

**University of Pretoria, Faculty of Health Sciences**

**School of Dentistry**

**THE EFFECTIVENESS OF A TOOTH BRUSHING PROGRAMME FOR CHILDREN IN  
THE EHLANZENI DISTRICT, MPUMALANGA AND THE RELATIONSHIP BETWEEN  
BODY MASS INDEX (BMI) AND ODONTOGENIC INFECTIONS.**

**Degree: MSc (Community Dentistry)**

**Student:** M van der Walt 95029177

**Contact Details:**

PO Box 12542

Nelspruit, 1200

Tel: 082 302 1011

**E-mail:** mariusenliezl@hotmail.com

**Supervisor:**

Prof PJ van Wyk

Flip.vanwyk@up.ac.za

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## **DECLARATION**

I, Marius van der Walt, hereby declare that this dissertation entitled “The effectiveness of a tooth brushing programme for children in the Ehlanzeni District, Mpumalanga and the relationship between body mass index (BMI) and odontogenic infections” was undertaken by myself. All the resource material used and or quoted have been acknowledged.

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Marius van der Walt

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Date

## **DEDICATION**

This dissertation is dedicated to all the oral health care professionals actively working in schools, those of us who are dedicated and committed in making a difference in children's lives. I sincerely hope that this study will motivate you in continuing the hard work and endure the many frustrations that go hand in hand with implementing and monitoring brushing programs. If you are fed up of motivating teachers, begging for funding, running around organising transport and trying to convince managers that preventative dentistry is also important, just remember, it is all worth it. Your hard work really makes a difference in children's lives!

I would also like to dedicate it to all the children, teachers and principals that were part of this study. Without your dedication to the project, the results we achieved would not have been possible. You touched my heart in so many ways during the three years of the study. Thank you for allowing me into your schools and into your hearts.

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## **LIST OF ABBREVIATIONS**

BMI: body mass index

CI: confidence interval

CPI: community periodontal index

DMFS: decayed, missing, filled surfaces (permanent dentition)

dmfs: decayed, missing, filled surfaces (primary dentition)

DMFT: decayed, missing, filled teeth (permanent dentition)

dmft: decayed, missing, filled teeth (primary dentition)

ECC: early childhood caries

FDI: World Dental Association

IADR: International Association of Dental Research

OR: odds ratio

PUFA: pulp, ulceration, fistula, abscess (permanent dentition)

pufa: pulp, ulceration, fistula, abscess (primary dentition)

SD: standard deviation

UK: United Kingdom

UP: University of Pretoria

UTN: unmet treatment need index

WHO: World Health Organisation

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## **ABSTRACT**

### **1. Introduction**

Dental caries is the most frequently occurring non-communicable disease world-wide and the most common disease found in children. Although dental caries in South Africa reduced significantly during the last 3 decades, the high levels of untreated caries in all age groups is an alarming cause for concern. Experts are of the opinion that the dramatic decline in caries is mostly due to the use of fluoride toothpaste. Whilst water fluoridation had been proven as effective in reducing caries prevalence and severity and promoted as a major public health intervention by the World Health Organisation (WHO), no water fluoridation schemes exist in South Africa.

There is little evidence that caries in South African children is addressed adequately through policy and service provision efforts. Due to persistent oral health inequalities in access to care the South African public sector is under constant strain to deliver equitable, cost effective primary oral preventive services.

As children spend a considerable proportion of their lives in education, schools can play a significant role in promoting children's health and oral health. Although several studies indicated that caries prevalence and severity can be reduced by brushing programmes, very little is known on the effectiveness of such interventions in the South African public school set up.

Odontogenic infections may influence the ability of a child to ingest food which in turn could have a negative impact on the development of the child. Despite the pandemic character of dental decay, particularly in children, there are only a few studies that have examined the relationship between the severity of dental decay and the Body Mass Index (BMI).

Rob Ferreira Hospital, Dental Department, under supervision of the author of this dissertation, introduced the Colgate Bright Smile Bright Future tooth brushing programme in low socio-economic areas in the Ehlanzeni district of Mpumalanga for children in Grades R to three in June 2012. Teachers supervised children that participated in the programme to ensure they brushed daily at school according to the prescribed methods.

This provided an ideal opportunity to evaluate the effectiveness of a three year tooth brushing programme in primary schools (community trial) in a South African public school setup and to evaluate the relationship between odontogenic infections and BMI of the children.

## **2. Objective**

The purpose of the study was to evaluate the effectiveness of the tooth brushing programme in a community trial in the Ehlanzeni district of Mpumalanga. The idea was to evaluate the impact of this programme on dental caries by comparing the caries status of children who took part in a brushing programme since 2012, with the caries status of a comparable group of children from the same district who did not take part in the brushing programme, in the three years prior to the survey. The purpose of the second part of the study was to investigate the relationship between odontogenic infections and BMI of eight to ten year old children.

## **3. Study methodology**

Two samples of 250 children each, in the age group eight to ten years old, were randomly selected from children in Grade three. The first sample was drawn from children who took part in the brushing project and only the six schools that were part of the brushing project since the commencement of the project in 2012, were included. The second sample was drawn from children in six schools, in the same district, who did not participate in the brushing programme, but who were in the proximity of the intervention schools.

DMFT/dmft index was used to measure caries experience and PUFA/pufa index used to measure odontogenic infections due to untreated dental caries according to standard procedures. Anthropometric measurements were performed and this information was used to compute the BMI.

PUFA outcome was assessed using logistic regression while the data analysis for the evaluation of the effectiveness of tooth brushing compared intervention *versus* non-intervention groups using independent samples T-tests.

#### **4. Results**

Two hundred and fifty children were examined in both the intervention and control groups. Mean ages of 111.62 (SD: 8.24) and 111.97 (SD: 8.18) months were, respectively, recorded for the two groups.

The results of the study show that the prevalence of dental caries (primary and permanent teeth) in the intervention group was 57.2% and in the control group it was 74.8%. The severity of dental caries expressed as the mean DMFT and the mean dmft in the intervention group was 0.15 (SD: 0.48) and 1.82 (SD: 2.28), respectively. In the control group the corresponding figures were 0.38 (SD: 0.92) and 2.50 (SD: 2.31), respectively. Of the children in the intervention group, 22% presented with odontogenic infections (mean PUFA/pufa score 0.40 with SD of 0.92) compared to 36% of children in the control group (mean PUFA/pufa score 0.82 with SD of 1.38). P-values for the comparisons between the groups were significant ( $p < 0.05$ ).

The results of the study show a difference of 30.8% and 63.6% in the prevalence of dental caries and odontogenic infections for the intervention and control groups, respectively.

The odds ratios (OR) obtained from logistic regression model with low BMI as the dependent variable show that children with odontogenic infections (PUFA+pufa  $> 1$ ) and dental caries (DMFT+dmft  $> 0$ ) as compared to those without odontogenic infections and caries do not have a statistically significant increased likelihood of below normal BMI (OR:1.12 and 1.03, respectively) ( $p > 0.05$ ).

#### **5. Conclusion**

This study showed that teacher supervised tooth brushing programmes implemented and closely monitored by oral health professionals, can be very effective in the South African public school set-up with significant differences noticed in caries and odontogenic infection prevalence and severity between the control and intervention groups. Significantly less caries and odontogenic infections were recorded in the intervention than in the control group.

## **CHAPTER 1: INTRODUCTION**

### **1.1 Background**

Dental caries and gingivitis are the most common oral diseases among children with 60-90% of children being affected globally as indicated in a 2003 World Health Organisation (WHO) report.<sup>1</sup> The results of the last National Children's Oral Health Survey that was conducted in South Africa between 1999 and 2002 indicated that 39.7% of the 6-year-old children were caries free, which was still below the goal of 50% set by the Department of Health and the WHO for the year 2000.<sup>2,3</sup> The National Children's Oral Health Survey was conducted more than a decade ago, but still relevant with no recent data available.

Dental caries is a progressive disease and if left untreated can negatively affect children's quality of life. Pain resulting from decayed teeth can compromise learners' concentration and participation in school, hampering their development and denying them the full benefit of schooling.<sup>4</sup>

Although dental caries in South Africa reduced significantly during the last 3 decades as indicated in data obtained from the National Oral Health surveys, the high levels of untreated caries in all age groups is an alarming cause for concern.<sup>5,6</sup> It has been shown in these studies that more than 80% of caries in children has been left untreated according to the Unmet Treatment Need Index (UTN).<sup>3</sup> The UTN is expressed as a percentage and calculated by dividing the decayed component of the permanent and primary teeth D(d) by the DMFT(dmft). The DMFT Index is used to express the level of severity of dental caries in the permanent dentition of an individual and is expressed as the total number of teeth that are decayed (D), missing (M) or filled (F). The dmft Index is used to express the level of severity of dental caries in the primary dentition of a child and is expressed as the total number of teeth that are decayed (d), missing (m) and filled (f).

The WHO Oral Health Programme emphasises the importance of public health approaches for the prevention of dental caries through the effective use of fluorides that includes implementation of water fluoridation.<sup>7</sup> Fluoridated drinking water is shown to be the most common method for systemically applied fluoride and to be effective in reducing

the severity of dental decay in entire populations.<sup>8</sup> Up to date water, fluoridation had not been implemented in South Africa with the local authorities expressing concern regarding cost of implementation and effectiveness of such an intervention in the past.<sup>9</sup> A study conducted in 2012, concluded in that it is still a viable option to implement water fluoridation in South Africa to prevent and reduce the prevalence of dental caries.<sup>9</sup>

There is a global consensus that regular use of fluoride toothpaste is critical in child dental health. Most experts are of the opinion that the dramatic decline in caries during the last decade of the 20<sup>th</sup> century is due to the use of fluoride toothpaste.<sup>10</sup> Health promotion programs that involved tooth brushing have been among the most successful educational programs in caries prevention.<sup>11,12</sup> Cross-sectional surveys, clinical trials, and experiments related to tooth brushing research studies involving populations of 1450–1545 children have found that tooth brushing twice a day resulted in increased tooth retention.<sup>11</sup>

## **1.2 Problem statement**

South Africa is unique as its health care system needs to provide services to a wide spectrum of the population that ranges from poor historically disadvantaged groups to sections of the population with a high socio-economic status.<sup>13</sup> There is little evidence that caries in children is addressed adequately through policy and service provision efforts.<sup>14</sup> Due to persistent oral health inequalities in access to care the public sector is under constant strain to deliver equitable, cost-effective primary oral preventive services.<sup>15</sup>

Prevention through the use of fluoride is suggested to be the most cost-effective way of reducing this public health burden.<sup>16</sup> In the absence of water fluoridation schemes in South Africa, the introduction of tooth brushing programmes, with fluoridated toothpaste in schools located in low socio-economic neighbourhoods could be a realistic way in preventing the high level of untreated dental caries. Although several studies indicated that caries prevalence and severity can be reduced by brushing programmes, very little

is known on the effectiveness of such an intervention in the South African public school set up.

Rob Ferreira Hospital Dental Department, under supervision of the author of this dissertation, introduced the Colgate Bright Smile Bright Future tooth brushing programme in low socio-economic areas in the Ehlanzeni district of Mpumalanga for children in Grades R to three in June 2012. This provided an ideal opportunity to evaluate the effectiveness of a tooth brushing programme in primary schools (community trial) in a South African public school setup. Children were provided with toothbrushes and toothpaste. They were allowed to brush their teeth once a day, after break, during the school week under supervision of a teacher. Due to a lack of oral health human resources, the supervising oral health professional only visited the school on a 4 to 6 weekly basis. The execution of the tooth brushing programme was therefore not entirely under the control of an oral health professional.

This study also provided the researchers with an opportunity to evaluate the relationship between infections in the mouth due to untreated dental decay (odontogenic infections) and the physical development of children by calculating the body mass index (BMI) of each participant. Odontogenic infections in the context of this study include abscesses, draining fistulas, necrotic tooth pulps or ulcerations of oral mucosa due to root fragments. Odontogenic infections may influence the ability of a child to ingest food which could have a negative impact on the development of the child. Despite the pandemic character of dental decay, particularly in children, there are only a few studies that have examined the relationship between the severity of dental decay and the BMI.

### **1.3 Reference method**

The Vancouver referencing method is used in this dissertation.

### **1.4 Study outline**

The following structure will be followed in the exposition of the dissertation:

**Chapter 2** reviews the published literature on dental caries and its trends and the evidence related to the effectiveness of tooth brushing programmes with fluoridated toothpaste at schools. This chapter concludes with a brief overview of the literature on odontogenic infections and the physical development of a child.

In **Chapter 3**, a detailed explanation of the implementation and the execution of the tooth brushing programme is provided.

The aim and objectives of the study are stipulated in **Chapter 4**. The important indicators used in this dissertation to evaluate the effectiveness of the tooth brushing programme are provided here.

**Chapter 5** focuses on the study methodology that was used to achieve the objectives of the study. In this chapter the sampling technique, the staff involved and their training, the indices employed, ethical considerations and data analysis are addressed.

The results obtained are reported in **Chapter 6**. The chapter highlights the reliability of the data and the most important findings of the study.

In **Chapters 7 and 8**, the results are discussed and conclusions are drawn. Finally recommendations are made based upon the results obtained in this study.

