHING TEETH

Figure 4.1:Frequency of brushing teeth

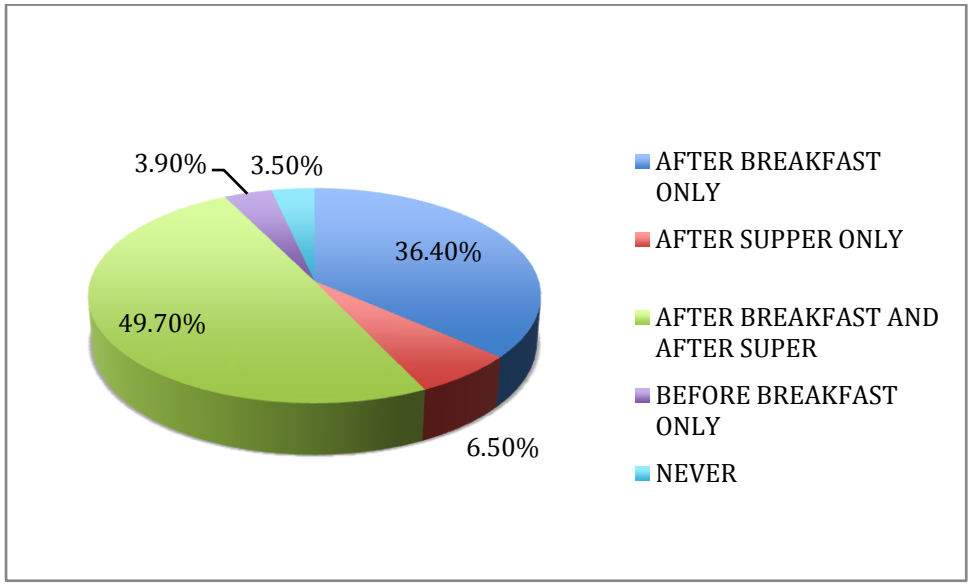


Results in the chart indicated that half of the pupils' (n=741, 50%) in the study brushed their teeth more than once a day while 30% (n=447) were found to brush their teeth once a day. A significant proportion of pupils (n=253, 17%) reported brushing their teeth only once in a week. More girls reported brushing their teeth once a day (50.6%) and more than once a day (54.7%) than boys (49.4% and 45.3% respectively). However the difference was not statistically significant (χ^2 = 6.284, df =3, p = .099). This indicates that the pupils gender did not significantly affect their brushing frequency.

4.4.2 TIMES OF BRUSHING TEETH

FIG 4.2

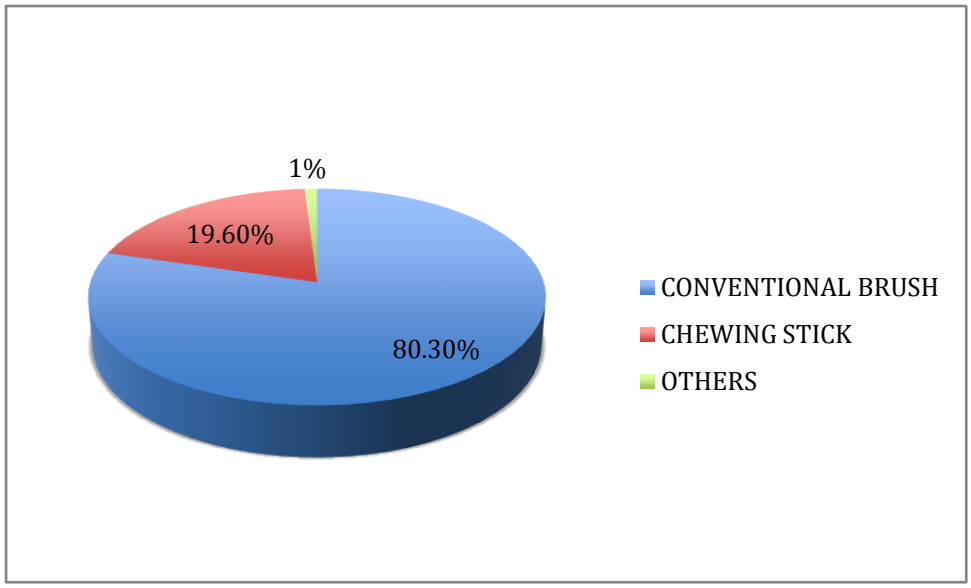
The times when pupils brush their teeth are summarized in the chart below. N=1470



For the pupils' who brush their teeth, roughly a half of them (n=731, 49.7%) reported that they brushed their teeth after breakfast and after supper whereas 36.4% of them brushed their teeth only after breakfast. Very few pupils reported brushing their teeth after supper only (6.5%) and before breakfast (3.9%) only. The cross tabulation between the times of brushing teeth and the pupils' gender indicated that no significant differences (χ^2 = 8.918, df =4, p = .063) were found between boys and girls, with respect to times of brushing teeth.

4.4.3: TYPES OF TOOTHBRUSHES USED:

FIGURE 4.3 Types of toothbrushes used



N=1483

The study found that a majority of pupils (n=1191, 80.3%) used conventional brushes while a sizeable proportion of them were found to use chewing sticks (n=291, 19.6%). Other items used for brushing were charcoal (0.1%). The cross tabulation between the type of brush used by pupils and the pupils' gender is presented in Table 4.9 below.

Table 4.3 Types of Brushes used and their distribution in different categories

		Pupils' type of brush		
Variable Categories		**Conventional brush**	**Chewing stick**	**Total**
Pupils' gender	Female	608 (51.0)	158 (54.3)	766 (51.7)
	Male	583 (49.0)	133 (45.7)	716 (48.3)
	Total	1191 (100.0)	291 (100.0)	1482 (100.0)

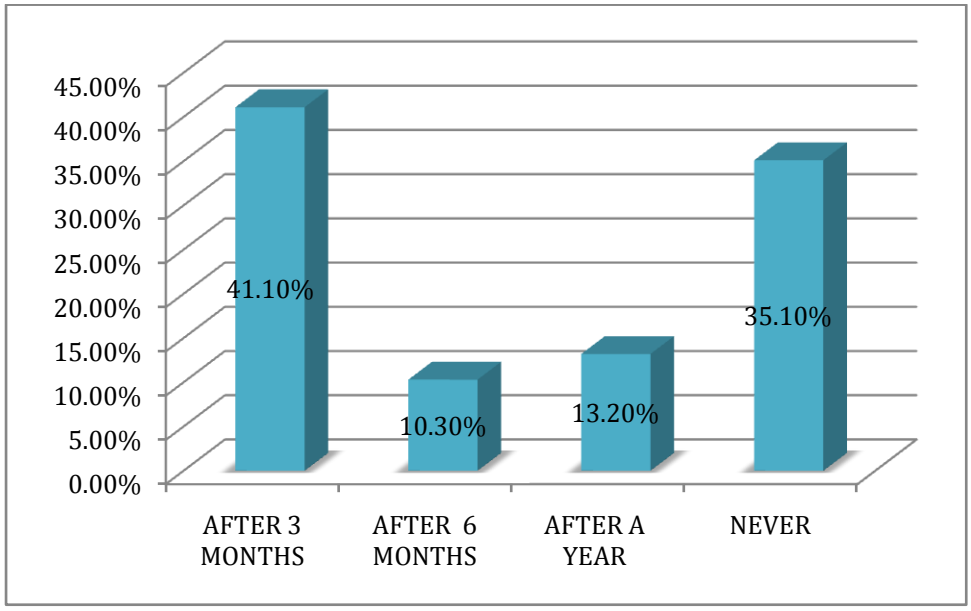
Key: numbers in parentheses are percentages; those without are the number of pupils' who selected that answer. **Pupils' gender**: $\chi^2 = 0.987$, df =1, p = .321.

Since there was only one case of a student using charcoal as a tooth brush, it was removed from the analysis as it created cells in the Chi-square table with fewer than the expected counts. However, no significant differences ($\chi^2 = 0.987$, df =1, p = .321) were found between boys and girls in the type of brush they used.

4.4.4 FREQUENCY OF CHANGING TOOTHBRUSHES

Information on how frequent the pupils in the study changed/replaced their tooth brushes is presented in the figure below below. N=1338

FIGURE 4.4: Frequency of changing toothbrushes



Less than a half of the pupils (n=554, 41.4%) reported to be changing their toothbrushes after every three months. On the other hand a sizeable proportion of pupils (35.1%) were found to never change their toothbrushes while 10.3% and 13.2% of the pupils changed their brushes after 6 months and a year, respectively.These results suggested that pupils in the study area rarely changed their toothbrushes. The frequency of changing toothbrushes was similar between boys and girls in the study area (χ^2 = .310, df =3, p = .958).

4.4.5 USAGE OF TOOTHPASTE

Information on the usage of toothpaste by pupils in the study is presented in Table 4.12 below.

Table 4.4 Usage of toothpaste

How often do you use toothpaste?	Frequency	Percent
Every time I brush	619	42.0
Once a week	75	5.1
Whenever its available	554	37.6
Never	225	15.3
Total	1473	100.0

The results implied that most pupils in the study area are not able to access toothpaste whenever they want to brush their teeth. This is because less than a half of the pupils (n=619, 42%) used paste when brushing while 37.6% of them once a week. Of these, No significant differences were found (χ^2 = .723, df =3, p = .868) between pupils' gender and usage of toothpaste, indicating that usage was similarly, irrespective of their gender

4.4.6 REASONS FOR BRUSHING TEETH

Pupils were found to brush teeth mainly to protect themselves from having cavities (n=948, 63.9%) and to a lesser extent, to avoid bad breath, (n=411, 27.7%). Table 4.15 below presents the cross tabulation between the reasons for brushing teeth by pupils and their gender and school zone.