## **CHAPTER 2: LITERATURE REVIEW**

### **2.1 Dental caries and its trends**

Dental caries is the most frequently occurring, non-communicable disease world-wide and the most common disease found in children.<sup>1</sup> Edelstein described dental caries as pandemic as it is a global disease that could affect all people with severe consequences: pain, dysfunction, negative impact on eating, sleeping, speaking, being productive and enjoy general health.<sup>17</sup>

Dental caries is a multi-factorial disease with patterns related to biological mechanisms, population risks that involve social determinants inclusive of financial status and education. Behavioral and demographic factors, environmental conditions and the accessibility of fluoride at community or individual level all have an impact on the disease.<sup>1,18</sup> The high consumption of sugar-sweetened drinks and the lack of regular tooth brushing are found to be the key factors strongly linked to dental caries, especially among primary-aged school children<sup>19</sup>.

The WHO observed that caries experience is higher in developed countries compared to developing countries. Although the disease level is classified as relatively low in Africa it is expected to increase in many developing African countries due to changing living conditions that includes increasing consumption of sugars and inadequate fluoride exposure.<sup>1</sup>

Dental caries rates have declined worldwide in the past century<sup>4</sup> and this trend was also observed in South Africa when analysing data obtained from the last three national oral health surveys that were conducted in 1982, 1988/89 and 1999/2002<sup>5</sup>. These studies were conducted more than a decade ago but no new national surveys were conducted during the past 15 years and therefore no new national data are available. The prevalence of caries among 12 year olds decreased substantially from 64.4% in 1982 to 41.7% in 1999/2002, while the DMFT also decrease significantly from 2.52 in 1982 to 1.17 in 1999/2002. A larger reduction in DMFT was observed among Whites (75.3%) compared to Asians (64.1%), Blacks (49.8%) and Coloureds (44.8%). Caries were reported to be

more prevalent and severe in coastal areas than interior regions of the country. Children living in urban areas had slightly higher rates of dental caries. Alarming high levels of untreated caries and low levels of treatment were noticed with the unmet treatment need in 12 and 15 year olds increasing and more than 70% of caries in 6-, 12- and 15-year old children reported as untreated.<sup>5</sup>

The most recent conducted (1999-2002) children's oral health survey in South Africa indicated that 39.7% of 6 year old children were caries free, which was still below the 50% target set by the Department of Health and the WHO for the year 2000. The DMFT of 12 year-old children was 1.1 which was below the target of 1.5 as set by the Department of Health. Based on the Unmet Treatment Need index more than 80% of caries in children were untreated. The greatest need for dental caries treatment among children in South African was for preventive services, restorations and extractions. The need of treatment varied between the age groups, with younger children needing more conservative care and extractions compared to older children. In all the age groups the need for restorations was higher than the need for extractions.<sup>3</sup> Negligible levels of filled teeth were recorded in all age groups. This might be due to the inadequacy of resources such as oral health personnel and dental facilities as well as lack of awareness about oral health amongst the population.<sup>3</sup>

## **2.2 Role of fluoride**

The benefits of fluoride in caries prevention had been justified by researchers. It is achieved in at least 3 ways; remineralization of early damage to enamel caused by acid produced by the plaque bacteria, improving the chemical structure of enamel and therefore making it more resistant to acid and reducing the ability of plaque bacteria to produce acid.<sup>20</sup>

Peterson and Phantumvanit (2012) report that fluoride action is predominantly post-eruptive with fluoride in the oral fluids interchanging with soft tissue, hard tissue and dental plaque. The method of delivery can be either self-applied by the individual, professionally administered or community-based fluoridation. Self-administered fluoride includes mouth

rinses and fluoride toothpastes. Professional administration of fluoride is conducted through the use of topical fluorides in the form of gels or varnishes. Three types of delivery had been used through community approaches that included, water, salt or milk.<sup>16</sup>

The worldwide decline in dental caries is partly attributed to the availability of fluoride toothpaste<sup>10,19</sup> and is the most widely used form of fluoride delivery<sup>21</sup>. Toothpastes must have sufficient fluoride content to be effective. A systematic review of seven randomised controlled trials comparing low fluoride toothpastes (containing 600 ppm F or less) with high fluoride toothpastes (containing 1,000 ppm or more) in children or adults showed that 250 ppm fluoride dentifrice was not as effective in caries prevention in the permanent dentition as a toothpastes containing 1,000 ppm F or more.<sup>22</sup>

The WHO emphasised the importance of public health approaches to the effective use of fluorides for the prevention of caries. People should be encouraged to brush twice daily with fluoride toothpaste and where the incidence and prevalence of caries in the community is moderate to high or where it is increasing an additional source of fluoride should be considered in the form of water, milk or salt.<sup>7</sup>

A report by the Medical Research Council in the United Kingdom stated that water fluoridation was effective in reducing dental caries, and that the reduction in dental caries experience had been greater in those areas with higher levels of dental caries prior to water fluoridation. The change in the prevalence of dental caries was an estimated 15% increase in the proportion of caries free subjects. It also stated that water fluoridation reduced the incidence of caries in children age 5-14 by an average of 2.3 dmft/DMFT.<sup>23</sup>

Water fluoridation had been proven to have additional benefits to those associated with the use of fluoride toothpastes alone. There is also no credible evidence that water fluoridation is associated with any adverse health effects except for an increased risk of unaesthetic dental fluorosis by an average of 13%.<sup>24</sup> It had been suggested that

preventing dental caries is likely to be far more beneficial than the possibility of a minor cosmetic side effect of mild fluorosis.<sup>25</sup>

Whilst water fluoridation had been proven as effective and is promoted as a major public health intervention by the WHO, no water fluoridation scheme for the prevention of dental caries exist in South Africa.<sup>9</sup> In September 2000 the Minister of Health approved regulations which compelled every water supplier in South Africa to initiate water fluoridation unless exempted thereof.<sup>26</sup> A new Health Act approved in 2003, however necessitated an amendment to the regulations on fluoridating water supplies. These amendments are yet to be finalised and approved.<sup>27</sup>

The WHO Oral Health Expert Committee on Oral Health Status and Fluoride Use recommended that where a country has a moderate level of economic and technical development, a municipal water supply reaching a large population, trained water engineers and favorable public opinion, water fluoridation using fluoride at a concentration of 0.5-1 mg/l is the method of choice in addition to daily brushing.<sup>7</sup> Kroon and Van Wyk conducted a study in 2012 and concluded that it's still a viable option to implement water fluoridation in South Africa to prevent and reduce the prevalence of dental caries. A model based on a cost evaluation of 44 communities in Florida, United States of America and applied to South Africa was used as the basis of their study.<sup>9</sup>

It should be emphasised that toothpaste can also have a systemic effect when ingested. It is recommended that dental fluorosis be monitored periodically to detect increases in levels of fluorosis especially in areas with a high fluoride level in the drinking water.<sup>7</sup> Government should also consider removing taxation on toothpaste to make it more affordable for citizens and encourage daily tooth brushing among high risk groups as advised by the WHO, FDI (World Dental Association) and IADR (International Association of Dental Research).<sup>28</sup>

### **2.3 Role of schools**

Schools are considered as an important setting for health education programmes, controlling the growing burden of oral diseases and promoting oral health<sup>29</sup>. As children spend a considerable proportion of their lives in education, schools can play a significant role in promoting children's health and oral health.<sup>30</sup> The WHO strongly recommends that children's oral health should be promoted through schools.<sup>31</sup> A study among 20 primary schools located in socially and economically disadvantaged areas in the UK identified that there was a good level of awareness of the importance of health promotion in all schools. In general schools realised they had an important role to play in promoting health. Teachers welcomed the idea of oral health professionals visiting classes and talking to children directly. The study however identified that oral health was seen as a separate entity to general health and that more should be done to integrate oral health into mainstream health promotion activities in schools.<sup>30</sup>

Peterson et al (1990) suggested that teachers should be considered the key persons in dental health education in ensuring the success of school based dental health programmes. They found the level of dental knowledge of teachers to be more superior to those of mothers who were mostly informed through television or radio.<sup>32</sup>

According to Teng et al (2004) the cooperation of schools in oral health preventative programmes is very important. They reported that children from schools with good cooperation had a significantly lower dental caries prevalence compared to children from schools with partial or poor cooperation.<sup>33</sup>

The WHO launched the Global School Health Initiative in 1995 with the aim of strengthening health promotion and education activities at schools. The initiative was designed to improve the health of children, school personnel, families and other members of the community through schools. The WHO encouraged the development of Health Promoting Schools by giving guidelines on how to assist schools and community leaders to improve the health and education of school children. It is also encouraging schools in constantly strengthening its capacity as a healthy setting for living, learning and working.

Through the extensive Health Promoting Schools network training of teachers are conducted to increase oral health promotion in schools.<sup>1</sup>

Jurgensen and Petersen reported the results of a WHO survey conducted in 2012 of school oral health projects across 61 countries. Schools focused primarily on prevention and health education rather than an overall health promotion. Prevention of dental caries and appropriate fluoride exposure were the two main elements emphasised by schools. Teachers were reported to be the most frequently mentioned personnel involved in oral health school activities. Limited available human resources that include teachers, dental staff and administrators also negatively affected the implementation of oral health activities. The limited supervision and regular monitoring of activities were also reported. Another barrier reported was budget constraints with limited finances available for personnel, health education material, training and provision of services. School oral health programmes were also not well documented and only a few interventions were actually evaluated and reported on.<sup>34</sup>

The WHO advised that teachers and learners should have sound understanding of caries prevention. Essential oral health messages should constantly be reinforced through oral health education sessions. Important aspects to be addressed include; brushing twice daily with fluoride toothpaste, reducing the number of sugary snacks and drinks and consume healthy foods such as fruits and vegetables.<sup>31</sup>

## **2.4 Tooth brushing at schools**

Several studies indicate that daily tooth brushing using fluoride toothpaste reduces tooth decay if incorporated early and becomes a routine.

A good example is a longitudinal study conducted in Jordan, aimed at testing the efficacy of a school-based caries preventive program. The dental caries status of two groups were compared, where the experimental group received intensive oral hygiene instructions sessions and supervised daily tooth brushing using fluoridated tooth paste, while the control group only received oral hygiene instructions. The results of this study

indicated that after 4 years, the caries status of the children in the experimental group was lower than that of the control group. The difference was statistically significant ( $p$ -value $<0.001$ ).<sup>35</sup>

A study in the London Boroughs of Kensington, Chelsea and Westminster showed that a programme of daily teacher-supervised tooth brushing with fluoride toothpaste can be effectively implemented into socially deprived communities. This study showed that a significant reduction in dental caries can thereby be achieved, especially among caries-susceptible children. A total of 517 children with a mean age of 5.63 years participated in the study that was conducted over 21 months. All the schools in the study had catchments areas from socially deprived neighbourhoods. No attempt was made to change the diet and no toothbrushes or toothpaste were issued for home use. The study coordinator visited the schools twice a term to ensure the programme is carried out as prescribed.<sup>36</sup> The intervention group brushed daily at school with commercially available toothpaste containing 1,450 ppm fluoride while the control group did not participate in the brushing programme. The reduction of caries prevalence was higher in primary dentition compared to permanent dentition. Significant reduction ( $p<0.01$ ) was noticed in the decayed, missing and filled components of the proximal surfaces with a non-significant effect noticed on the occlusal and smooth surfaces.

A recent study in Thailand indicated the positive effect of the use of fluoride toothpaste, administered by schoolteachers in a brushing programme, undertaken as part of an enhanced school oral health programme. The study involved 3 706 children in 15 schools over a two year period. The results of the study suggested up to 34% reduction in caries for all schools participating and up to 41% for the most cooperative schools. There was significant less plaque reported in the intervention group. Teachers continued to encourage their new pupils to brush daily even after the project finished and indicated that they felt more confident in providing children with oral health education after completion of the project.<sup>37</sup>

A two year study conducted on 534 Scottish children (mean age 5.3 years) in deprived areas illustrated a significant reduction in caries among high caries risk children after participating in a supervised tooth brushing programme with fluoridated toothpaste at schools. Twelve schools participated. Children were also issued with toothbrushes and toothpaste for home use. Each school had one randomly selected intervention class that participated in the daily brushing and a parallel control class that did not participate in the activity. Significantly less caries developed in the first permanent molars in the intervention group compared to the control group with reductions ranging between 32 to 56%. It is noteworthy to mention that local mothers were trained in infection control procedures, record keeping and to be supervisors in the brushing activity, rather than the teachers. The mothers were financially compensated for the one hour per school day they were conducting supervision.<sup>11</sup>

Laloo and Solanki evaluated a comprehensive oral health care programme seven years after its introduction in 1986 with 110 children participating. Five schools were randomly selected in the Cape Town area, three schools participated in the programme and two schools did not participate. The mean DMFS in the experimental group was 1.94 compared to 6.12 for the control group. The percentage caries free children in the experimental group was 62.5% compared to 37.5% of the control group. The researchers concluded that an oral health care programme consisting of the use of fluoridated toothpaste during brushing, reduced the prevalence and severity of dental caries significantly.<sup>38</sup>

## **2.5 Socio-economic factors**

Numerous studies demonstrated a link between socio-economic status and health, including oral health. Individuals with a low socio-economic status presented with definite poorer oral health compared to those on the higher end of the spectrum.<sup>39,40</sup>

Tooth brushing should ideally commence at home with eruption of the first tooth under supervision of the parents. For low income families the cost of toothbrushes and toothpaste had however been identified as a potential obstacle to brushing teeth

frequently.<sup>41</sup> In Europe it was suggested that 80% of decay in children have been confined to 20% of the population.<sup>42</sup> In general these affected children had been living in low socio-economic neighbourhoods, tended to have parents with lower educational levels, brushed teeth less often, did not utilize fluoride toothpaste frequently and had diets high in sugar.<sup>43,44</sup>

Timis and Danila suggested the most important indicators for evaluation of socio-economic status is occupational status, income and level of education. They also suggested that a high level of education increased the opportunity for individuals to participate in oral health promoting activities. Moreover the difference in income and employment of parents resulted in inequalities in oral health status (expressed by the level of dental caries in children).<sup>45,46</sup>

Ayo-Yusuf *et al* (2007) indicated that with decreasing social capital, caregivers would have lower capacity coping with environmental stress within a community, resulting in neglect of children's oral hygiene and dietary habits. Social capital referred to available resources to individuals due to participation in social networks. They also suggested that low social capital or cohesion can lead to maladaptive behaviors in attempting to combat stress that includes smoking and excessive drinking.<sup>47</sup> It had also been shown that children exposed to environmental tobacco smoke had an increased risk of caries on primary teeth.<sup>48</sup>

Studies confirmed the link between inequalities in socio-economic status and inequalities in oral health. Researchers suggested that socio-economic indicators can be a useful tool in administration and planning as they influence oral health of parents and their children.<sup>39,40</sup> Jones and Worthington suggested that fluoridation should be used as the most powerful mean of addressing inequalities in dental health.<sup>49</sup>

Oral health school programmes have the potential to reach all children.<sup>14</sup> Curnow *et al* suggested that inequalities in dental health can be reduced by implementing regular tooth brushing with fluoridated toothpaste into the daily routine of high risk children through a

targeted population strategy rather than implementing mass preventive programmes to all children.<sup>11</sup> Tooth brushing and oral hygiene should ideally also be part of the curriculum on health education for these identified groups of children.<sup>36</sup>

## **2.6 Odontogenic infections**

Odontogenic infections, due to untreated dental caries such as dental abscesses, necrotic pulps, draining fistulas or ulcerations of mucosa due to root fragments may influence the ability of a child to ingest food which in turn could have a negative impact on the development of the child. Despite the pandemic character of dental decay, particularly in children, there are only a few studies that have examined the relationship between the severity of dental decay and the BMI.

Previous research concluded that children with early childhood caries (ECC) who needed tooth extraction had lower mean weights than those without treatment need.<sup>50,51</sup> A retrospective review of 115 patient records who received sedation or general anesthesia to manage ECC was conducted. The children received treatment on at least one pulp involved tooth and had a mean age of 3.2 years. The weights of these children were compared to children with a similar age, gender, race and socio-economic status without gross carious lesions. Of the patients in the ECC group, 8.7% presented with a weight less than 80% of their ideal weight compared to only 1.7% of children in the non-ECC group. This study indicates that the progressive ECC with pulp involvement may effect growth negatively.<sup>50</sup>

Children, aged 3

to 5 years old, that presented with nursing or rampant caries were examined at the Ankara University Medical School. These children were compared with a control group of similar age and gender with no dental caries. The mean weight of children in the caries group was noticed to be between the 25-50<sup>th</sup> percentile while the control group's mean weight was between the 50-75<sup>th</sup> percentile. Of the caries group, 7.1% weighed less than 80% of their ideal body weight while only 0.7% of the control group weighed less than 80% of their ideal body weight.<sup>51</sup>

In a larger survey involving 2 788 five year old children in South Africa, the relationship between caries and underweight remained inconclusive. This study was conducted in rural and urban communities and indicated that the nutritional status was not found to be significantly correlated to dental caries prevalence. In this study one rural and three urban communities were examined for nutritional status and dental caries.<sup>52</sup>

A recent large population-based prospective cohort study in the United Kingdom (UK) among five year olds, reported that children with tooth decay had slightly smaller increases in weight and height in the previous years than children without tooth decay.<sup>53</sup>

### **CHAPTER 3: THE TOOTH BRUSHING PROGRAMME**

Three dentists from Rob Ferreira hospital were trained and calibrated and collected baseline data from 250 children in the age group eight to ten years during 2012 at selected schools in the Ehlanzeni district. Prof PJ van Wyk from the Department of Community Dentistry at the University of Pretoria conducted the training and calibration. This baseline data were collected before the implementation of the brushing programme. The results of this study showed that: The overall prevalence of caries (DMFT + dmft >0) was 79.2%; the mean dmft was 2.73 and the mean DMFT was 0.70. The BMI of 64% of the children was below normal and 24% were below one standard deviation (SD) of the median of the WHO standard. The regression coefficient between BMI and caries was significant,  $p = 0.013$ . The results of the pilot study showed that children with odontogenic infections as compared to those without odontogenic infections had an increased risk of below normal BMI with an odds ratio (OR) of 2.98 (CI 95%).

Data for odontogenic infections was collected by making use of the PUFA/pufa index and was used according to the standard procedure.<sup>54</sup> PUFA/pufa is an index used to assess the prevalence of oral conditions and infections resulting from untreated caries in the primary (pufa) and permanent (PUFA) dentition. The index is recorded separately from the DMFT/dmft and scores the presence of either a visible pulp (P/p), ulceration of the oral mucosa due to root fragments (U/u), a fistula (F/f) or an abscess (A/a). The PUFA/pufa index per child is calculated in the same cumulative way as the DMFT/dmft index and represents the mean number of teeth per child meeting the PUFA/pufa diagnostic criteria.

Rob Ferreira Dental Department under supervision of the author of this dissertation introduced the Colgate Bright Smile Bright Future tooth brushing initiative during June 2012 in schools in the Ehlanzeni district of Mpumalanga. This initiative allowed oral health professionals based at Rob Ferreira Hospital to request toothbrushes and toothpaste for Grade R to 3 learners by completing a classroom kit request form that is also signed by the relevant school principal. Based on this request, toothbrushes, toothpaste and

educational oral health material were then provided to Rob Ferreira Hospital. Colgate only supplied stock once a year per school which is inadequate to sustain a brushing programme throughout the calendar year. Rob Ferreira Hospital, through a budget by the Mpumalanga Department of Health purchased and supplied additional toothbrushes and toothpaste to schools participating in the research project.

The toothpaste used in this study contained 1,450 ppm fluoride. Toothbrushes with small heads were utilised in the project. No toothbrushes or toothpaste for home use was supplied, although children were allowed to take the old toothbrushes home after being replaced at school.

All schools participating in the research project were located in low socio-economic areas around Nelspruit. Meetings were conducted with each school principal to ensure that they are fully informed of the project and written consent was obtained. The school principal had to nominate a teacher that was responsible for coordinating all oral health activities in the relevant school and ensure the brushing programme is implemented correctly. The coordinator was also responsible for safe keeping of surplus toothbrushes and toothpaste stock. The school oral health coordinator was the contact person for the school and provided an open and easy accessible communication channel for the oral health professional to arrange inspection dates and times and providing advice when needed.

All children and teachers participating in the brushing programme received oral health education, inclusive of correct brushing methods and diet advice, at the beginning of the calendar year. Large demonstration toothbrushes and models were utilised and teachers were issued with posters, timers and a printed summary of their duties to ensure that brushing programmes are implemented correctly. Emphasis was placed on motivating children and teachers.

Only children with completed consent forms signed by parents were allowed to participate in the brushing programme. In the consent letter parents were requested to send a cup

to school that is used for storing of the child's toothbrush. The cup had to be easily cleanable and sharp edges were not allowed. Teachers marked each toothbrush with a permanent marker by writing the name of the child on the handle of the brush and covering it with clear sticky tape. The name of the child was also written on the cup that was used for storing the brush. The toothbrush was stored upright with the handle inside the cup. Cups were stored in a clean dry area of the class and in such a way that toothbrushes were not touching each other to prevent cross-contamination.

Tooth brushing sessions were conducted on a daily basis directly after break. The class teacher was responsible for distribution of toothpaste. When a toothpaste tube was shared between children the teacher dispensed toothpaste on a clean surface such as a paper towel or tissue. The teacher was responsible for preventing cross-contamination and had to ensure that there is enough space between dispensed toothpaste to allow collection onto toothbrushes. Children in Grade R brushed with a pea size amount of toothpaste while children in Grade 1 to 3 had toothpaste the full length of the toothbrush. Each class teacher was also issued with his/her own toothbrush and encouraged to participate in the tooth brushing session. Teachers stood in front of the class or in the middle of the class and demonstrated the quadrant to be brushed ensuring that all quadrants were brushed during the two minutes time frame as indicated by the supplied timer. The dispersion of toothpaste around the teeth was encouraged. The cups were then used to rinse after brushing and children encouraged to only use the minimum amount of water. All excess water had to be thoroughly shaken off the brush before storing it in the cup. Teachers had to ensure that cups were kept clean and washed with soap regularly.

Oral health professionals visited the schools every four to six weeks. Toothpaste stock was then issued for the next six weeks and a meeting conducted with the school oral health coordinator. The number of stock issued was recorded and signed for by the coordinator and the school stamp placed. The oral health professional completed the school journal and had a brief meeting with the school principal. Due to time constraints only random checks were conducted and two classes per school were requested to

demonstrate how they conducted the brushing programmes. Initial resistance were experienced from teachers to conduct the demonstration as the oral health professional can pick up very easily if the class teacher was conducting the sessions daily and correctly. The coordinator and principal were informed if a class teacher was not conducting sessions correctly. Once again great importance was placed on motivating the coordinator, teachers and children with emphasis that the all parties participating should have fun while conducting the activity.

Due to budget constraints toothbrushes were replaced every six months or if bristles became severely splayed before this time. Surplus stock of toothbrushes were issued to the school coordinator for this purpose.

## **CHAPTER 4: AIM AND OBJECTIVES:**

### **4.1 Aim**

The aim of this study was to evaluate the effectiveness of the tooth brushing programme in a community trial in the Ehlanzeni district of Mpumalanga and to evaluate the relationship between odontogenic infections and the BMI (physical development) of children.

### **4.2 Objectives**

**4.2.1** The objective of this study was to evaluate the effectiveness of the tooth brushing programme in a community trial in the Ehlanzeni district of Mpumalanga and the impact of this programme on dental caries by comparing the caries status of children who took part in a brushing programme since 2012, with the caries status of a comparable group of children from the same district who did not take part in the brushing programme in the three years prior to the survey. The following indicators were used to evaluate the effectiveness of the brushing programme:

(i) The prevalence of dental caries expressed as a percentage. The prevalence of dental caries in the intervention group was statistically compared with that of the control group.

(ii) Severity of dental caries expressed as the DMFT and the dmft and components of the DMFT and the dmft. The severity of dental caries in the intervention group was statistically compared with that of the control group.

(iii) The prevalence and severity of odontogenic infections. The prevalence and severity of odontogenic infections was expressed as the percentage of children meeting the PUFA/pufa diagnostic criteria and the mean number of teeth per child meeting the PUFA/pufa diagnostic criteria. The prevalence and severity of odontogenic infections in the intervention group was statistically compared with that of the control group.

(iv) The treatment needs expressed as percentage of children needing care and the mean number of teeth per child needing care. The treatment needed in the

intervention group was statistically compared with that of the control group. The treatment needs were further analysed to identify additional benefits of the tooth brushing programme, should it exist.

(v) The Unmet Treatment Need (UTN) was calculated to convince the reader of the magnitude of the caries problem in this group of children, that this problem cannot be solved by restoring and the extraction of teeth alone but that the prevention of the development of dental caries is the only sustainable solution.

**4.2.2** The objective of the second part of the study was to investigate the relationship between odontogenic infections and BMI in eight to ten year-old children in the Ehlanzeni district of Mpumalanga.

## **CHAPTER 5: STUDY METHODOLOGY**

### **5.1 Study design:**

A quasi-experimental comparison group post-test-only design was used to achieve the objectives of the study.<sup>55</sup>

In this design type, the one group is the experimental group which is exposed to the independent variable, tooth brushing, while the other group, the comparison group is not exposed to the independent variable. This design type differs from a true experimental design in the sense that the two groups were not obtained through random assignment and that the researcher was not completely in control of the independent variable. Please note, random allocation here refers to the allocation of the two groups into the experimental and the control group at the beginning of the study and not the selection of samples to compare the two groups after three years.

### **5.2 Sampling:**

Two samples of 300 children each, in the age group eight to ten years old, were randomly selected from children in Grade 3. The first sample was drawn from children who took part in the brushing project and only the six schools that were part of the brushing project since the commencement of the project in 2012, were included. The second sample was drawn from children in six schools, in the same district, who did not take part in the brushing programme, but who were in the proximity of the schools who took part in the brushing project and who were willing to participate in the survey. Within each of the schools (both samples), a list of all children in Grade 3 was obtained. The children in each list were numbered consecutively and the required number of children per school was drawn randomly by using a table of random numbers which was generated through Random Integer Generator<sup>56</sup>. The required number of children per school was based on the proportion of children per school who were in Grade 3.

All schools that participated in the study were located in low socio-economic areas around Nelspruit and classified by the Department of Education as either Quintile

2 or 3 schools whereby children can attend school without having to pay school fees.<sup>57</sup>

### **5.3 Personnel:**

Two dental examiners, two record clerks and a dental assistant to assist with sterilisation procedures were involved in the study. The examiners are employees of the Mpumalanga Health Department and the survey was conducted under supervision of Dr Marius van der Walt (the author of this dissertation).