Table 4.5:Reasons for brushing teeth in different categories

		Reasons for brushing teeth			
Variable Categories		To avoid bad breath	Protect against cavities	To prevent gum bleeding	Total
Pupils' gender	Female	195(47.4)	514(54.2)	53(46.1)	762(51.7)
	Male	216(52.6)	434(45.8)	62(53.9)	712(48.2)
	ALL	411(100)	948(100)	115(100)	1474(100)

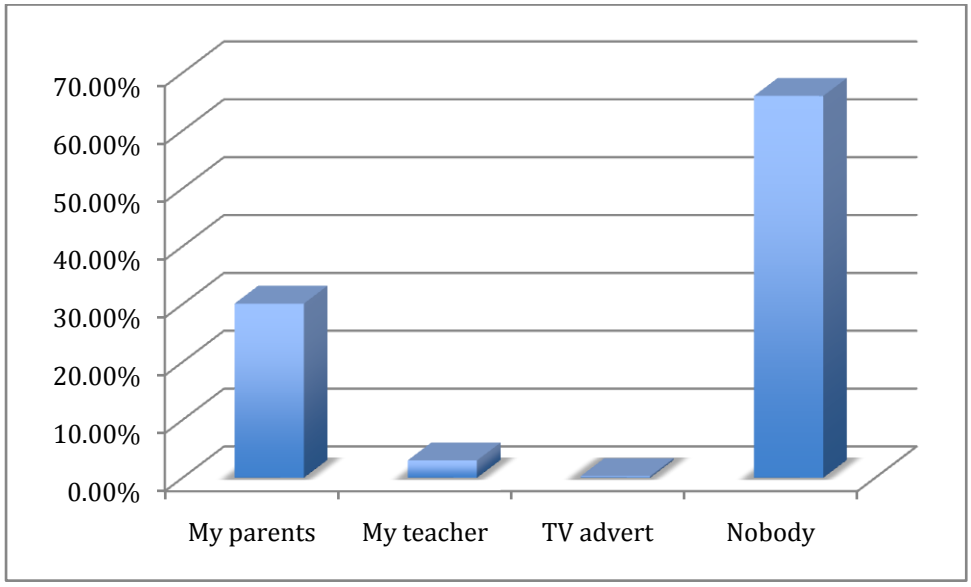
Key: numbers in parentheses are percentages; those without are the number of pupils' who selected that answer. **Pupils' gender**: χ^2 = 6.84, df =2, p = .033.

The cases of “failure to brush to avoiding seeing the dentist” were removed from the analysis because they were too few. The gender of the pupil was found to influence the reason for brushing teeth (χ^2 = 6.84, df =2, p = .033). The results implied that whereas girls brush mainly to protect themselves against getting cavities (54 .2%) boys did so chiefly to avoid bad breath (52.6%) and prevent bleeding of gums (53.9%).

4.4.7: The person that reminds pupils to brush teeth

Table 4.16 presents information on person who reminds the children in the study to brush their teeth.

Figure 4.5: Reminder to brush



Most pupils in the study (66.6%) reported that nobody reminded them to brush their teeth, suggesting that the children were left to their own devices when it came to brushing teeth. The results also indicated that parents were better reminders of the children in brushing their teeth (30.1%) compared to teachers (3%) or TV advertisements (0.3%). Cross tabulations between the person who reminds the pupils to brush their teeth and their gender revealed no significant relationships (χ^2 = .309, df =2, p=.857). This implied that when it came to reminding pupils to brush their teeth, all of them had similar experiences, irrespective of whether they were boys or girls.

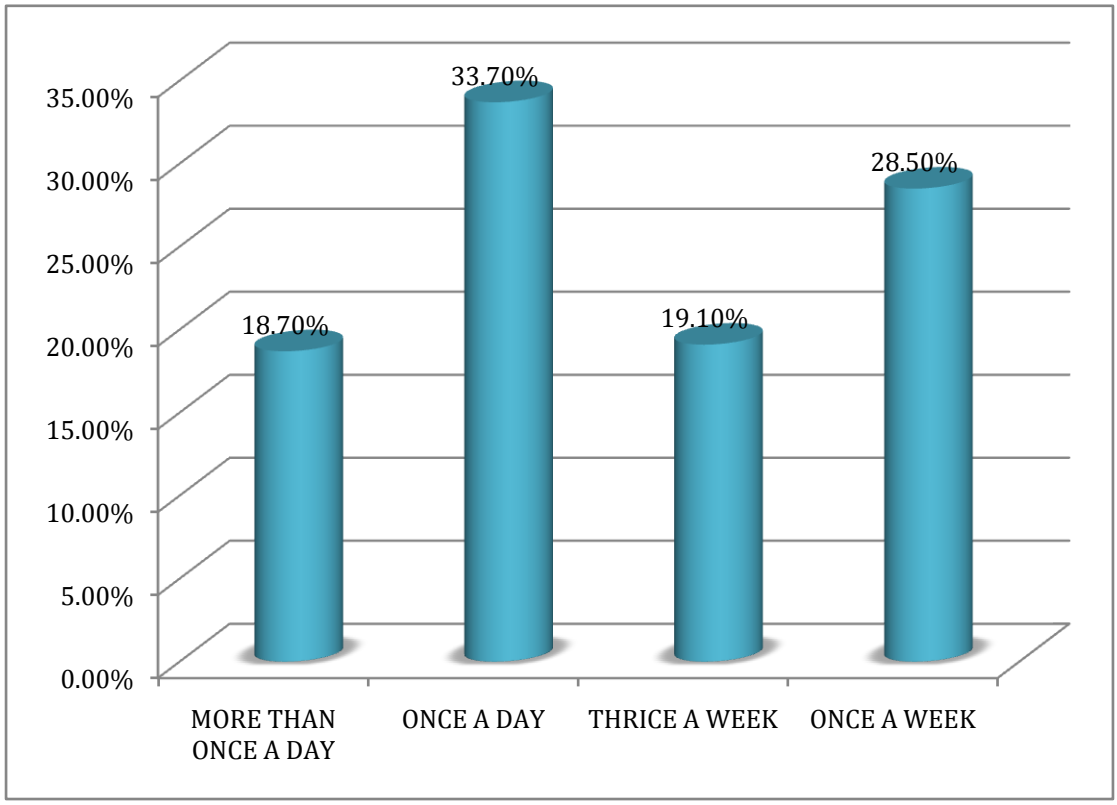
4.4.9: VISITING THE DENTIST FOR REGULAR CHECK UPS

An overwhelming proportion of pupils (n=1056, 71.3%) reported to never have visited the dentist with only 28.7% (n=426) of the pupils in the study having done so. Of those who ever visited the dentist, 52.3% were girls and 43.7% boys. The pupils' gender did not significantly influence the likelihood of their visiting the dentist (χ^2 = 0.104, df =1, p = .747).

Amongst the children who visited the dentist, most of them 28.9% (n=267) visited only when their teeth were painful. Pupils who visited the dentist twice a year were found to be 16.6% (n=154) whereas 9.8% (n=91) visited once a year.

4.4.10: FREQUENCY OF EATING SWEET SNACKS

Figure 4.6: Frequency of eating sweet snacks



Up to 52.4% of the pupils consumed a sweet snack everyday with 18.7% doing so more frequently than once daily. Only 28.5% of the pupils were found to eat them once a week. Chi-square tests showed that the pupils' gender did not significantly influence the pupil's odds of eating sweet snacks ($\chi^2 = 0.947$, df =3, p = .814).

The finding that eating of sweet snacks by pupils in the study was often was supported by the answers received when pupils were asked the last time they had eaten a snack. Majority of them (n=599, 40.8%) had had a snack the day before, whereas 19.9% and 25.1% had had a snack on the material day and three days previously, respectively. Only 14.2% (n=208) of the pupils had last eaten snacks more than three days previously.

4.5.0: DENTAL PLAQUE LEVELS OF PUPILS IN ELDORET MUNICIPALITY

The baseline dental plaque levels of pupils in the study are presented in Table 4.5 below.

Table 4.6 Baseline dental plaque levels of pupils in Eldoret Municipality

Mean plaque levels	Intervention group	Control group
A. Pupil		
Overall plaque levels	2.46±1.45	2.43±1.52
Plaque in pupils' gender		
Female	2.33±1.45	2.27±1.38
Male	2.58±1.45	2.60±1.63
B. Cluster (School) factors		
Numbers of clusters analyzed	17	17
Cluster zone		
1. Pioneer	2.26±1.29	2.79±1.43
2. Kapsoya	2.05±1.46	1.74±1.46
3. Chepkoilel	2.67±1.33	2.44±1.72
4. Kibulgen	2.64±1.70	2.01±1.21
5. Kabiyemit	2.88±1.52	2.38±1.39

The mean plaque levels for the intervention group (2.46) and control group (2.43) were comparable, which indicated that the process of randomly assigning clusters (schools) into the two arms of study were largely successful. The baseline plaque levels in both groups was found to be moderately high, with an average of 2.45 out of a possible maximum score of 6, suggesting that the oral hygiene of pupils in the study area was poor. The average plaque score showed that most pupils' had teeth on which soft debris covered between more than one third and two thirds of the exposed tooth surface.