### **5.4 Indices and methods for measurements:**

#### **5.4.1 Measurement of dentition status**

Both letters and numbers were used for recording dentition status as indicated in the survey form (Annexure 1). A tooth was considered present in the mouth when any part of it was visible. When a permanent and primary tooth were present in the same tooth space only the status of the permanent tooth was recorded.

A tooth was recorded as sound if no treated or untreated decay was present. Early stages of caries were excluded as they cannot be reliably diagnosed. This included white spots, discolored spots that were hard to touch with a CPI (Community Periodontal Index) probe, pits or fissures with no visual signs of undermined enamel or softening of the floor or walls as detected by a CPI probe.

A tooth was recorded as decayed when there was an unmistakable cavity, undermined enamel or detectable softened floor or wall. A tooth was also recorded as decayed if it had a temporary filling or a fissure sealant with a caries lesion. The CPI probe was used to confirm any visual evidence of caries on all smooth surfaces.

A tooth was recorded as filled with decay when it had a permanent restoration as well as a caries lesion. A tooth was recorded as filled with no decay when it had a permanent restoration but no caries.

A tooth was recorded missing as a result of caries when it had been extracted due to caries. Care were taken to only record this classification when normal exfoliation could be ruled out as it can be difficult to distinguish between unerupted teeth and

missing teeth due to caries. The tooth eruption pattern, caries status of other teeth present and appearance of the alveolar ridge were taken into consideration.

A tooth was recorded as missing due to any other reason when the tooth was congenitally absent, removed due to orthodontic reasons or absent due to trauma.

A tooth was recorded as unerupted when a tooth space is without a primary tooth and unerupted permanent tooth. These scores were not considered in dental caries calculations.

#### **5.4.2 Measurement of treatment needs**

Both letters and numbers were used to record the treatment need of each tooth as indicated on the bottom of the survey form (Annexure 1).

Examiners used their own clinical judgment on the type of treatment considered appropriate, based on what the probable treatment for the average person in the area would be.

A filling was considered unsatisfactory when it had a deficient or leaking restoration margin. It also had to be replaced if an overhang margin was present or if the existing restoration had been fractured.

A tooth was recorded as in need of pulp care when deep and extensive caries was present extending into the pulp.

A tooth was recorded as indicated for an extraction when caries destroyed the tooth to the extent that it was not restorable.

The treatment needs were calculated as the percentage of children that needed treatment as well as the mean number of teeth that needed treatment (in the primary and permanent dentition) in both the intervention and control groups.

#### **5.4.3 Dental caries prevalence and severity (DMFT/dmft index).**

Data was collected by making use of the DMFT/dmft (permanent and primary dentition) index according to the standard procedure<sup>58</sup>. The index had been used for over 50 years and is well established as the key measure of caries experience

in dental epidemiology.<sup>59</sup> The DMFT Index is applied to the permanent dentition of an individual and is expressed as the total number of teeth that are decayed (D), missing (M) or filled (F). The dmft index is applied to the primary dentition. The caries experience for a child was expressed as the total number of teeth that were decayed (d), missing (m) or filled (f).<sup>58</sup>

The prevalence of dental caries (primary and permanent teeth, DMFT/dmft >0) was expressed as a percentage of children with caries experience.

The severity of dental caries was expressed by evaluating the DMFT and dmft and their components.

#### **5.4.4 Measurement of the prevalence and severity of odontogenic infections (PUFA/pufa Index).**

Data for odontogenic infections was collected by making use of the PUFA/pufa index and was used according to the standard procedure<sup>54</sup>. PUFA/pufa is an index used to assess the presence of oral conditions and infections resulting from untreated caries in the primary (pufa) and permanent (PUFA) dentition. The index is recorded separately from the DMFT/dmft and scores the presence of either a visible pulp (P/p), ulceration of the oral mucosa due to root fragments, (U/u), a fistula (F/f) or an abscess (A/a). The PUFA/pufa index per child was calculated in the same cumulative way as the DMFT/dmft index and represented the number of teeth meeting the PUFA/pufa diagnostic criteria.

During the survey 10% of the sample were re-examined to test for intra- and inter-examiner reliability.

#### **5.4.5 Measurement of untreated dental caries**

The Unmet Treatment Need Index (UTN) was used to express the percentage of caries left untreated for both the intervention and control groups. The UTN was calculated by dividing the D(d) component by the DMFT(dmft).

#### **5.4.6 Anthropometric measures:**

All measurements were performed by the oral health personnel according to standard guidelines<sup>60</sup>. The height of children, standing upright without shoes, was measured with a portable stadiometer to the nearest 0.5 cm for all individuals. Weight was assessed with a calibrated portable electronic digital scale to the nearest 0.5 kg for all the children. No adjustments were made for clothing, but children were requested to remove shoes, jackets and jerseys. Height and weight were used to compute BMI (weight in kilograms divided by height in meters squared - weight (kg)/height (m<sup>2</sup>)) for age. A child's BMI was considered below normal when it was below one standard deviation (SD) of the median of the WHO standard.

#### **5.5 Survey forms**

Various WHO forms were combined in a single form for the collection of the general survey information, child's demographic information, dentition status, treatment needed and anthropometric data (Annexure 1).

#### **5.6 Instruments, equipment and consumables**

Instruments, equipment and consumables for the epidemiological examination consisted of the following:

- CPI probes (WHO periodontal probe).
- Mouth mirrors. The ordinary mouth mirror (No 4) was used.
- Clipboards, pencils, sharpeners and erasers.
- Consumables: Cold sterilization agents, paper-towels, rubber gloves, face masks.
- Equipment: Portable lights and dental chairs and suitable receptacles for the return of used instruments.
- An autoclave.
- A stadiometer.
- An electronic digital scale.

## **5.7 Infection control**

- All dental instruments used during the survey were autoclaved.
- Cold sterilization agents were only used in the pre-cleaning of used instruments.
- All stainless steel containers, used in connection with the cleaning and disinfection of instruments at schools were cleaned and autoclaved every afternoon for use at a subsequent school the following morning.
- The use of the disposable gloves and surgical masks for examiners were compulsory.

## **5.8 Calibration and training**

In order to obtain an acceptable level of reliability, the two examiners (Dr M van der Walt and Dr J Bester) based at Rob Ferreira Hospital were trained and calibrated prior to the study by Prof PJ van Wyk from the University of Pretoria, Community Dentistry Department. They were trained in survey procedures, survey protocols and how to correctly capture the required data on the assessment form. Training was provided on caries assessment by using the DMFT/dmft index, odontogenic infection assessment by using the PUFA/pufa index and treatment needed. Caries diagnostic exercises were conducted. Practical caries calibration was conducted on patients by the facilitator as well as the two examiners where Kappa value of 0.6 and higher and were allowed to take part in the survey.

## **5.9 Ethical matters**

The following ethical matters were adhered to:

### **5.9.1 Consent to be examined:**

Consent for the examination of school children was obtained from the parent or legal guardian (Annexure 2), assent from the child concerned (Annexure 3) as well as consent from the principal of the school (Annexure 4).

### **5.9.2 Reporting of findings to study subjects**

Parents or legal guardians of school children were notified of the need for oral health treatment or any other treatment needed by the child, through the existing channels.

### **5.9.3 Ethics committee**

The protocol as well as the relevant annexures were submitted to the University of Pretoria, Research Committee of the School of Dentistry and the Ethics Committee of the Faculty of Health Sciences for approval. Approval was granted by both Committees and attached as Annexures 5 and 6 (Protocol 342/2015).

## **5.10 Data capturing and analysis**

The study assessed the influence of a three year tooth brushing program in eight to ten year-old children (intervention schools) compared to eight to ten year-olds from control schools. Random samples of 300 children from each of the intervention and control schools were drawn. The data was captured using Microsoft Excel. The captured data included, general survey information, the child's demographic information (date of birth, sex, race), anthropometric data (weight and height), dentition status and treatment need of each tooth. This data was analysed and conclusions drawn in terms of gender and age distribution, frequency distribution of caries, prevalence of caries, severity of caries, treatment needs and caries left untreated. In the statistical analysis independent sample T-tests were used to compare continuous data and Chi<sup>2</sup>-analysis was used to compare categorical data from the intervention and control groups. Testing was done at the 0.05 level of significance.

The relationship between PUFA/pufa and BMI was assessed using logistic regression. In the logistic regression model low BMI was used as the dependent variable. A child's BMI was considered below normal when it was below one standard deviation (SD) of the median of the WHO standard. The only potential covariates for which data was available, were PUFA/pufa, school category (intervention or control group) and DMFT/dmft.

Kappa statistics were used to evaluate examiner reliability. Reliability was assessed separately for dentition status, treatment needs, PUFA/pufa and anthropometric measurements.

## **CHAPTER 6: RESULTS**

### **6.1 Sample realisation and sample description**

As indicated in Chapter 5 two samples of 300 children each, in the age group eight to ten years old, were randomly selected by the examiners from children in Grade 3. The first sample was drawn from children who took part in the brushing project and only the six schools that were part of the brushing project since the commencement of the project in 2012 were included. The second sample was drawn from children in six schools, in the same district, who did not participate in the brushing programme, but who are in the proximity of the schools who took part in the brushing project and who were willing to participate in the survey.

After capturing the data, the composition of the sample of the intervention and the control groups were compared and it was observed that there was an over representation of eight year-old children in the intervention group and an over representation of nine year-old children in the control group. To address this issue both samples were reduced to 250. This was done by systematically removing every third eight year-old in the intervention group and every third nine year-old from the non-intervention group. In order to regain the proportionate distribution per school the sample was weighted using school size divided by sample from the school.

All samples were calculated to be accurate to the level of 5% (confidence interval) at the 95% confidence level. With a realised sample of 250 each for the intervention and the control group and the prevalence levels for dental caries obtained in this study (paragraph 6.2.2) the calculated confidence intervals for the intervention and the control groups were 5.31% and 4.66%, respectively.

#### **6.1.1 Gender and age distribution of the sample**

The age and gender distribution of the final realised samples of the intervention and control groups are shown in table 1.

**Table 1: Age (months) and gender distribution of the realised samples of the intervention and control groups.**

		<b>Intervention group</b> n = 250	<b>Control group</b> n = 250
<b>Age</b>		111.62 (SD:8.33)	111.97 (SD:8.18)
<b>Gender</b>	Male	126 (50.4%)	117 (46.8%)
	Female	124 (49.6%)	133 (53.2%)
	Total	250	250

The age and gender distribution of the two groups were compared using independent samples T-test and Chi-square analysis, respectively. No statistically significant differences were observed for the age and gender distributions between the intervention and control group. The respective P-values for the analyses were 0.64 and 0.43.

### **6.1.2 Socio-economic comparison of the two samples**

All 12 schools that participated in the study were located in low socio-economic areas. The school quintile system was introduced through the publication of the National Norms and Standards for School Funding in 1998 whereby schools are annually classified according to poverty levels of the specific geographical area into one of five quintiles. Quintile 1, 2 and 3 schools are classified as no fees schools whereby children may attend school without paying school fees and parents could make a voluntary contribution if they can afford it. Quintile 4 and 5 schools are allowed to charge school fees determined by annual public meetings of school governing bodies where parents vote on the amount to be paid. No fees schools are allocated a higher state subsidy than Quintile 4 or 5 schools.<sup>57</sup>

All the schools that participated in this study were Quintile 2 or 3 schools. The schools in both the intervention and control groups were therefore comparable in terms of socio-economic status.

### 6.1.3 Reliability of the data

As indicated in the study methodology, 10% of the sample were re-examined to test for inter- and intra-examiner reliability. Kappa statistics were used and the kappa values for intra-examiner reliability for dentition status, treatment needs, PUFA/pufa and anthropometric measurements are shown in Table 2.

**Table 2: Intra-examiner reliability in the study expressed as Kappa-values**

	Examiner 1 (Cases)	Examiner 2 (Cases)
Dentition status	0.93 (736)	0.98 (1280)
Treatment needs	0.79 (736)	0.95 (1280)
PUFA/pufa	0.89 (736)	0.80 (1280)
Anthropometric measurements	0.75 (46)	0.97 (80)

Not enough cases were available to test individually for the different measurements for inter-examiner reliability and the available data was combined in one data set to provide a single Kappa value. The kappa value for inter-examiner reliability for the study was 0.76 (98 cases).

## 6.2 Effectiveness of tooth brushing

### 6.2.1 The frequency distribution of caries in the two groups.

The frequency distribution of caries in the intervention and the control groups is shown in Tables 3 and 4, respectively.

**Table 3: The frequency distribution of caries in the intervention group.**

DMFT/dmft	Frequency	Percent	Cumulative Percent
0.00	107	42.8	42.8
1.00	31	12.4	55.2
2.00	36	14.4	69.6
3.00	14	5.6	75.2
4.00	19	7.6	82.8
5.00	17	6.8	89.6
6.00	10	4.0	93.6
7.00	9	3.6	97.2
8.00	2	.8	98.0
9.00	4	1.6	99.6
10.00	1	.4	100.0
Total	250	100.0	

**Table 4: The frequency distribution of caries in the control group.**

DMFT/dmft	Frequency	Percent	Cumulative Percent
0.00	63	25.2	25.2
1.00	20	8.0	33.2
2.00	43	17.2	50.4
3.00	39	15.6	66.0
4.00	22	8.8	74.8
5.00	22	8.8	83.6
6.00	16	6.4	90.0
7.00	12	4.8	94.8
8.00	7	2.8	97.6
9.00	2	.8	98.4
11.00	3	1.2	99.6
12.00	1	.4	100.0
Total	250	100.0	

A total of 42.89% of children from the intervention group (Table 3) did not present with dental caries compared to only 25.2% in the control group (Table 4). The results of Tables

3 and 4 further show that in both groups a DMFT/dmft of two occurs with the highest frequency. Children in both groups that presented with caries were more likely to present with caries on two teeth than on a single tooth. Children in the control group were more likely to present with caries on three, four or five teeth compared to the intervention group.

### 6.2.2 The prevalence of caries in the two groups.

The prevalence of dental caries (primary and permanent teeth, DMFT/dmft>0) in the intervention group was 57.2% and the prevalence of dental caries in the control group was 74.8% (Tables 3 and 4). Employing Chi<sup>2</sup>-analysis the difference between the two groups was statistically significant (p<0.05). The results of the study show that the intervention group presented with 30.8% less dental caries than the control group.

The prevalence of dental caries was considerably higher in the primary teeth in both the intervention and control groups compared to the permanent teeth as indicated in Table 5.

**Table 5: Prevalence of dental caries in primary and permanent teeth**

<b>Caries prevalence</b>	<b>Intervention group (n=250)</b>	<b>Control group (n=250)</b>
Primary teeth	54.4%	71.6%
Permanent teeth	10.8%	20.4%

### 6.2.3 The severity of caries in the two groups.

The severity of dental caries expressed as the DMFT and the dmft and components of the DMFT and the dmft of the two groups are shown in Table 6.

**Table 6: Severity of dental caries expressed as the DMFT and the dmft and components of the DMFT and the dmft.**

	Intervention group (n=250)		Control group (n=250)	
	Mean	SD	Mean	SD
<b>d</b>	1.68	2.09	2.34	2.08
<b>m</b>	0.11	0.49	0.16	0.79
<b>f</b>	0.02	0.15	0.00	0.00
<b>dmft</b>	1.82*	2.28	2.50	2.31
<b>D</b>	0.13	0.45	0.35	0.85
<b>M</b>	0.01	0.13	0.03	0.19
<b>F</b>	0.01	0.09	0.00	0.00
<b>DMFT</b>	0.15	0.48	0.38	0.92

\* Rounded

The mean DMFT (permanent teeth) of 0.15 and 0.38 obtained in the intervention group and control group, respectively, were low compared to the matching dmft (primary teeth) of 1.82 and 2.50. Using an independent sample T-test, the differences in the DMFT- and dmft-values between the intervention group and control group were highly significant with P-values of 0.000 and 0.001 respectively.

The mean number for missing teeth due to caries was higher in the control group (m=0.16, M=0.03) than the intervention group (m=0.11, M=0.01) for both primary and permanent dentition (Table 6).

The mean number of filled teeth was negligible for all the age groups with no restorations recorded in the primary or permanent teeth of the control group (Table 6).

The frequency distributions for each component of dmft and DMFT for intervention and control groups are attached as Annexure 7.

The severity of dental caries expressed as the DMFT and components of the DMFT on the first permanent molars of the intervention and the control groups are shown in Table 7.

**Table 7: Severity of dental caries expressed as the DMFT and components of the DMFT on the first permanent molars of the two groups.**

	Intervention group n = 250		Control group n = 250	
	Mean	SD	Mean	SD
<b>D</b>	0.12	0.41	0.33	0.80
<b>M</b>	0.01	0.13	0.02	0.18
<b>F</b>	0.01	0.09	0.00	0.00
<b>DMFT</b>	0.14	0.45	0.36*	0.86

\*Rounded

If the mean DMFT of dental caries on the **first permanent molars** of the intervention (0.14) and the control groups (0.36)(Table 7) are expressed as a percentage of the mean DMFT of the intervention group (0.15) and control group (0.38)(Table 6) the results show that caries on the **first permanent molars** constitute more than 93% of all caries present on permanent teeth in the mouths of children in this age group. First permanent molars can therefore be regarded as very vulnerable teeth at this stage and although tooth brushing provide valuable protection additional measures are necessary to provide complete protection.

The UTN, expressed as a percentage was calculated by dividing the D(d) component by the DMFT(dmft). The UTN ranged from 86.7% for permanent teeth in the intervention group to 93.6% for primary teeth in the control group as indicated in Table 8. For all children in the study more than 85% of all caries went untreated.

**Table 8 The Unmet Treatment Need Index**

	<b>Intervention group UTN% (n=250)</b>	<b>Control group UTN% (n=250)</b>
<b>Primary teeth</b>	92.3%	93.6%
<b>Permanent teeth</b>	86.7%	92.1%

#### **6.2.4 The prevalence and severity of PUFA/pufa in the two groups.**

The PUFA score for the permanent dentition was very low in these age groups and PUFA and pufa were therefore combined into one score, PUFA/pufa. The prevalence and severity of the PUFA/pufa scores is shown in Table 9.

**Table 9: The prevalence and severity of the PUFA/pufa scores in the two groups**

	<b>Intervention group (n=250)</b>	<b>Control group (n=250)</b>
<b>Prevalence</b>	22	36
<b>Severity</b>	0.40	0.82

Odontogenic infections as reflected in the PUFA/pufa index were lower in children of the intervention group. Twenty-two per cent of children in the intervention group presented with odontogenic infections (mean:0.40, SD: 0.93) compared to 36% of children in the control group (mean: 0.82, SD: 1.38). When comparing the differences in the PUFA/pufa-scores between the intervention group and control group, the independent sample T-test yields a P-value of 0.00, which is highly significant.

#### **6.3 Treatment needed**

The treatment needs for children in the intervention group and control groups are shown in Table 10.

**Table 10: Treatment needed in the Intervention and Control groups**

Treatment needed	Intervention group		Control group	
	% of children needing treatment	Mean number of teeth needing treatment (SD)	% of children needing treatment	Mean number of teeth needing treatment (SD)
<b>Fissure sealants</b>	25.6	0.87 (1.56)	53.6	1.84 (1.84)
<b>Arresting care</b>	1.6	0.02 (0.20)	4.8	0.05
<b>1 surface filling</b>	22.8	0.36 (0.78)	32.8	0.52 (0.92)
<b>2 or more surface filling</b>	45.2	1.0 (1.40)	61.2	1.43 (1.61)
<b>Crown and veneer</b>	0	0	0	0
<b>Pulp care</b>	13.6	0.22 (0.64)	18	0.26 (0.62)
<b>Extractions</b>	10.4	0.2 (0.69)	26.8	0.56 (1.17)
<b>Preventive care</b>	26	0.9 (1.58)	55.6	1.9 (1.84)
<b>Extractions and restorations</b>	56.4	1.8 (2.18)	74.8	2.79 (2.36)

The number of children in need for two or more surface restorations were noticeably high in both the intervention (45.2%, mean 1.0, SD:1.40) and control groups (61.2%, mean 1.43, SD:1.61). In relative terms, the number of children in need of one surface restorations were low in both the intervention (22.8%, mean 0.36, SD:0.78 ) and control groups (32.8%, mean 0.52, SD:0.92). Two or more surface fillings therefore constitute 66.5% and 58.8% of the restorative treatment needed in the intervention and the control groups respectively. Treatment needs as specified in Table 10 were higher in all categories for children in the control group compared to children in the intervention group.

In the control group the need for extractions (26.8%, mean 0.56, SD:1.17) were higher than the need for pulp care (18%, mean 0.26, SD:0.62) while in the intervention group the need for pulp care (13.6%, mean 0.22, SD:0.64) was more than for extractions (10.4%, mean 0.2, SD:0.69).

The need for preventative treatment on arrested decayed teeth were low in both groups with no need for crown or veneer placement in any of the groups.

The need for fissure sealants in the control group (53.6%, mean 1.84) was considerably higher than the need in the intervention group (25.6%, mean 0.87).

Overall the combined need for extractions and restorations was higher than the need for preventative care in both groups.

#### **6.4 Treatment needs in the permanent dentition of the total group of children (intervention and control group combined)**

The distribution of treatment needs (number of teeth) on the first permanent molars of the total group of children (intervention and control groups combined) expressed as a percentage of the distribution of treatment needs (number of teeth) in the permanent teeth of the total group (intervention and control group combined) is shown in Table 11.

**Table 11: Distribution of treatment needs (number of teeth) on the first permanent molars of the total group of children (intervention and control groups combined) expressed as a percentage of the distribution of treatment needs (number of teeth) in the permanent teeth of the total group (intervention and control group combined)**

	<b>Treatment needed in the permanent teeth of the total group expressed as the number of teeth</b>	<b>Treatment needed on the first permanent molars of the total group expressed as the number of teeth</b>	<b>Treatment needed on the first permanent molars expressed as a percentage of the treatment needed in the permanent teeth of the total group</b>
<b>Fissure sealants</b>	664	660	99.4
<b>Arresting care</b>	19	19	100
<b>1 surface filling</b>	97	88	90.7
<b>2 or more surface filling</b>	29	16	55.2
<b>Crown and veneer</b>	0	0	0
<b>Pulp care</b>	4	4	100
<b>Extractions</b>	8	8	100
<b>Preventive care</b>	683	679	99.4
<b>Extractions and restorations</b>	138	127	92.0

The results of Table 11 show in this eight to ten year-old group, that although the four first permanent molars constituted only 33.3% of the permanent teeth present in the mouth in this age group (four mandibular incisors, four maxillary incisors and four first permanent

molars) it represents more than 92% of the curative treatment and more than 99% of the preventive services needed. In contrast to the total treatment need (Table 10) where two or more surface fillings constitute 66.5% and 58.8% of the restorative treatment needed in the intervention and the control groups respectively, the results of table 11 show that one surface fillings constitute 76.9% of the restorative care needed for the permanent teeth. In addition to the large percentage of one surface fillings needed in the permanent dentition, 660 first permanent molars (Table 11) were also identified as teeth needing fissure sealants.

### 6.5 The relationship between odontogenic infections and BMI

The odds ratios (OR) obtained from logistic regression model with low BMI as the dependent variable are shown in Table 12.

**Table 12: Odds ratios obtained from the logistic regression model**

Low BMI (Dependent variable)	OR	[95% Conf. Interval]	P value
(PUFA+pufa)>1	1.12	0.66 – 1.89	0.68
School Category/Intervention group (Intervention group = 1)	0.94	0.63 – 1.40	0.75
Total caries (DMFT+dmft> 0)	1.03	0.24 – 0.48	0.54

A child's BMI was considered below normal when it was below one standard deviation (SD) of the median of the WHO standard. The results of this study suggested that children with odontogenic infections (PUFA+pufa >1) and dental caries (DMFT+dmft > 0) as compared to those without odontogenic infections and caries do not have an increased risk of below normal BMI (OR:1.12 and 1.03 respectively ).

## **CHAPTER 7: DISCUSSION**

Rob Ferreira Hospital, Dental Department implemented tooth brushing programmes in several schools located in low socio-economic areas in the Ehlanzeni District of Mpumalanga. The objective of this study was to determine the effectiveness of this intervention over a three year period. The author of this dissertation initiated and conducted the study to measure the impact of the programme on the prevalence and severity of dental caries. The results obtained by collecting data on children that participated in the brushing programme for three years as well as a comparable group of children that did not participate in the brushing programme were described in Chapter 6. These results are discussed in more detail in the section below. The discussions are presented in a similar sequence as it was presented in the previous chapter; sample realisation and description, effectiveness of the tooth brushing programme by evaluating certain indicators, treatment needed and the possible relationship between odontogenic infections and BMI.

### **7.1 Sample realisation**

#### **7.1.1 Comparability of the intervention and control groups**

The results of the study show that there are no statistically significant differences in the age and gender distribution between the intervention and the control groups (Table 1, page 31). The schools are all situated in the same geographical area and are in terms of socio-economic status, all classified as quintile 2 or 3 schools (paragraph 6.1.2). One can therefore accept that the schools are comparable in terms of the variables age, gender and socio-economic status.

#### **7.1.2 Appropriateness of the sample**

An important consideration when implementing brushing programmes is the target age of the participants. The Colgate initiative only supplied stock to children in Grade R, Grade 1, Grade 2 and Grade 3. This age group is appropriate as children's first molars normally erupts at age six. The first permanent molars are indeed very vulnerable at this age. This is also the age where habits are being formed. Several studies indicate that daily tooth brushing using fluoride toothpaste reduces tooth decay if incorporated early and becomes

a routine.<sup>11, 21, 22, 23</sup> Studies also indicated that high consumption of sugar-sweetened drinks and lack of regular tooth brushing are found to be the key factors strongly linked to dental caries, especially among primary-aged school children.<sup>19</sup> With daily tooth brushing conducted according to the correct methods combined with appropriate education on diet, children that participated in this study were being taught how to look after their teeth from age five (Grade R) for a period of three years therefore creating a beneficial routine or habit. It can hence be deduced that the target population was appropriate for the study.