4.6.0 IMPACT OF ORAL HEALTH EDUCATION ON PUPILS' ORAL HEALTH KNOWLEDGE AND PLAQUE LEVELS

4.6.1PUPILS' ORAL HEALTH KNOWLEDGE AFTER ORAL HEALTH EDUCATION

The pupils in the intervention group were given four (once-weekly) sessions of oral health education whereas those in the control group were not, after which both groups of pupils were asked questions to establish their oral health knowledge. This information is presented in Table 4.22.

Table 4.7 Oral health knowledge of pupils post intervention: Intervention and control groups

What are common mouth diseases?		Gum disease	Dental caries	Ulcers in mouth	Don't know
Sample responses	**IG**	714(54.7)	663(55.3)	125(56.3)	1(3.3)
	CG	592(45.3)	535(44.7)	97(43.7)	29(96.7)
What causes gum disease?		Failure to brush teeth	Dental plaque accumulation	Poor oral hygiene habits	Don't know
Sample responses	**IG**	538(53.1)	589(59.2)	477(58.7)	1(2.1)
	CG	476(46.9)	406(40.8)	335(41.3)	46(97.9)
What are signs of gum disease?		Bleeding gums	Red gums	Foul smell / Shaky teeth	Don't know
Sample responses	**IG**	661(53.8)	590(61.9)	664(60.3) / 511(62.8)	1(2.1)
	CG	567(46.2)	363(38.1)	438(39.7) / 303(37.2)	47(97.9)
How do we prevent gum disease?		Brush teeth	Visit dentist	Use mouth wash	Don't know
Sample responses	IG	671(54.9)	620(58.1)	553(60.1)	1(2.3)
	CG	552(45.1)	448(41.9)	367(39.9)	42(97.7)
What causes dental caries?		No brushing	Sweet foods	Poor brushing	Don't know
Sample responses	IG	517(56.8)	634(52.4)	508(54.8)	43(44.3)
	CG	394(43.2)	577(47.6)	419(45.2)	54(55.7)
What are signs of dental caries?		Sensitivity	Pain from teeth	Holes on teeth	Don't know
Sample responses	IG	557(54.2)	646(53.3)	594(53.5)	43(45.3)
	CG	470(45.8)	566(46.7)	516(46.5)	52(54.7)
How can dental caries prevented?		Brushing	Less sweet food	Visit dentist	Don't know
Sample responses	IG	566(54)	557(53)	576(53.3)	43(42.6)
	CG	482(46)	493(47)	504(46.7)	58(57.4)
When should you visit a dentist?		Check up 1/year	Check up 2/year	When teeth ache only	Don't know
Sample responses	IG	303(55.8)	358(53)	166(46.4)	1(5.9)
	CG	240(44.2)	318(47)	192(53.6)	16(94.1)
When a tooth aches?		Use painkiller	Use herbs	Remove tooth	See dentist
Sample responses	IG	48(57.8)	82(59.9)	293(53.1)	433(51)
	CG	35(42.2)	55(40.1)	259(46.9)	416(49)

Key: IG – Intervention group; CG – Control group. Numbers in parentheses are percentages; those without are the number of pupils' who selected that answer

More pupils in the control group answered “I don’t know” compared to pupils in the intervention group, after oral health education of the latter group. This suggested that education resulted in an improvement of the pupils’ oral health knowledge. For instance, whereas 96.7% (n=29) pupils in the control group still did not know the common mouth diseases, only one pupil (3.3%) in the intervention group did not know the diseases after oral health education intervention. Likewise, while only one pupil in the intervention group did not know the etiology of gum disease after oral health education, 97.9% of pupils in the control group did not know what causes the disease after the elapse of the four weeks.

Results in Table 4.22 also suggest that oral education intervention might not have had a uniform impact on all aspects of oral health. The proportion of pupils in the intervention group who did not know the causes (44%), signs (45%) and prevention (42%) of dental caries was higher than those who did not know the causes (2.1%), signs (2.1%) and prevention (2.3%) of gum diseases at the end of education. This suggested the impact of oral health intervention was bigger with respect to gum diseases relative to dental caries.

4.6.2PUPILS’ ORAL HEALTH KNOWLEDGE INDEX AFTER INTERVENTION

Table 4.23 presents the oral health knowledge index of pupils in both the control and intervention groups before and after the latter group was given oral health education.

Table 4.8 Comparison of OH knowledge Score before and after intervention

Knowledge index	Oral health education intervention	Intervention group	Control group	ICC	DEFF/VIF	Adjusted t statistic
A. Pupil (Individual) factors						
Overall knowledge index	Before	41.83±20.62	41.70±21.05			
	After	71.44±23.49	61.28±23.96	0.13	6.77	3.184***
pupils' gender						
Female	Before	42.00±20.96	40.58±20.62			
	After	72.29±22.99	59.81±24.96	0.15	4.46	3.43***
Male	Before	41.67±20.30	42.97±21.49			
	After	70.56±23.99	62.94±22.71	0.115	3.51	2.33*
B. Cluster (School) factors						
Cluster zone						
1. Pioneer	Before	40.77±17.34	37.73±19.02			
	After	71.13±22.30	63.64±21.25	0.09	4.92	1.67 ns
2. Kapsoya	Before	38.20±22.96	48.82±14.49			
	After	64.54±33.09	66.88±18.55	0.026	2.45	-0.266
3. Chepkoilel	Before	50.26±16.57	38.32±23.73			
	After	74.76±17.68	65.14±23.70	0.08	4.92	1.89*
4. Kibulgen	Before	44.48±22.91	46.02±19.32			
	After	70.01±24.89	42.59±26.57	0.24	12.13	2.36*
5. Kabiyemit	Before	30.75±22.59	46.96±19.99			
	After	78.52±14.19	62.03±22.61	0.23	11.19	1.82 ns

Key: mean ± standard deviation; *** and * p value significant beyond the 0.01 and 0.05 significance levels, respectively; ns= not significant at 0.05 significance level.

Table 4.23 provides the baseline measures ("Before" values) only for comparative purposes. Consequently, the t-statistic is not provided for comparing intervention and control groups with respect to baseline values because since the assignment of schools to either group was randomized, it implied than any significant differences (were they to occur) between the groups would be because of chance. The intra-cluster correlation (ICC) for overall knowledge index was 0.13, which implied that 13% of the variance in the observed knowledge index could be adduced to the clusters in the study (schools) rather than to individual pupils. The design effect/DEFF (variance inflation factor/VIF) for this ICC was 6.77, which indicated that the variance of the estimated knowledge index was inflated by a factor of about six, owing to the clusters, compared to an equivalently sized individually randomized study. However, the adjusted t statistic of 3.184 was found to be significant beyond the 0.01

level. This indicated that the group to which oral education was admitted (intervention group) had a significantly higher overall knowledge index after the intervention compared to the control group, suggesting that educating pupils on oral heath improves their oral knowledge. After intervention, the knowledge index was also found to be significantly higher in both female and male pupils in the intervention group, compared to the control group. This suggested that regardless of the sex of the pupil, oral health education would both increase their oral health knowledge. Put differently, the gender of a pupil has no influence on the ability of pupils to understand oral health matters. However, the absolute effect size was greater in female (12.48) pupils relative to male pupils (7.62), suggesting that although both types of pupils are able to learn about oral health issues, girls appear to be more enthusiastic at learning compared to boys.

4.6.3IMPACT OF ORAL HEALTH EDUCATION ON PUPILS' ORAL HEALTH KNOWLEDGE

A hierarchical mixed linear model was conducted to test whether the pupils' experimental group, education intervention (represented by time before and after the intervention), and the pupils' gender and zone of the school could predict a pupil's oral health knowledge. First, a random effects ANOVA was estimated to determine whether the variance due to cross-school (clusters) differences was larger enough relative to individual differences to warrant the mixed approach. The results of this analysis are presented in Table 4.24.