## **7.2 Effectiveness of the tooth brushing**

### **7.2.1 The prevalence of caries**

The statistically significant difference in caries prevalence observed between the intervention and control groups (Table 5, page 34) suggests that the brushing programme was effective. The results in Table 5 also showed that the prevalence of caries for both groups were higher for primary teeth than permanent teeth, which is to be expected due to the longer duration of exposure of the primary teeth to cariogenic agents. This was also noted in other studies where teacher-supervised tooth brushing were introduced.<sup>36</sup>

The fact that all the schools are located in low socio-economic areas might also have contributed to the high prevalence of dental decay as studies had shown that there is a link between low socio-economic status and poor oral health.<sup>39,40,47</sup> With decreasing social capital, caregivers have lower capacity coping with environmental stress resulting in neglect of children's oral hygiene and dietary habits. Low social capital can lead to maladaptive behaviors in attempting to combat stress that include smoking and excessive drinking.<sup>47</sup> It had also been proven that children exposed to environmental tobacco smoke had an increased risk of caries on primary teeth.<sup>48</sup> The neglect of dietary habits can include an increase in the use of sugar consumption which in turn can lead to an increase in dental caries.<sup>61,62</sup> Studies indicated that for low income families the cost of toothbrushes and toothpaste had been identified as a potential obstacle to brushing teeth frequently.<sup>41</sup> This was also observed in this study as some children reported to the dentists monitoring the brushing programmes that this was the first time they possessed their own toothbrush.

The overall prevalence of caries (DMFT + dmft > 0), according to baseline data, obtained in 2012 in the intervention group of schools before introduction of the brushing programme was 79.2% compared to the 74.8% in the control group in 2015. This indicated that the number of children presenting with caries were slightly reduced over a three year period even though no brushing programmes were conducted at the control schools. This could possibly be due to a greater awareness of oral health in schools.

### **7.2.2 The severity of caries**

Dental caries severity in the primary and permanent dentition of the intervention group was consistently lower than in the control group.

The frequency distribution of caries in children in the intervention group (Table 3, page 33) indicate that children were more likely to present with two teeth that are decayed missing or filled due to caries (14.4%) than one tooth (12.4%) or three teeth (5.6%). Children in the control group (Table 4, page 33) were more likely to present with two (17.2%) or 3 (15.6%) or four (8.8%) or five (8.8%) decayed, missing or filled teeth due to caries than one tooth (8.0%). This show that when children are not caries free they are more prone to have decay on more than one tooth.

The number of decayed teeth in primary and permanent teeth contributed the most to the dmft/DMFT (Table 6, page 35). The low socio-economic status of parents of children attending the schools may have contributed to the high severity of dental caries as reported by studies in the past and explained under 7.2.1.<sup>47,48,61,62</sup>

Several studies indicate that daily tooth brushing using fluoride toothpaste reduces tooth decay if incorporated early and becomes a routine.<sup>11, 21, 22, 23</sup> The 30.8% difference observed between the prevalence of dental caries in the intervention and control groups in this study compares very favorably with other similar studies. Curnow *et al* (2002) found a reduction of between 32% to 56% in a randomised controlled trial in Scotland.<sup>11</sup> While in Thailand Peterson *et al* (2014) found a reduction of 34% in a brushing programme administered by school teachers.<sup>37</sup> Jackson *et al* (2005) found a significant reduction of 21.4% in the decayed missing and filled proximal surfaces in a study conducted on children in the London Boroughs of Kensington, Chelsea and Westminster.<sup>36</sup> Lalloo and

Solanki (1994) evaluated a comprehensive oral health care programme implemented in schools located in the Cape Town area and reported that the percentage caries free children in the experimental group was 62.5% compared to 37.5% of the control group.<sup>38</sup>

More teeth were also extracted, due to caries, in the control group than in the intervention group (Table 6, page 35). This could possibly be due to the larger number of children that presented with symptoms because of the higher caries prevalence rate in the control group.

The current study showed a high caries rate on the first permanent molars that constituted more than 93% of all caries present on the permanent teeth. This observation confirmed that additional measures are necessary to protect these teeth. Since pit and fissure caries are the most common types of caries found on first molars fissure sealant programmes should be considered together with brushing programmes to achieve optimum protection of first permanent molars.

### **7.2.3 The prevalence and severity of odontogenic infections**

The prevalence and severity of odontogenic infections were lower in the intervention group in comparison to the control group as indicated in Table 9 (Page 37). The results of the study showed a 63.6% difference in the prevalence of odontogenic infections when comparing the results of the intervention and control groups. This result suggested that brushing at school may be effective in preventing the development of odontogenic infections. Pulpal involvement, traumatic ulceration, fistula and abscesses (PUFA/pufa) are usually associated with pain and discomfort and a lower PUFA/pufa score could therefore have a positive impact on the oral health related quality of life of children. Symptoms caused by odontogenic infections might have a negative impact on children's ability to concentrate in class or even result in the child being absent from school.

### **7.3 Treatment needed**

An alarming large amount of caries go untreated as indicated in this study by the UTN. The high percentage of untreated dental caries is consistent with other studies conducted in South Africa, which show that more than 80% of caries remained untreated.<sup>3,6,63</sup> This

might be due to the inadequacy of resources including dental facilities and oral health professionals in the region as well as a lack of awareness about oral health and available dental services amongst the majority of the population.<sup>3</sup> The UTN index provided important information regarding the availability of treatment and accessibility of oral health services to policy makers and planners. In this study the UTN results reflected the fact that there were no oral health professionals employed at the several clinics and community health centres located in the catchment areas of the schools. The number of children in need for two or more surface restorations were noticeably high in both the intervention and control group. In comparison the number of children in need for 1 surface restorations were considerably less in both the intervention and control groups (Table 10, page 38). This indicated that in this group of children, interproximal caries were more prevalent and severe than caries of pits and fissures.

The low number of restorations recorded in the current study compared favorably with the most recent children's oral health survey conducted in South Africa<sup>3</sup>. This could be due to parents' unawareness of the importance to save primary teeth and that none of the government dental clinics in the area where the schools are situated offer restorative services. In order to receive restorative treatment, children have to be referred to Rob Ferreira Hospital, which results in a longer waiting times before the child receives treatment, extra travelling and extra time off work for parents. It is therefore conceivable that parents may rather decide on immediate pain relief through extractions. Socio-economic status of parents of children may also have contributed to the low number of filled teeth as it had been shown before that higher socio-economic status is synonymous with higher filled values.<sup>64</sup>

The need for extractions in the control group were higher than the need for pulp care while in the intervention group the need for pulp care was more than extractions. This could possibly indicate that teeth in the intervention group were not that extensively decayed and could still be restored by performing pulpotomy or pulpectomy procedures compared to teeth in the control group that were irreparably damaged.

The need for therapeutic treatment on arrested decayed teeth was low in both groups with no need for crown or veneer placement in any group.

The need for fissure sealants in the control group was considerably higher than in the intervention group. This could possibly be due to the fact that in this group, the children's caries susceptibility are higher based on decayed lesions already present in a large percentage of the primary teeth. In contrast to the total treatment need (Table 10, page 38) where two or more surface fillings constitute 66.5% and 58.8% of the restorative treatment needed in the intervention and the control groups respectively, the results of Table 11 (page 40) showed that one surface fillings constitute 76.9% of the restorative care needed for the permanent teeth. This observation, combined with finding that 33% of the total number of first permanent molars present also needed fissure sealants, indicated that the placement of fissure sealants should be part of any caries preventive program. However, the placement of sealants, whether for preventive or therapeutic reasons, should be based on caries risk assessment<sup>65</sup> at patient and tooth surface levels.<sup>66</sup> Alarming high levels of treatment needed were also reported in the last 3 national oral health surveys.<sup>5</sup>

#### **7.4 Access to care**

Due to persistent oral health inequalities in access to care, the South African public sector is under constant pressure to deliver effective primary oral health preventive services. It had been suggested that oral health promotion programmes are not implemented and distributed uniformly and appear to be fragmented with lack of evaluation. Facilities conducting primary oral health care is focusing mainly on emergency relief of pain and sepsis.<sup>38,39</sup> This was confirmed in this study when analysing statistics of the extremely low number of children receiving dental treatment. This indicated that by far the majority of dental caries are untreated and extractions were the choice of treatment when provided. Studies also indicated that the treatment of dental caries is expensive for governments and this could contribute to the lack of access.<sup>67,68</sup>

As discussed before, the lack of oral health personnel and dental facilities and limited knowledge of available dental services amongst the general population are contributing factors why many South Africans are denied access to care.<sup>6</sup>

Researchers found that an unrealistic high number of personnel and substantial amount of time to perform treatment is required if the current backlog of dental caries for children under the age of 15 is to be treated. Such a programme will be financially astronomical and unaffordable.<sup>6</sup> Preventing dental diseases will be financially more beneficial.

This study confirmed what was suggested by other researchers that caries in South African children is not adequately addressed through current policies and service provision.<sup>14</sup>

### **7.5 Human resources**

The brushing programme for this research project was implemented and monitored by dentists due to the absence of oral health care professionals employed at primary health care facilities such as community health centres in Mpumalanga and a severe shortage of oral hygienists and dental therapists in the Province. This intervention should ideally be introduced and monitored by district based oral hygienists and also funded on District level.

The National Human Resource Audit recognised oral hygienists and dental therapists as important members of the oral health team. They advised an urgent need for additional training of oral hygienists and dental therapists.<sup>69</sup> The White Paper for Transformation of the Health System in South Africa also suggested that oral health services should be transformed through the primary health care approach. It advised focusing on equitable preventive services integrated with primary care services. It also suggested a minimum package of services which could be delivered by oral hygienists and dental therapists.<sup>70</sup>

As the oral health professional cannot be at the school full time the importance of school principals and teachers should not be underestimated for such a programme to be successful. Peterson *et al* (1990) suggested that teachers should be considered the key persons in dental health education in ensuring the success of school based dental health programmes. They found the level of dental knowledge of teachers to be more superior to those of mothers who were mostly informed through television or radio.<sup>32</sup> Great care should especially be taken in selecting the correct teacher to be the oral health school coordinator as they are important to oversee that the programme is implemented

correctly. Oral health school coordinators should be responsible and motivated individuals who is respected by other teachers with the well-being of learners at heart. Such a person should be identified after consultation with the school principal who can advise the correct candidate which in most cases was the head of the foundation phase. The researchers observed that constant motivation of all parties involved (principals, coordinators, teachers and children) was crucial for the programme to succeed over an extended period of time. This was also reported by Teng *et al* (2004) who indicated that children from schools with good co-operation had a significant lower dental caries prevalence compared to children from schools with partial or poor cooperation.<sup>33</sup> Random checks, by requesting classes to demonstrate how they conducted the brushing activities, were found to be very effective as teachers didn't want to be exposed as uncooperative. In general, learners found the daily brushing a fun event to participate in and did not need as much motivation as teachers.

In a study in Scotland local mothers were successfully trained and utilised as tooth brushing supervisors rather than teachers and were compensated for the function they rendered.<sup>11</sup> Dedicated community workers could also be considered although teachers are still the preferred logical option as they are already present at the school, receiving remuneration, know all the children well and are found to be safe working with children.<sup>11</sup>

## **7.6 Odontogenic infections and BMI**

The results of a pilot study which was conducted in July 2012, in the same district, together with the baseline study for dental caries, showed that children with odontogenic infections (PUFA+pufa >1) as compared to those without odontogenic infections had an increased risk of below normal BMI (OR: 2.98; 95%CI, [1.26 - 7.09]) (Chapter 3). The results of the current study however, showed a slight risk (OR:1.12; 95%CI, [0.66 – 1.89]) but the association between odontogenic infections (PUFA+pufa >1) and below normal BMI was not significant (p=0.68). During the pilot study other independent variables such as employment status of the breadwinner, number of siblings in the family and the presence of a television set in the house were included in the model. The association between these variables and below normal BMI was however found not to be significant and was therefore excluded from the current model. Similar conflicting results were found

in the literature. Studies in the US and Turkey concluded that children with early childhood caries (ECC) who needed treatment for tooth extraction had lower mean weights than those without treatment need<sup>50,51</sup>. In a larger study among 4-5 year-old non-hospital visitors, the relationship between caries and underweight children remained inconclusive<sup>52</sup>. The current study design was a cross-sectional study, which limits the ability to identify causative factors. A longitudinal design would be more appropriate to reveal the relationship between odontogenic infections and low BMI should it exist.

### **7.7 Holistic approach**

Modern dentistry had become very isolated from other elements of the health service.<sup>71</sup> Sheiham and Watt suggested that many oral health programmes are developed and implemented in isolation from other oral health programmes which often lead to duplication of efforts. Oral health programmes tend to concentrate on individual behaviour change and largely ignore the influence of socio-political factors as the key determinants of health.<sup>72</sup>

With the alarming high level of untreated dental caries in South African children and access to dental care still a realistic problem for the majority of the population, a whole-population approach should ideally be considered to combat this public health burden and address the inequalities. As studies indicated water fluoridation is the ideal and viable choice as it targets the population as a whole.<sup>9,23,24,</sup>

Prevention by the use of fluoride is the only realistic and most cost-effective way in reducing the burden that dental caries is placing on the public health care system. It has been stated that access to fluoride for dental health is part of the basic human right to health.<sup>16</sup> With the absence of fluoridated water schemes and the high level of untreated dental caries in children in South Africa alternative fluoride exposure methods should be considered.

A holistic approach should be considered to improve oral health of school children by developing healthy lifestyles and creating healthy environments. To achieve sustainable lifestyles, oral health education should involve active participation of children, parents and “significant others” such as school teachers.<sup>32</sup> Policies on national level should be

encouraged to provide a framework for environmental change as is the case with water fluoridation.<sup>42</sup>

### **7.8 Limitations of the study**

This was not a blind study. Although the examiners did their best not to be biased when collecting data, they were still aware which children participated in the brushing programme.

The control group and intervention group were, although comparable, still completely independent from each other and subsequently the data collected from each group's participants. The results obtained should be viewed in this light.

The dentists who implemented the brushing programmes were not in full control of the study and were relying on the motivation level of the teachers and children to conduct the brushing as prescribed.

Other elements that could influence the prevalence and severity of caries and odontogenic infections such as the availability of sugary drinks and food from vendors and tuck shops located at and adjacent to each school could not be isolated.

## **CHAPTER 8: CONCLUSION**

This study showed that teacher supervised tooth brushing programmes implemented and closely monitored by oral health professionals may be effective in the South African public school set-up, if combined with oral health education in socially deprived communities. This targeted population approach resulted in noticeable differences in the prevalence and severity of dental caries when comparing results of the two groups. A substantial reduction in dental treatment needs in children could be achieved if the findings in this study could be translated to the population at risk in South Africa.

This study also illustrated the high percentage of untreated dental caries among the children examined with negligible low number of restorations placed. This might be due to the inadequacy of resources such as oral health personnel and dental facilities as well as lack of awareness about oral health amongst the population.

This study provide additional evidence, as suggested by other researchers, that caries in South African children is not adequately addressed through current policies and service provision.<sup>14</sup> It is suggested that policies and strategies should focus on reducing the burden of oral diseases through prevention and need to be integrated with other health programmes to be successful.<sup>1</sup> As the White Paper for Transformation of the Health System in South Africa suggested, oral health services should be transformed through a primary health care approach with equitable preventive services integrated with the primary care services.<sup>70</sup>

Most importantly, this study showed that tooth brushing programmes may be a feasible option in the SA school setup to reduce the severity and prevalence of dental caries.

## **CHAPTER 9: RECOMMENDATIONS**

Due to the lack of whole population implemented water fluoridation schemes and a high amount of untreated dental decay in children, the introduction of targeted population fluoridated tooth brushing programmes should be seriously considered in schools located in low socio-economic areas in South Africa.

Currently school related oral health programmes are not standardised and implemented uniformly by oral health professionals. Comprehensive practical guidelines in the form of a manual should be compiled and communicated to oral health professionals advising on implementation of school oral health related activities, inclusive of fluoridated brushing programmes. This should include step by step practical guidance on identifying target schools, age groups, correct implementation of preventative programmes, standardised consent forms and the importance of integration with other stakeholders for instance, school health nurses.

There is a need for more effective communication and integration between oral health professionals, education authorities (school district circuit managers, school principals and teachers) and school health nurses. The Integrated School Health Programme compiled by the Department of Health and Department of Basic Education does promote integration between the relevant stakeholders and provides guidance to school health nurses but none to oral health professionals working in schools. By having school health nurses and oral health professionals working together, oral health prevention and promotion programmes can be conducted more effectively. Workload can be reduced in terms of dental screenings, completion and collection of consent forms and oral health education.

In this study the brushing programmes were implemented and monitored by dentists but can easily be conducted by oral hygienists or dental therapists which will be financially more beneficial to utilise.

The implementation of water fluoridation should be reconsidered as a matter of priority and until implemented the Government should consider removing taxation on

toothbrushes and toothpaste and ensure that affordable fluoride toothpaste is available on the market.

With dental inequality and access to care still a huge obstacle, the focus should move away from relief of pain and sepsis and limited curative services to the provision of preventative services through an integrated primary oral health care approach and improving the living standards of the population with emphasis on the most disadvantaged groups.

## **BIBLIOGRAPHY**

1. Petersen PE. The World Oral Health Report 2003: Continuous improvement of oral health in the 21st century – the approach of the WHO Global Oral Health Programme. *Community Dent Oral Epidemiol.* 2003 Dec; 31 (S1): 3-24.
2. Peterson PE. Challenges to improvement of oral health in the 21<sup>st</sup> century – the approach of the WHO Global Oral Health Programme. *Int Dent J.* 2004; 54(6): 329-343.
3. Van Wyk PJ, van Wyk C. Oral Health in South Africa. *Int Dent J.* 2004; 54(6): 373-377.
4. Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye, C. The global burden of oral diseases and risks to oral health. Geneva: World Health Organisation; 2005.
5. Van Wyk PJ, van Wyk C. Trends in dental caries prevalence, severity and unmet treatment need levels in South Africa between 1983 and 2002. *SADJ.* 2010 Aug; 65(7):310, 312-4.
6. Van Wyk PJ, Louw AJ, du Plessis JB. Caries status and treatment needs in South Africa: report of the 1999-2002 National Children's Oral Health Survey. *SADJ.* 2004 Jul; 59(6):238, 240-2.
7. World Health Organization Expert Committee on Oral Health Status and Fluoride Use. Fluorides and oral health. WHO Technical Report Series No. 846. Geneva: World Health Organization; 1994.
8. Centers of Disease Control and Prevention. Populations receiving optimally fluoridated public drinking water: United States, 1992-2006. *MMWR Morb Mortal Wkly Rep.* 2008 Jul;57(27):737–41.

9. Kroon J, Van Wyk PJ. A retrospective view on the viability of water fluoridation in South Africa to prevent dental caries. *Community Dent Oral Epidemiol* 2012; 40:441-50.
10. Bratthall D, Hansel-Petersson G, Sundberg H. Reasons for the caries decline: What do the experts believe? *Eur J Oral Sci.* 1996;104:416–22. discussion 23-5,30-2.
11. Curnow MM, Pine CM, Burnside G, Nicholson JA, Chesters RK, Huntington E. A randomised controlled trial of the efficacy of supervised toothbrushing in high-caries-risk children. *Caries Res.* 2002;36:294–300.
12. De Almeida CM, Petersen PE, Andre SJ, Toscano A. Changing oral health status of 6- and 12-year-old schoolchildren in Portugal. *Community Dent Health.* 2003;20:211–6.
13. Van Rensburg HCH. Profile of health and disease in South Africa. Pretoria: Academia; 1982;1-22.
14. Singh S. Dental caries rates in South Africa: implications for oral health planning. *South Afr J Epidemiol Infect.* 2011;26(4):259-61.
15. Singh S, Myburgh NG, Lalloo R. Policy analysis of oral health promotion in South Africa. *Glob Health Promot* 2010;17(1);16-24.
16. Peterson PE, Phantumvanit P. Perspectives in the effective use of fluoride in Asia. *J Dent Res* 2012; 91(2):119-121.
17. Edelstein BL. The dental caries pandemic and disparities problem. *BMC Oral Health.* 2006;6(Suppl 1)S2. DOI: 10.1186/1472-6831-6-S1-S2.
18. Kwan S, Peterson PE, Oral health: equity and social determinants. In: Equity, social determinants and public health programmes. Blas E, Kurup AS, editors. Geneva: World Health Organization, pp159-176.

19. Levine RS, Nugent ZJ, Rudolf MC, Sahota P. Dietary patterns, tooth brushing habits and caries experience of schoolchildren in West Yorkshire, England. *Community Dent Health*. 2007;24(2):82-87.
20. Featherstone JD. The science and practice of caries prevention. *J Am Dent Assoc*. 200;131:887-99.
21. Jones, S., Burt, B.A., Petersen, P.E. and Lennon, M.A. The effective use of fluorides in public health. *Bulletin of the World Health Organization*. 2005;83:670-676.
22. Ammari AB, Bloch-Zupan A, Ashley PF. Systematic review of studies comparing the anti-caries efficacy of children's toothpaste containing 600 ppm of fluoride or less with high fluoride toothpastes of 1,000 ppm or above. *Caries Res*. 2003;37(2):85-92.
23. Medical Research Council. Working Group Report: Water fluoridation and health. London: MRC;2002.
24. McDonagh MS, Whiting PF, Wilson PM, Sutton AJ, Chestnutt I, Cooper J. Systematic review of water fluoridation. *BMJ* 2000;321:855-9.
25. Zero DT, Marinho VCC, Phantumvanit P. Effective use of self-care fluoride administration in Asia. *Adv Dent Res*. 2012, 24(1):16-21.
26. Republic of South Africa. Regulations on fluoridating water supplies. *Government Gazette* vol 423, no 21533. Pretoria: Government Printer, 2000.
27. Republic of South Africa. National Health Act, 2003 (Act 61 of 2003). *Government Gazette* vol 469 no 26595. Pretoria: Government Printers, 2003.
28. FDI, IADR, WHO. Global consultation on Oral Health through Fluoride: Call to action to promote dental health by using fluoride; 2006.

29. Yazdani R, Vehkalahti MM, Nouri M, Murto H. School-based education to improve oral cleanliness and gingival health in adolescents in Tehran, Iran. *Int J Paediatr Dent.* 2009;19(4):274-281.
30. Gill P, Chestnutt IG, Channing D. (2009). Opportunities and challenges to promoting oral health in primary schools. *Community Dent Health.* 2009;26(3):188-192.
31. World Health Organisation. Oral Health through schools. Geneva: WHO document 11, 2003.
32. Peterson PE, Hadi R, Al-Zaabi FS, Hussein JM, Behbehani JM, Skougaard MR, Vigild M. Dental knowledge, attitudes and behavior among Kuwait mothers and schools teachers. *J Pedod.* 1990; 14(3):158-164.
33. Teng O, Narksawat K, Podanj J, Pacheon O. Oral health status among 12 year old children in primary schools participating in an oral health preventive school program in Phnom Penh City, Cambodia, 2002. *Southeast Asian J Trop Med Public Health.* 2004; 35(2):458-462.
34. Jurgensen N, Petersen PE. Promoting oral health of children through schools – results from a WHO survey 2012. *Community Dent Health.* 2013 Sept; 30: 204-218.
35. Al-Jundi SH, Hammad M, Alwaeli H. The efficacy of a school-based caries preventive program: a 4-year study. *Int J Dent Hyg.* 2006;4(1):30-34.
36. Jackson RJ, Newman HN, Smart GJ, Stokes E, Hogan JI, Brown C, Seres J. The effects of a supervised toothbrushing programme on the caries increment of primary school children, initially aged 5-6 years. *Caries Res.* 2005 Mar-Apr;39(2):108-115.

37. Peterson PE, Hunsrisakhun J, Thearmontree S, Pitchpornchaiyakul S, Hintao J, Jurgensen N et al. School-based intervention for improving the oral health of children in southern Thailand. *Community Dent Health*. 2014 Aug 26;31:1-7.
38. Lalloo R, Solanki GS. An evaluation of a school-based comprehensive oral health programme. *Community Dental Health*. 1994;11(3):152-155.
39. Locker D. Deprivation and oral health: a review. *Community Dent Oral Epidemiol*. 2000;28:161-9.
40. Locker D. Measuring social inequalities in dental health services research: Individual, household and area based measure. *Community Dental Health* 1993, 10:139-150.
41. Pine CM, McGoldrick PM, Burnside G, Curnow MM, Chesters RK, Nicholson J et al. An intervention programme to establish regular toothbrushing: undertaking parents beliefs and motivating children. *Int Dent J Suppl*. 2000;50:312-323.
42. Marthaler TM, O'Mullane DM, Vrbic V. The Prevalence of dental caries in Europe 1990-1995. *Caries Res*. 1996;30:237-255.
43. Gregory J, Lowe S. National diet and nutrition survey; young people aged 4-18. London, HMSO,2000
44. Silver DH. A comparison of 3-year-olds' caries experience in 1973, 1981 and 1989 in a Hertfordshire town, related to family behavior and social class. *Br Dent J*. 1992; 172:191-197.
45. Timis T, Danila I. Socioeconomic status and oral health. *The Journal of Preventive Medicine*. 2005;13(1-2)116-121.

46. Gratix D, Holloway P. Factors of deprivation associated with dental caries in young children. *Community Dent Health*. 1994;11:66-70.
47. Ayo-Yusuf OA, Ayo-Yusuf IJ, van Wyk PJ. Socio-economic Inequities in Dental Caries Experience of 12 –year old South Africans: Policy Implications for Prevention. *South African Dental Journal* 2007;62(1):6-11.
48. Shenkin JD, Broffitt B, Levy SM. The association between environmental tobacco smoke and primary teeth caries. *Journal of Public Health* 2004;64:184-186.
49. Jones CM, Worthington H. Water fluoridation, poverty and tooth decay in 12 year old children. *Science Direct*, 2001.
50. Acs G, Lodolini G, Kaminsky S, Cisneros GJ. Effect of nursing caries on body weight in a pediatric population. *Pediatr Dent*. 1992;14:302–305.
51. Ayham H, Suskan E, Yildirim S. The effect of nursing caries or rampant caries on height, body weight and head circumference. *J Clin Pediatr Dent*. 1996;20:209–212.
52. Cleaton-Jones P, Sinwell R, Mogotsi M, Richardon BD, Granath L, Fatti LP, Walker AR. Nutritional status and dental caries in a large sample of 4-and 5-year-old South African children. *SA J Clin Nutr*. 2000;90:631–635.
53. Kay EJ, Northstone K, Ness A, Duncan K, Crean SJ. Is there a relationship between birth weight and subsequent growth on the development of dental caries at 5 years of age. A cohort study. *Community Dent Oral Epidemiol*. 2010;38:408–414.
54. Monse B, Heinrich-Weltzien R, Benzian H, Holmgren C, van Palenstein Helder W. PUFA - An index of clinical consequences of untreated dental caries. *Community Dent Oral Epidemiol*. 2010;38:77–82.