Table 4.9 Results of the Mixed-effects regression

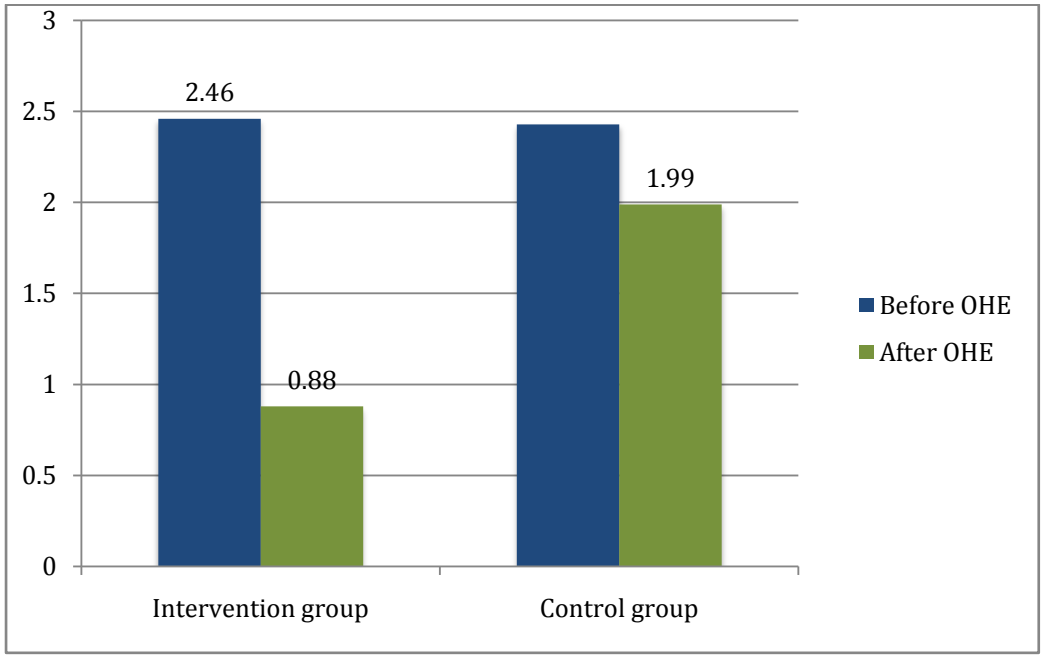
Panel 1					
knowledgeindex	**Coefficient**	**Standard error**	**z**	**P > z**	**95% conf. Interval**
Respondent type	-10.44	3.24	-3.22	0.001	-16.79 - -4.08
Time	19.58	1.13	17.27	P<0.0001	17.36 – 21.81
Respondent type*time	10.02	1.57	6.36	P<0.0001	6.93 – 13.11
Sex;	0.65	0.79	0.81	0.416	-0.91 – 2.20
Constant	43.77	2.31	18.93	P<0.0001	39.24 – 48.31
Panel 2					
Random-effects Parameters		**Estimate**	**Standard error**	**95% Confidence Interval**	
Cluster: Identity					
Variance (Constant)		34.33	10.04	19.35 – 60.91	
Variance (Residual)		464.74	12.07	441.67 – 489.02	
n=1500; Number of groups = 34					
Log likelihood statistic = -13493.105; Wald χ^2 = 1039.68, p<.0001 **Likelihood ratio (LR) test: χ^2 = 136.26, p <.0001**					

Regression analysis between Respondent type and time, was found to be significant (z=6.36, p<.0001). The results indicated that pupils in the Intervention group scored higher on oral health knowledge tests compared to pupils in the control group at time 2. The results suggested that oral health education intervention results in an improvement in the oral health knowledge of pupils.

The coefficients for the covariates of the pupils' sex (0.65) were found not to be significant at p<.05. This implied that oral knowledge uptake by pupils was likely to be similar regardless of whether they were boys or girls, and so whatever teaching method was used would benefit both gender.

4.6.4 IMPACT OF ORAL HEALTH EDUCATION ON PUPILS' PLAQUE LEVEL

Figure 4.7: Overall dental plaque before OHI – intervention and control



Results indicate that there was overall plaque reduction in both intervention and control group, with overall plaque index reducing from 2.46±1.45 to 0.88±0.98 in intervention group and 2.43±1.52 to 1.99±1.44 in the control group. Reduction in the intervention group was markedly high (as seen above) (64.23%) compared to that in control group (18.1%).

Figure 4.8: comparison of dental plaque levels in different gender – before and after intervention period

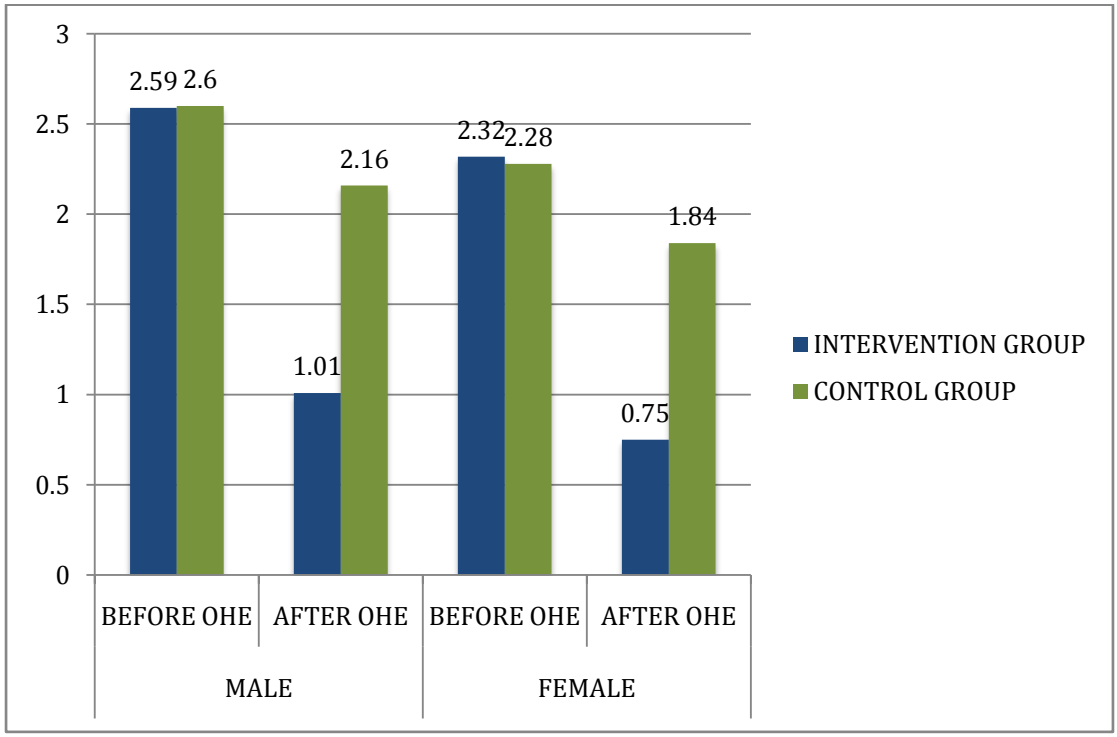


Table 4.10 Results of the OLS regression model of plaque levels

Panel 1					
Plaque Score	**Coefficient**	**Standard error**	**t**	**P > t**	**95% conf. Interval**
1. Respondent type	0.06	0.07	0.84	0.40	-0.08 – 0.20
1. Time	-0.44	0.07	-5.96	P<0.0001	-0.57 - -0.29
Respondent type#time 1	-1.14	0.10	-11.25	P<0.0001	-1.34 - -0.94
Sex	0.28	0.05	5.64	P<0.0001	0.18 – 0.38
Constant	2.17	0.06	32	P<0.0001	2.039 – 2.30
n=1500; Number of groups = 34					
Adjusted R square = 0.19 **F (5, 2874) =** 136.54; p<.0001					

Of the predictors, only the respondent type (Intervention or Control groups) was found not to be statistically significant at $p<.05$ ($t=0.84$, $p=0.40$). These results are buttressed by the confidence interval for Respondent type (-0.08 to 0.20), which spans the value zero, indicating that the coefficient for Respondent type is not significant different from zero. This suggested that there were no significant differences in plaque levels between pupils in the Intervention and Control groups. However, this conclusion is diminished by the fact that the comparison does not take into consideration the time of the study (that is, whether before or after the intervention). On the other hand, the coefficient for time was -0.44, which was found to be significant, ($t=-5.96$, $p<.0001$). The coefficient was negative which indicated that that plaque levels was about 44% lower in pupils after oral health education intervention compared to before intervention regardless of whether they belonged to the Intervention or Control groups.

However, the most important predictor was the interaction between Respondent type (intervention/ control) and time, which was found to be significant (-11.25, $p<.0001$). The results indicated that pupils in the Intervention group at time 2 had about 114% lower plaque levels compared to pupils in the control group. The results suggested that oral health education intervention results in a significant decrease in pupils' plaque levels.

CHAPTER 5: DISCUSSION

5.1: ORAL HEALTH KNOWLEDGE

In this study, at baseline, an average knowledge of all participants was 41.7%. It was slightly higher in boys (42.3%) than girls (41.3%). On the causes of gum disease, 43.3% identified lack of brushing, 28.2% accumulation of dental plaque, and 16.6% poor oral hygiene habits. 12%(n=233) did not know a single cause of this disease. About dental caries, 51.9% identified frequent snacking with sweet foods as a cause, 19.8% thought it was caused by lack of brushing while 17.4% thought it developed when one had poor brushing techniques.

A study done in Tanzania by Carneiro et al, (2011) among secondary school students revealed good oral health knowledge. 88.4% of participants were noted to have adequate knowledge on signs and prevention of dental caries. The high level of knowledge in this Tanzanian population may be attributed to the level of education (secondary school) and the fact that Tanzania has an ongoing school oral health education program which starts from primary school (Nyandindi et al, 1995). A study done in Burkina Faso (Varenne et al, 2006) among 12-year old children revealed a knowledge level of 35%. Another study by Varenne et al, in 2010 amongst 12-15 year old pupils revealed 57.7% oral heath knowledge in caries prevention. A Study done in Jaresh District of Jordan reported a similar finding of 57.7% oral health knowledge (El-Qaderi and Taani, 2005).

This study also compares with a study in Khartoum Province of Sudan (Darout et al, 2005) among secondary school students, which showed that 44.3% boys and 42.5% girls scored highly on knowledge about dental caries. Knowledge on gum disease was 39.5% and 47% respectively. In India, a study done (Gupta et al, 2012) among 15-

year old children revealed that 90% of them had knowledge about dental caries and the role of tooth brushing in its prevention. A lower proportion - 40% were aware of gum disease.

These findings are buttressed by a report by Al-Omiri et al (2006) who studied school children in North Jordan and found that knowledge on dental caries was higher than that on periodontal disease. Punitha and Sivaprakasam (2011) in their study among rural children in Kanchipuram District of China found that 50.61% of interviewed children were aware of dental caries as a disease associated with the mouth, with only one child being aware of gum disease. Of these, 58% know that sweets and chocolate cause dental caries, but they were not aware of any other factors causing this disease or any method of prevention.

From the above studies a trend of better knowledge on dental caries than that of gum disease is evident. This can possibly be attributed to the fact that periodontal disease which affects structures surrounding the teeth rarely presents with pain and may not be given a lot of attention like dental caries, which progresses from sensitivity to pain and swelling. Again signs and symptoms of dental caries have been emphasized much by manufacturers of dentifrices as part of their marketing strategies and many children may gain knowledge into dental caries as a disease through this.

5.2: ORAL HEALTH PRACTICES

5.2.1: Frequency of tooth brushing

Tooth brushing is a mechanical way of dental plaque removal, a major factor for control of both dental caries and periodontal diseases.

In this study, 80% of children brushed their teeth. Of these, about half (49.9%, n=741) brushed their teeth more than once a day; while 30.1% (n=447) brushed only once a day. This compares with findings from a study done in Kitale Municipality by Owino

et al (2011) where 67.5% of children brushed their teeth, with 55% brushing thrice a day, 43% brushing twice a day and 22% brushed only once a day. A study done in Uasin Gishu County (Okemwa et al, 2010) showed similar findings where 92% of interviewed children brushed their teeth. 48% of these children these children brushed at least twice a day. In their comparative study between urban and rural children, Gathecha et al (2011) reported that 61% and 45% of children in urban and rural children respectively brushed their teeth two or more times per day. Frequency of tooth brushing has a bearing on development of dental plaque and its accumulation. It indicates interruption in the formation of dental plaque and its maturation to be colonized by bacteria that contribute to development of periodontal diseases. Brushing also removes the cariogenic substrate onto which acidogenic bacteria act to produce acids that cause demineralization of hard tooth structure leading to development of dental caries. It is also a way of topical fluoride application (when fluoridated toothpaste is used), which is known to both help in strengthening the hard tooth structure. Fluoride is also toxic to the bacteria and it is found in most toothpaste.

5.2.2: Timing of tooth brushing and types of brushing materials used

In this study, 36.4% brushed their teeth after breakfast only, 6.5% after supper only, 49.5% did brush both after breakfast and after supper. Only 3.9% brushed their teeth before breakfast and 3.5% never brushed at all. Timing of brushing affects rate at which dental plaque accumulates. Debris from food taken provides a ready substrate for acidogenic bacteria in the mouth to act on as described earlier in development of dental caries. When this happens repeatedly in the mouth, it leads to destruction of dental hard tissues and so development of dental caries. Frequent brushing denies bacteria of this substrate and so less damage results. When brushing is done before

breakfast, only to be followed by intake of food, this has minimal impact on the control of dental diseases as the period in which there is no fermentation activity by acidogenic bacteria in the mouth is quite short. In the night, salivary flow from the glands is reduced. Saliva plays an important role in buffering of acids in the mouth and so reduction of demineralization of hard tissues (Llena-Puy, 2006). Brushing in the night gives the child a longer period of a clean mouth. A clean mouth in the night when the buffering function of saliva is reduced is paramount in controlling development of dental caries. At least two times a day brushing routine done after meals is encouraged by dentists to improve plaque control. Studies have shown this to be effective in maintenance of oral health. After meal brushing eliminates food impaction and shortens the duration of sucrose impact on teeth (Attin and Hornecker, 2005)

Other than frequency of brushing, other factors in control of dental plaque play a role. Long-term use of a toothbrush leads to its bristles flattening and this reduces the efficiency of plaque removal. Many dentists recommend that a toothbrush should be changed every three months to maintain its efficacy in plaque removal.

In this study, less than half the pupils (n=554, 41.4%) changed their toothbrush after every three months. 10.3% and 13.2% of pupils changed their brushes every six months and one year respectively. A sizeable proportion of 35.1% cannot remember changing their toothbrush. In as much as a lot of children are seen to brush their teeth (80% daily brushing), the impact of this on plaque control may not be much if the brush used is not efficacious enough, following long period of use without changing it.

5.2.3: Reasons for brushing teeth

Pupils were found to brush teeth mainly to protect themselves from having cavities (n=948, 63.9%) and to a lesser extent, to avoid bad breath (n=411, 27.7%). Only 7.7% of the pupils thought brushing their teeth will prevent bleeding gums. This relationship was across the board in terms of zones with no statistically significant difference between different zones. The results implied that whereas more girls brush mainly to protect themselves from cavities (54.2%), boys did so chiefly to avoid bad breath (52.6%) and prevent bleeding of gums (53.9%). This may be attributed to limited knowledge on dental diseases, their causes and how to prevent them in this population. The fact that these children may relate their good oral hygiene to how their peers view them (depicted by the percentage that brush their teeth to avoid bad breath) may be related to psychological development because at this age, children are already aware of themselves, and are keen about their self esteem.

5.2.4: Reminder to brush teeth

Results from this study suggests that most children were left to their own devices when it came to brushing teeth, and that parents were better reminders than teachers in this. Of all the participants in this study, 66.6% (n=989) reported that nobody reminded them to brush their teeth, while 30.1% (n=447) were reminded by parents. Those reminded by teachers and TV advertisements were 3% (n=44) and 0.3% (n=4) respectively. No significant relationship between the person who reminded them to brush their teeth and gender. (gender: $\chi^2 = 5.320$, df =3, p=.150). This implies that children had similar experiences, irrespective of gender. Previous studies have shown that parents and more so mothers have a great role in changing children's dental health practices (Rayner, JF 1970). Saied-Moallemi et al(2008) in her study also

found that mother's high level of oral health knowledge and better attitude scores were associated with children's sound dentition ($p<0.05$) while only mother's better attitude was associated with children's twice-daily tooth brushing ($p=0.01$). On multivariate analysis, she concluded that mother's knowledge per se had no effect on children's sound dental health, but showed an additive effect with mother had a positive oral health attitude. Other studies reveal a family related factor associated with children oral health related behavior. Poutanen et al (2006) demonstrated that parents of children who reported good oral health-related practices had better knowledge and more favorable behavior than those of children with poor oral health practices. This is similar to findings by Castilho et al (2013) and Poutanen et al (2007) where they demonstrated that parents' dental health habits influence their children's oral health. Punitha and Sivaprakasam in their study among Indian children found that parents (58.97%) played a major role as a source of information than teachers (48.14%)

All these point to the fact that parental influence on a child's oral health and self-care practices is of importance and identifies a channel of achieving better oral health in this age group where parents, who are with them on a daily basis in most cases can be used to influence the oral health of this age-group.

5.2.5: Visiting the dentist – frequency and reasons

By the time of this study, an overwhelming proportion (71.3%, n=1056) of the pupils had never visited a dentist with only 28.7% (n=426) having done so. The pupil's gender did not influence the frequency of visit to the dentist ($\chi^2 = 0.104$, df =1, p = .747). Among those who visited the dentist, 28.9% visited only when in pain while those who visited twice a year for check-ups were 16.6%, and 9.8% visited once a

year. This indicates that routine dental check-ups were not common in this population. Those who visited the dentist did so when they were in pain, and rarely (16.6%) for their routine dental check up.

During routine dental check ups, the oral health of the person is assessed and oral health education and motivation is given. It is an opportunity when oral diseases are picked at an early stage and treatment offered in time before too much destruction occurs to the dental and periodontal tissues. Gathecha et al (2012) in their study in Nairobi West (urban) and Mathira West Districts (rural) in Kenya indicated that 17.5% from Mathira and 38.0% from Nairobi West had ever visited the dentist.

In their study, Morrant et al (1995) noted that the mean DMFT of teenagers who attended dental check up in previous year was 2.9, and 3.6 for those who did not attend. Mean value of decayed in attendants was 0.8 compared to 1.2 of those who were not attendants. The number of filled teeth in the attendants was slightly lower than the other group with 2.0 and 2.2 respectively. However, though a positive difference was noted in the mean DMFT between these two groups, the difference was not statistically significant and so this is not conclusive whether dental check ups is an effective way reduction of dental disease burden. Another study by Weng et al (1992) showed similar results where children who had their check ups once every two years had higher increment in DMFT than those whose teeth were checked once a year. Again this difference was not statistically significant. Davenport et al (2003) in his systematic review paper concluded that there is no high quality evidence for or against dental check ups. For this, further studies may need to be done to a certain whether there is a real positive relationship between the frequency of dental check ups and the treated and untreated dental disease burden of individuals. Variation between results may emanate from the fact that ‘routine dental check-up’ may not have been well defined, with different people giving different definitions. For instance, Faculty

of Dental Surgery, Royal college of Surgeons (1997) in the United Kingdom defines routine dental checks as the examination performed at the planned, unprecipitated return of a patient who was in good oral health in the last visit, while the National Health Services (NHS executive, 2001) of the United Kingdom defined routine dental check ups as 'clinical examination, advice, charting including monitoring of periodontal status and report'. This highlights the fact that some aspect of oral health education may compose dental check-ups in one set up, and not in another. OHE reinforcement at check ups may possibly influence oral health practices towards good dental plaque control.

5.2.6: Consumption of cariogenic diet

In this population, frequency of eating sweet snacks was found to be high, with 52.4% of the pupils eating snacks daily, amongst whom18.7% did so more than once daily. Only 28.5% of the pupils were found to eat sweet snacks once a week. Chi-square tests showed that the pupils' gender ($\chi^2 = 0.947$, df =3, p = .814) did not significantly influenced a pupil's odds of eating sweet snacks. Thus, pupils in the study were likely to have similar frequencies of eating these snacks regardless of whether they were boys or girls.

The finding that eating of sweet snacks by pupils in the study was often was supported by the answers received when pupils were asked the last time they had eaten a snack. Majority of them (n=599, 40.8%) had had a sweet snack the day before, whereas 19.9% and 25.1% had had a snack on the material day and three days previously, respectively. Only 14.2% (n=208) of the pupils had last done so more than three days previously.

A report by Kiwanuka et al (2006) who studied an urban population of 10-14 year olds in Uganda indicated that more girls than boys took sweetened snacks in a day, with the difference being statistically significant. A high percentage of the children took sweet snacks with 57% eating chocolate and 93% taking sweetened tea at least thrice a week. In Thai, Petersen et al (2011) also found that many 12-year old children consumed sugared diet on a daily basis with24% consuming soft drinks, 34% milk with sugar and 26% tea with sugar. Consumption of these sweetened foods was identified as one of the important predictors of high caries experience with girls being more affected. Gathecha et al (2011) showed that children who frequently consumed sweet snacks had significantly more caries than those who never did so.

Sucrose is a sweetener used in these snacks and plays a major role in development of cariogenic plaque. On its fermentation, acids that cause demineralization of hard tissues are formed and this leads to dental caries.

Dental caries develops following an inter-play between cariogenic diet made of fermentable carbohydrates, acidogenic bacteria, tooth surface and time. The fermentable dietary carbohydrates are the key controllable environmental factors involved in its initiation and development (Riva Tougher and Cor Van, 2003). However, among the carbohydrates, sucrose is considered the most cariogenic, because, in addition to being fermented by oral bacteria, it is a substrate for the synthesis of extracellular polysaccharides (EPS) and intracellular polysaccharides (IPS). EPS promotes changes in the composition of the biofilms' matrix and better adhesion of bacteria to the tooth surface. They also contribute to the structural integrity of the dental plaque formed (Peas L et al, 2006). Dental plaque formed in the presence of sucrose presents a low concentration of Calcium, phosphate and fluoride and this causes swifter demineralization of dental hard tissues, the process by

which cavities form in dental caries. Among the four factors of development of caries, withdrawal of one factor hinders development of this disease. The factor that can easily be manipulated is consumption of cariogenic diet (contained in the sweetened stack.

Exposure of dental hard tissues to this acidic environment, which is created by the interplay of the above factors causes demineralization. Though demineralization and re-mineralization occur concurrently, repeated demineralization (secondary to repeated exposure to cariogenic diet) leads to a net loss of ions and so development of dental caries. This understates the significance of frequent intake of sweetened snacks in development of dental plaque and dental caries as a disease. During oral health education sessions, pupils were informed that frequent consumption of sweet snacks led to development of dental caries, and this practice was discouraged.

5.3: BASELINE DENTAL PLAQUE LEVELS AND IMPACT OF ORAL HEALTH EDUCATION TO ORAL HEALTH KNOWLEDGE AND DENTAL PLAQUE

In this study, mean plaque score index was moderately high with intervention group scoring 2.46 and 2.43 for control group. This was scored using the Green and Vermillion Oral hygiene index - debris component. (Calculation of plaque score as per appendix).

At the beginning of this study, the intervention group had an oral health knowledge index of 41.84% while the control had 41.70% knowledge index. Plaque scores at beginning of the study were 2.46 ± 1.45 in the intervention group and 2.43 ± 1.52 in the control group. At baseline, both plaque score index and oral health knowledge index for intervention and control arms of the study had no statistically significant

difference.

Following oral health education in the intervention group and lapse of the intervention period for the control group, knowledge index improved to 71.44±23.49 and 61.28±23.96 in intervention and control groups respectively. The difference was statistically significant (p=0.001, adj t=3.184). Dental plaque index also reduced to 0.88±0.98 and to1.99±1.44 in intervention and control groups respectively. The difference in improvement was statistically significant (p=.001; t=3.43). Better improvement in male than female and (19.3% and 16.9% respectively) was noted. Several studies have been done to assess whether oral health education has any impact on oral health knowledge and dental plaque. D'Cruz and Aradhya in 2013 studied 13-15 year old children in Bangalore. They identified an intervention and a control group of children where oral health education was given to the intervention group for nine months, with no intervention to the control group. After the nine months, data collected showed marked improvement in oral health knowledge, practices and reduction in levels of dental plaque.

Yazdani et al (2009) who did a study in Tehran in Iran among adolescents reported similar results. He started with a population which 100% had dental plaque and 93% had gingivitis demonstrated by gingival bleeding from at least one site. Oral health education was given over 12 weeks and a re-evaluation done after this. Of these students, positive outcome of oral cleanliness was 58% (p<0.001) of students where education was conducted by use of leaflets and 37% (p=0.001) for those who were educated via video. In the control group, change was only 10%. Following a three month oral health education program 12-15 year old children attending government schools in Sanjauli (Bwardwaj et al, 2013), findings reported were that plaque

reduction from baseline to post intervention was significant ($p>0.05$). In his study, Biesbrock et al (2004) who carried out an examiner-blinded, four-week oral health intervention program among 6-15 year old children in Chicago USA, dental plaque scores were noted to reduce from 3.06 to 2.97. In the same population improvement in oral health knowledge from 37% to 69% was reported too. Similar results have been reported by Boa-Jun Tai et al (2009) in his three year-long intervention study in Yichang – China with statistically significant difference in plaque scores between baseline and post intervention data ($p<0.013$); and Irlane Alves et al (2009) who did a similar study over four months reported visible plaque scores improved ($P=0.014$; CI0.24-0.8) with knowledge improving too ($p=0.0001$:CI 3.73-26.81). Shenoy and Sequiera (2010) who investigated 12-13 year-old children reported a positive change in oral health knowledge, practices, oral hygiene status and gingival health of the children who were in the intervention arm of their study. Smyth et al (2007) studied Spanish children in Galicia and concluded that there is a positive association between improvement in oral health knowledge and better oral self-care practices among 12-year old children. However, in this study, oral health attitude was seen not to be explained by change in the level of knowledge.

Many studies indicate an increase in oral health knowledge and practices after oral health education. Improvement in gingival scores (bleeding) is also reported in most of these short-term studies. Most of them however give a report of no change in the caries index or attachment loss and development of periodontal pockets due to periodontal disease (Akithkrishnan et al, 2010). This can be explained by the fact that these diseases take a long period to develop and most of the studies are short term, and don’t give enough time to assess development of the two diseases or a noticeable change in the incidence.

In 2010, Ajithkrishnan in his three-month study in Gujarat state noted different results. The study was to evaluate the impact of OHE on plaque, gingival and caries status. In the study, 12 and 15 year old subjects were examined at baseline and after three months of oral health education where 20-minute sessions were given. Findings were recorded using Loe and Silness Plaque index, Loe and Silness Gingival Index and WHO modified DMFT index. Paired T-test was used to evaluate change between baseline data and after OHE, and significance level was set at $P<0.05$. A total of 372 children were examined. No significant reduction in mean plaque scores of 12-year old subjects between before and after OHE was noted. There was a significant reduction on plaque scores of the 15 year olds after the OHE. No significant reduction was noted in mean gingival scores of the 12 and 15-year old subjects at the baseline and after OHE. There was also no difference in mean caries status for both groups before and after OHE. However, in this study, only one 20-minute oral health education session is cited to have been given. Information on practical demonstration on oral self-care practices is not stated. An oral health education program for a longer period of time may possibly show different results. Helderman et al (1997) used teachers to supervise tooth brushing once a week in intervention schools after sessions of oral health education were given to pupils in the intervention arm of their study. They reported no significant difference in mean plaque scores, gingival bleeding scores and calculus scores after 3, 8, 15 and 36 months between intervention and control groups in this population of 9-13 year old Tanzanian school children. Francken et al (2001) conducted OHE workshop for teachers. These were used to train pupils in their schools intervention schools while teachers who did not attend the training were used on control schools. 3.5 years down the line, no significant difference was found on plaque score index and caries incidence in these schools.

The frequency of oral health education, the frequency and mode of education seem to have an impact on the results after an OHE program is conducted.

Long-term intervention studies have revealed a positive change on oral hygiene and oral health. A six-year study on a health care program among elderly residents of a nursing home in Bergen, Norway revealed improvement on oral hygiene with 36% of the population having an acceptable OH at the beginning of the study and rising to 70% of this population (Samson et al, 2009). In his 3-year long study among children, their mothers and teachers in Wuhan city in China, Petersen et al (2004) reported reduction in gingival bleeding scores (an indication of reduction of dental plaque), positive change in oral self-care habits and increase in oral health knowledge indices. In Brazil, Mayer et al (2003) grouped 13-16 year old school children into intervention and control groups. On a 3-year oral health education intervention program, the intervention group had better knowledge and self-care practices. On the lapse of 5 years, these parameters were again assessed. Knowledge still remained high, but difference in behavior was not statistically significant.

In Belgium, the effect of a six-year oral health education program was evaluated in primary schools (Vonobbergen et al, 2004). This program consisted of annual 1-hour instructions for children and teachers. The authors found that the program did not result in significant reduction in the caries prevalence; however, it has been effective in improving some of the children's reported oral health behavior. This highlights the importance of the frequency of oral health education sessions

This shows that possibly repeated and long-term reinforcement in oral health education may bring better results in reduction of behavior related oral health diseases that are caused by poor plaque control. A continuous school-based oral health education program may be of more significance than short-term interventions.

The long-term effect of plaque control program on tooth morbidity and mortality is buttressed by a long-term study done by Axelsson et al, which was published in 2004. The aim was to monitor the incidence of tooth loss, caries and attachment loss during a 30-year period in a group of adults who maintained a carefully managed plaque control program, and were compared with pears who were not in the program between 1972 and 2002. Among the 550 subjects studied, 375 completed the study in intervention arm and 180 in control. Baseline statistics of caries, plaque, probing pocket depth and probing attachment level were recorded. Detailed OHE was given to each participant in intervention group. Follow up was done at 3,6,15 and 30 years. Findings were that only 21 teeth were lost due to progressive periodontitis or caries in the whole of the intervention group within the 30 years of study. Caries incidence was also reported to be low, with most lesions classified as recurrent caries. Most sites exhibited no attachment loss, and in fact attachment gain in approximal surfaces was noted in the 30-year period.

5.4: CONCLUSION

In this population, oral health knowledge is generally low. The plaque score index is moderately high. This is across the board and there are no major difference in oral health knowledge and dental plaque, in relation to gender or school location. This level of oral health knowledge may not be sufficient to mount proper practices that may lead to control of development of dental caries and periodontal disease, which are caused by accumulation of dental plaque and frequent intake of cariogenic diet.

Reminder to brush teeth is mainly from home (parents). This suggests a channel for development of proper oral health habits where parents can be involved in monitoring their children’s oral health practices.

Following oral health education, there is a marked reduction on dental plaque. This implies that OHE programs in this age and population may be used as a long-term tool to bring down oral disease burden in future.

5.5: RECOMMENDATIONS

1. Introduction of a school-based oral health education programs to improve oral health knowledge among children and also help them develop the right skills and attitudes towards oral self-care practices. This can be done through government policy and ministry of education in the country.
2. Involve parents in development and monitoring of children's oral health self-care practices and empowerment of teachers to participate in the same. This can be done by making parents part of the school-based OHE programs so they get to know what is expected of the children and are informed of what role to play.
3. A long-term study to assess impact of oral health education on the incidence of periodontal disease and dental caries in this set-up.

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APPENDIX

APPENDIX 1

ELDORET MUNICIPAL COUNCIL
EDUCATION DEPARTMENT
PUBLIC SCHOOLS 2013
PUPILS ENROLMENT STD SIX

S/NO	SCHOOL	STD 6		
		BOYS	GIRLS	TOTAL
01	ELDORET UNION	123	123	246
02	ST. PATRICK'S	60	64	124
03	TOWNSHIP	60	57	117
04	UASIN GISHU	111	135	246
05	SOSIANI	48	67	115
06	KAPSOYA	48	56	104
07	CENTRAL	49	53	102
08	G.K. PRISON	68	54	122
09	ST. MARY'S	81	87	168
10	KIMALEL	80	58	138
11	ATNAS KANDIE	150	145	295
12	KIDIWA	36	48	84
13	KIPKAREN	76	63	139
14	HURUMA	81	98	179
15	RACECOURSE	114	125	239
16	KAPYEMIT	79	82	161
17	KIPKENYO	28	23	51
18	KIMUMU	47	53	100
19	LANGAS	137	124	261
20	KAPCHUMBA	50	44	94
21	KAPSAOS	28	31	59
22	KAMUKUNJI	62	55	117
23	KAPKEBEN	29	27	56
24	MOI CHEPKOILEL	66	62	128
25	BORDER FARM	68	68	136
26	MWIRUTI	23	30	53
27	TUIYOBEI	33	32	65
28	ILLULA	26	23	49
29	SAROIYOT	25	33	58
30	MUNYAKA	81	84	165
31	KAPKOROS	25	55	80
32	EMKOIN	35	36	71
33	KAPKENDUIYWO	51	59	110
34	AINABTICH	38	24	62
35	GITWE	17	21	38
36	OASIS	5	9	14
37	GREEN FIELD	17	14	31
38	ST MARY'S	17	30	47

	CHEBARUS			
39	MOI MARULA	45	36	81
40	ELDORET CHEBARUS	23	22	45
41	KIPTANUI	32	36	68
TOTAL		**2272**	**2346**	**4681**

APPENDIX 2:

QUESTIONNAIRE ON ORAL HEALTH KNOWLEDGE
NAME OF SCHOOL.....
CODE NO. OF PUPIL: ..... DATE OF BIRTH.....

1. What are the two most common diseases of the mouth?

    a. Gum disease (periodontal disease)
    b. Cavities on teeth (dental caries)
    c. Ulcers in the mouth
    d. I don't know

2. What causes gum disease

    a. Failure to brush teeth
    b. Accumulation of dental plaque on teeth
    c. Poor oral hygiene habits
    d. I don't know

3. What are signs of gum disease?

    a. Bleeding gums
    b. Reddish swollen gums
    c. Foul smell from the mouth
    d. Shaky teeth that easily fall
    e. I don't know.

4. How do we prevent gum disease?

    a. Brushing our teeth regularly
    b. Visiting the dentist for a dental check up regularly
    c. Using a mouth wash to keep our mouths clean
    d. I don't know

5. What causes dental caries

    a. Lack of regular brushing
    b. Eating too many sweet foods
    c. Poor brushing technique
    d. I don't know

6. What are the signs of dental caries?

    a. Sensitivity when eating hot, cold or sweet foods
    b. Pain from teeth
    c. Holes on teeth
    d. I don't know

7. How can dental caries be prevented?

    a. Brushing regularly
    b. Reducing intake of sweet foods

c. Visiting the dentist regularly for check –ups
d. I don't know

8. When should you visit the dentist?

a. For a check up once a year
b. For a check twice a year
c. When my teeth ache only
d. I don't know.

9. When a tooth aches,

a. One should swallow a pain killer and the pain will stop
b. One should take some herbal medicine and pain will stop
c. One should go to the dentist to have that tooth removed

One should go to see the dentist for the dentist to establish the course of the pain and administer the necessary treatment.

Appendix 3:

QUESTIONNAIRE ON ORAL HEALTH PRACTICES

NAME OF SCHOOL:.....CODE NO. OF PUPIL: ..... DATE OF BIRTH.....

1. How often do you brush your teeth
    a. Once a day
    b. More than once a day
    c. Once a week
    d. Never
2. When do you brush your teeth
    a. After breakfast only
    b. After supper only
    c. After breakfast and after supper
    d. Before breakfast only
    e. Never
3. What form of brush do you use?
    a. Conventional brush
    b. Chewing stick
    c. Charcoal
    d. Others (specify) . . . . . .
4. How often do you change your tooth brush
    a. After three months
    b. After six months
    c. After a year
    d. Never
5. How often do you use toothpaste?
    a. Every time that I brush
    b. Once a week
    c. Whenever it is available
    d. Never
6. Why do you brush your teeth?
    a. To avoid bad breathe
    b. To protect myself from having cavities
    c. To prevent my gums from bleeding
    d. To avoid going to see the dentist who will inject me and extract my teeth
7. Who reminds you to brush your teeth?
    a. My parents
    b. My teacher
    c. A television advertisement
    d. Nobody

8. If you don't brush your teeth, why don't you do it
    a. I don't have a tooth brush
    b. I don't have tooth paste
    c. My gums bleed/hurt when I brush
    d. Other reasons (specify) . . . . . .
9. Have you ever visited the dentist?

    a. Yes
    b. No
10. If Yes, How frequent do you visit the dentist

    a. Once a year for dental check-up
    b. Twice a year for dental check-up
    c. When I'm in pain
    d. Never
11. How frequently do you eat sweet snacks (biscuits, sweets, chocolate, chewing-gum)?

    a. More than once a day
    b. Once a day
    c. Once a week
    d. Thrice a week

11. When did you last eat a sweet snack?
    a) Today
    b) Yesterday
    c) Three days ago
    d) More than three days ago Appendix 4: DENTAL PLAQUE SCORE FORM

APPENDIX 4: CLINICAL DATA COLLECTION FORM

NAME OF SCHOOL: .....
PUPIL'S INDEX NO: ..... DATE OF BIRTH:.....

	RIGHT		**ANTERIOR**		**POSTERIOR**		**TOTAL**	
	Buccal	**Lingual**	**Labial**	**Lingual**	**Buccal**	**Lingual**	**Buccal**	**Lingual**
UPPER								
LOWER								
TOTAL								

(Scored teeth: Upper: 16, 11, 26. Lower: 46, 31, 36)

Criteria for classifying debris

Scores	**Criteria**
0	No debris or stain present
1	Soft debris covering not more than one third of the tooth surface, or presence of extrinsic stains without other debris regardless of surface area covered
2	Soft debris covering more than one third, but not more than two thirds, of the exposed tooth surface.
3	Soft debris covering more than two thirds of the exposed tooth surface.

DI=(Total no of upper and lower buccal surfaces) + (Total no of upper and lower lingual surfaces) /Number of segments scored (6) = ...

(Green and Vermillion1960 – Oral Hygiene Index – Debris component)

Appendix 5:

RESPONDENT INFORMATION SHEET

Evangeline Mwikali Kyende is a postgraduate student at Moi University Eldoret. She is conducting a study to establish the impact of oral health education on dental plaque among 11-12 year old children in public primary schools within the Eldoret Municipality.

In this study, the pupils will be asked questions to determine their oral health knowledge and their oral health care practices. An examination of their teeth will also be done to establish their oral hygiene. Education on how to take good care of their teeth will also be given in the course of this study.

Information given by the pupils will be kept confidentially; code numbers instead of names will be used to identify the participants. Participation will be voluntary and one will be free to withdraw from the study at any stage. There will be no penalty for withdrawal.

Further information on this study will freely be available from the IREC office, which is located on the second floor MTRH main block. Parents and guardians of participating pupils are free to contact this office for any clarification about the study.

Evangeline Mwikali Kyende

CONSENT

INVESTIGATOR: **Evangeline Mwikali Kyende**
ADDRESS: **School of Public Health**
MOI UNIVERSITY
ELDORET – KENYA

PURPOSE OF THE STUDY:

The purpose of this study is to determine the impact of oral health education on oral hygiene of 11-12 year old public school children in Eldoret Municipality Uasin-Gishu County. The study findings will generate data, which will help stakeholders in decision-making at development of intervention policies in fighting dental diseases among these children.

I understand the purpose of this study and authorize my child to participate in it.

Parent's signature..... ..... Date: .....

Appendix 6:

CLASSIFICATION OF SCHOOLS IN TO ZONES

KIBULGEN ZONE

1. Eldoret Union
2. St Patrick's Primary School
3. Township Primary School
4. St Mary's Primary
5. Kidiwa
6. Kapchumba
7. Kamukunju
8. Kapkeben
9. Kiptanui
10. Green Field

KABIYEMIT ZONE

1. Uasin-Gishu Primary School
2. Atnas Kandie
3. Huruma
4. Kapiyemit
5. Kapsaos
6. Kapkoros
7. Emkoin

PIONEER ZONE

1. Sosiani Primary School
2. Kipkaren
3. Kimalel Primary
4. Racecourse
5. Kipkenyo
6. Langas
7. Mwiruti
8. Tuiyobei
9. Kapkenduiywo
10. Gitwe
11. St Mary's Chebarus
12. Oasis

KAPSOYA ZONE

1. Kapsoya Primary
2. Border farm
3. Ilula
4. Saroiyot
5. Munyaka

CHEPKOILEL ZONE

1. Central Primary
2. G.K. Prisons
3. Kimumu
4. Moi Marura
4. Moi Chepkoilel
5. Ainabtich
6. Eldoret Chebarus

(NB: Appendix 4 and 5: Information obtained from Ministry of Education – Eldoret Municipality Office).

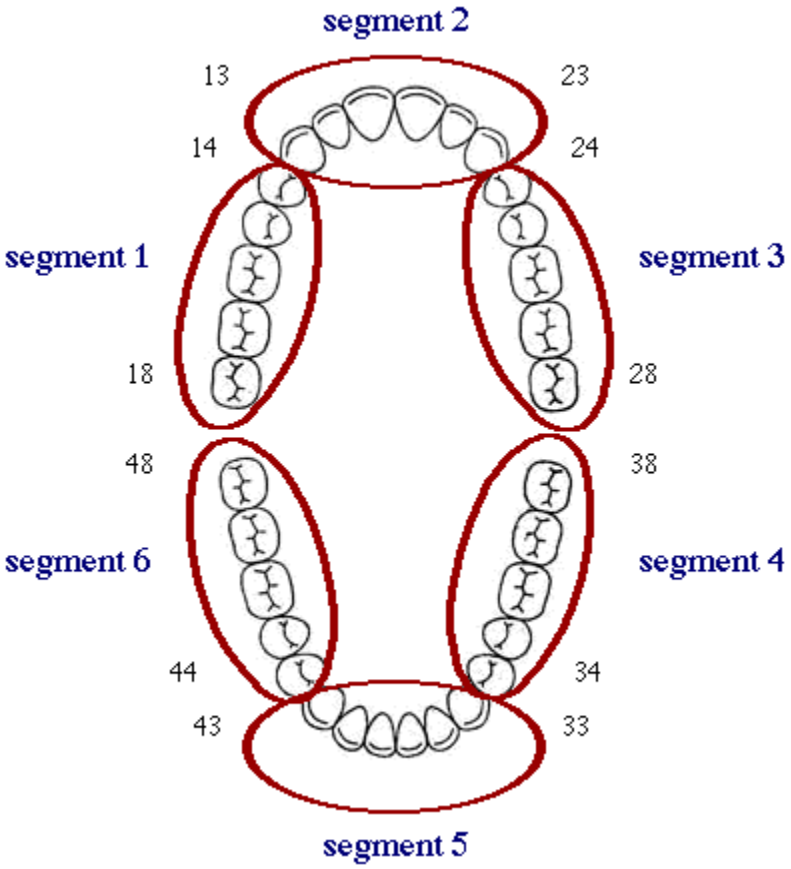
Appendix 7:

Oral Hygiene Index -(Greene and Vermillion, 1960)

DEBRI INDEX COMPONENT

The Oral Hygiene Index – Debri component is based on 12 numerical determinations representing the amount of debris found on the buccal and lingual surfaces of three segments of each dental arch, namely:

1. The segment distal to the right cuspid (see picture).
2. The segment distal to the left cuspid. 3. The segment mesial to the right and left first bicuspids.

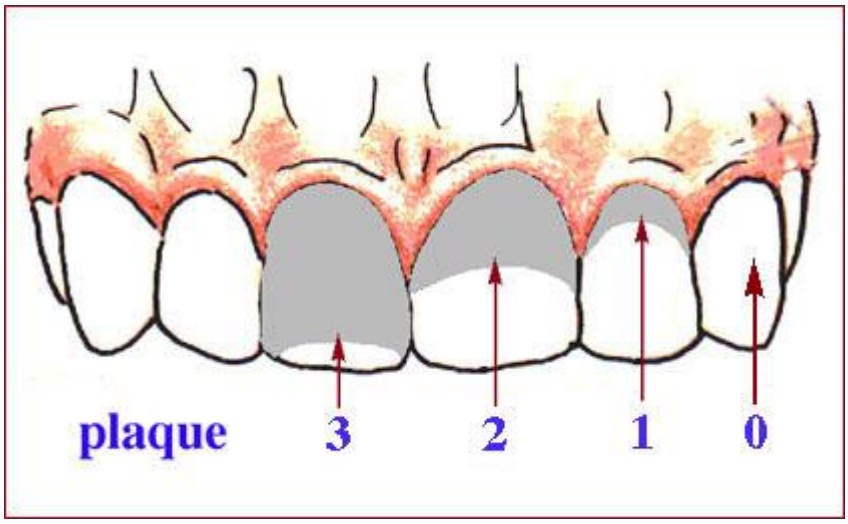


The Maxillary and the Mandibular arches are each composed of three segments (these are illustrated above).

Each segment is examined for debris. From each segment one tooth is used for calculating the individual index, for that particular segment. The tooth used for the calculation must have the greatest area covered by either debris or calculus.

Criteria for classifying debris

Scores	Criteria
0	No debris or stain present
1	Soft debris covering not more than one third of the tooth surface, or presence of extrinsic stains without other debris regardless of surface area covered
2	Soft debris covering more than one third, but not more than two thirds, of the exposed tooth surface.
3	Soft debris covering more than two thirds of the exposed tooth surface.



CALCULATION EXAMPLE:

After the scores for debris are recorded, the Index values are calculated. For each individual, the debris scores are totalled and divided by the number of segments scored.

The following example shows how to calculate the indices. The scores for debris should be tabulated separately and indexes for each calculated independently, but in the same manner.

Debris

	Right		**Anterior**		**Left**		**Total**	
	Buccal	Lingual	Labial	Lingual	Buccal	Lingual	Buccal/Labial	Lingual
Upper	3	1	2	2	3	1	8	4
Lower	2	2	1	1	1	2	4	5
Total	**5**	**3**	**3**	**3**	**4**	**3**	**12**	**9**

Debris Index = (The total of the upper and lower buccal-scores) **+** (The total of the upper and lower lingual-scores) **/**(The number of segments scored).

Debris Index = (12+9) / 6= 3.5

(Adopted from:

WHO Oral Health Country/Area Profile Programme
WHO Headquarters Geneva, Oral Health Programme (NPH)
WHO Collaborating Centre, Malmö University, Sweden