55. De Vos AS, Delport CSL, Fouche CB, Strydom H. Research at grass roots: a primer for the social science and human professions. Pretoria: Van Schaik Publishers; 2011.
56. Randomness and Integrity Services Ltd. Random.org: True random number service. Available from URL <http://www.random.org/integers>. (Accessed 7 May 2015).
57. Department of Education. National Norms and Standards for school funding. 1998. Pretoria. Government Printer.
58. World Health Organisation. Oral Health Surveys, Basic Methods. 4th ed. Geneva: World Health Organisation; 1997. p.39.
59. Broadbent JM, Thomson WM. For debate: problems with the DMF index pertinent to dental caries data analysis. Community Dent Oral Epidemiol. Dec 2005; 33(6): 400–409.
60. Lohmann TG, Roche AF, Martorelli R. Anthropometric standardization reference manual. Champaign, IL: Human Kinetics; 1988.
61. Steyn NP, Myburg NG, Nel JH. Evidence to support a food-based dietary guideline on sugar consumption in South Africa. Bulletin of the World Health Organization. 2003;81(8):599-608.
62. Labadarios D, Steyn NP, Maunder E, McIntyre U, Swart R, Gericke G. The National Food Consumption Survey (NFCS): Children aged 7-9 years, South Africa, 1999. Pretoria: Department of Health, Directorate: Nutrition; 2000.
63. Department of Health. National Oral Health Survey: South Africa 1988/89. Pretoria: Government Printer; 1994.

64. Cleaton-Jones PE, Hargreaves JA, Roberts G, Williams S, Leidal T. The dmfs and dmft of young South African children. *Community Dent Oral Epidemiol.* 1998;17(1):38-40.
65. Deery C. 2013. Caries detection and diagnosis, sealants and management of the possibly carious fissure. *Br Dent J.* 214(11):551–557.
66. Splieth CH, Ekstrand KR, Alkilzy M, Clarkson J, Meyer-Lueckel H, Martignon S, Paris S, Pitts NB, Ricketts DN, van Loveren C. 2010. Sealants in dentistry: outcomes of the ORCA Saturday Afternoon Symposium 2007. *Caries Res.* 44(1):3–13.
67. Sheiham A. Dietary effects on dental diseases, *Public Health Nutrition* 2001;4:569-591.
68. Moynihan P, Petersen PE. Diet, nutrition and the prevention of dental diseases. *Public Health Nutrition* 2004;7(1A):201-206.
69. Department of Health. The Human Resource Audit for Health Care Personnel in South Africa. Department of Health, Pretoria, 1996.
70. Department of Health. White Paper for the Transformation of the Health System in South Africa. *Government Gazette Vol 382 No 17910, Notice 667 of 1997, Pretoria* 16 April 1997.
71. Daly B, Watt RG, Batchelor P, Treasure ET. Determinants of Oral Health. In: Daly B, Watt RG, Batchelor P, Treasure ET, editors. *Essential dental public health.* Oxford: Oxford University Press; 2002. p. 28-30.
72. Sheiham A, Watt R. The common risk factor approach: a rotational basis for promoting oral health. *Community Dent Oral Epidemiol.* 2000; 28(6):399-406.

## **ANNEXURES**

Annexure 1: Survey form

Annexure 2: Parent consent form

Annexure 3: Child assent form

Annexure 4: Principal consent form

Annexure 5: Approval by the UP Research Committee of the School of Dentistry

Annexure 6: Approval by the UP Ethics Committee of the Faculty of Health Sciences

Annexure 7: Frequency distributions for each component of dmft and DMFT for intervention and control groups.



**Annexure 2**

**EVALUATION OF A TOOTHBRUSHING PROGRAMME IN PRIMARY SCHOOLS IN  
MPUMALANGA**

Dear Parent/Guardian

During the past 3 years the Department of Health has been running the Brite Smiles Brite Future tooth brushing programme in the Ehlanzeni district of the Province. In order to evaluate the impact of the programme on the oral health of children in the province an oral health survey is planned. We invite you to allow your child to participate in this study. This information leaflet will help you to decide if you want your child to participate. Before you agree to take part you should fully understand what is involved. If you have any questions that this leaflet does not fully explain, please do not hesitate to ask the investigator.

The aim of this study is to determine whether the Brite Smiles Brite Future programme is effective i.e. whether the programme prevents tooth decay and whether tooth decay impacts negatively on general health.

This study involves an examination of the mouth and teeth. This examination will take about 4 to 6 minutes, during which time the most important findings will be recorded. In addition to the oral examination your child's weight and height will also be measured. There are no risks involved in participating in the study and although you will not benefit directly from the study, the results of the study will enable the health authorities of the Province to improve oral health services and facilities. The examiner will also inform you of conditions in your child's mouth that would need attention.

Your child's participation in this study is entirely voluntary. You can refuse to participate or stop at any time during the study without giving any reason. Your withdrawal will not affect you or your child's treatment or participation in the programme in any way.

This study has received written approval from the Ethics Committee of the Faculty of Health Sciences at the University of Pretoria (UP) and from the principal of the school.

The contact person for the study is Dr Marius van der Walt. If you have any questions about the study please contact him at cell 0823021011.

All information that you give or that we collect will be kept strictly confidential. Once we have analyzed the information no one will be able to identify your child.

**CONSENT TO PARTICIPATE IN THIS STUDY**

I confirm that the person asking my consent to take part in this study has told me about the nature, process, risks, discomforts and benefits of the study. I have also received, read and understood the above written information regarding the study. I am aware that the results of the study, including personal details, will be anonymously processed into a research report. I am participating willingly. I have had time to ask questions and have no objection to allow my child to participate in the study. I understand that there is no penalty should I wish to discontinue with the study and my withdrawal will not affect any treatment in any way.

Parent's name .....(Please print)

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

Investigator's name .....(Please print)

Investigator's signature ..... Date.....

Witness's Name .....(Please print)

Witness's signature ..... Date.....

**Annexure 3**

**Title: EVALUATION OF A TOOTHBRUSHING PROGRAMME IN PRIMARY SCHOOLS IN  
MPUMALANGA**

**Dear** (Name of learner) .....

During the past 3 years the Department of Health has been running the Brite Smiles Brite Future tooth brushing programme in the Ehlanzeni district of the Province. In order to determine the effectiveness of this project you are requested to take part in an oral health survey. This information leaflet will help you to decide if you want to participate. Before you agree to take part you should fully understand what is involved. If you have any questions that this leaflet does not fully explain please do not hesitate to ask the investigator.

The aim of this study is to determine whether the Brite Smiles Brite Future programme is effective i.e. whether the programme prevents tooth decay. This study involves a thorough examination of the mouth and teeth. This examination will take about 4 to 6 minutes, during which time the most important findings will be recorded by a clerk. In addition to the oral examination your weight and height will also be measured. There are no risks involved in participating in the study and although you will not benefit directly from the study, the results of the study will enable the health authorities of the Province to improve oral health services and facilities. The examiner will also inform your parents of conditions in your mouth that would need attention.

If you do not want to take part any more, you may decide at any time during the study, not to carry on. No one will force you to carry on. No one will be cross or upset with you if you don't want to. You don't have to give us your answer now, take your time and inform us of decision as soon as possible.

If you sign at the bottom it will mean that you have read this document, and that you would like to be in this study.

Your name .....(Please print)

Your signature: ..... Date.....

Investigator's name .....(Please print)

Investigator's signature ..... Date.....

Witness's Name .....(Please print)

Witness's signature ..... Date.....

#### **Annexure 4**

The Principal  
(Name of School)

**Dear Sir**

**Re: Permission to do research at (Name of School) Primary School**

I am a dentist working for the Mpumalanga Department of Health. During the past 3 years we were running the Brite Smiles Brite Future tooth brushing programme in the Ehlanzeni district of the Province. In order to evaluate the impact of the programme on the oral health of children in the district an oral health survey is planned. Six hundred children at various schools in the Ehlanzeni District will be examined for tooth decay. This study involves an examination of the mouth and teeth and the measuring of weight and height of the child. This examination per child will take about 4 to 6 minutes, during which time the most important findings will be recorded. About 30 to 80 children from your school will be examined. Permission is herewith requested to conduct a study on the school grounds. Separate permission will be obtained from the parents and children involved in the study. The contact person for the study is Dr Marius van der Walt. If you have any questions about the study please contact him at cell 0823021011.

We intend to publish the findings of the study in a professional journal and/ or at professional meeting like symposia, congresses, or other meetings of such a nature.

We intend to protect the personal identity of the learners by assigning each learner a random code number.

We undertake not to proceed with the study until we have received approval from the Research Ethics Committee of the Faculty of Health Sciences, University of Pretoria.

Yours sincerely

(Signature of the Researcher)

Permission to do the research study at this school is hereby approved.

The Principal  
(Name of School)

Mr/Ms (Name of Principal)

\_\_\_\_\_  
Signature of Principal

**School Official**

Annexure 5

**Chairperson:**  
Prof LM Sykes  
**Members:**  
Prof T Swart  
Prof SM Dawjee  
Dr P Brandt  
Prof A Bhaya  
**Secretary:**  
Ms C Swart

**RESCOM/ NAVKOM**  
School of Dentistry / Skool vir Tandheelkunde  
Faculty of Health Sciences  
Fakulteit Gesondheidswetenskappe



UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

P.O. Box 1200  
PRETORIA 0002  
Tel: 012 319 2683/2415  
Fax: 012 323 0581  
E-mail:  
leanne.sykes@up.ac.za  
christa.swart@up.ac.za

Prof AJ Ligthelm  
Dean  
School of Dentistry

2015-07-07

Dear Professor

**PROTOCOL APPROVAL: DENT 2015/25**

Name: M van der Walt

Title: **"The effectiveness of a tooth brushing programme for children in the Ehlanzeni District of Mpumalanga and the relationship between body mass index (BMI) and odontogenic infections."**

The protocol attached hereto was evaluated by the Research Committee of the School of Dentistry. The Research Committee recommends the approval of the title and the protocol.

Your sincerely

**PROF L SYKES**

**CHAIRPERSON: RESEARCH COMMITTEE**

Protocol approved/not approved

**PROF AJ LIGTHELM**

**DEAN: SCHOOL OF DENTISTRY**

## Annexure 6

The Research Ethics Committee, Faculty Health Sciences, University of Pretoria complies with ICH-GCP guidelines and has US Federal wide Assurance.

- FWA 00022557, Approved dd 22 May 2002 and Expires 20 Oct 2016.
- IRB 0000 2235 ICRG0001762 Approved dd 22/04/2014 and Expires 22/04/2017.



UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

Faculty of Health Sciences Research Ethics Committee

1/10/2015

### Approval Certificate New Application

Ethics Reference No.: 342/2015

**Title:** THE EFFECTIVENESS OF A TOOTH BRUSHING PROGRAMME FOR CHILDREN IN THE EHLANZENI DISTRICT, MPUMALANGA AND THE RELATIONSHIP BETWEEN BODY MASS INDEX (BMI) AND ODONTOGENIC INFECTIONS.

Dear Philippus van Wyk

The **New Application** as supported by documents specified in your cover letter dated 16/09/2015 for your research received on the 16/08/2015, was approved by the Faculty of Health Sciences Research Ethics Committee on its quorate meeting of 30/09/2015.

Please note the following about your ethics approval:

- Ethics Approval is valid for 1 year
- Please remember to use your protocol number (**342/2015**) on any documents or correspondence with the Research Ethics Committee regarding your research.
- Please note that the Research Ethics Committee may ask further questions, seek additional information, require further modification, or monitor the conduct of your research.

Ethics approval is subject to the following:

- The ethics approval is conditional on the receipt of 6 monthly written Progress Reports, and
- The ethics approval is conditional on the research being conducted as stipulated by the details of all documents submitted to the Committee. In the event that a further need arises to change who the investigators are, the methods or any other aspect, such changes must be submitted as an Amendment for approval by the Committee.

We wish you the best with your research.

Yours sincerely

**Dr R. Sommers**; MBChB; MMed (Int); MPharMed.

**Deputy Chairperson** of the Faculty of Health Sciences Research Ethics Committee, University of Pretoria

*The Faculty of Health Sciences Research Ethics Committee complies with the SA National Act 61 of 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 and 45. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).*

☎ 012 354 1677    📠 0866516047    ✉ [deepeka.behen@up.ac.za](mailto:deepeka.behen@up.ac.za)    🌐 <http://www.healthethics-up.co.za>  
📍 Private Bag X323, Arcadia, 0007 - 31 Dophelo Road, HW Snyman South Building, Level 2, Room 2.33, Gezins, Pretoria

**Annexure 7**

**FREQUENCY DISTRIBUTIONS FOR EACH COMPONENT OF dmft AND DMFT FOR INTERVENTION AND CONTROL GROUPS**

**INTERVENTION GROUP**

**Table 7.1: Total decayed (primary teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	115	46.0	46.0	46.0
1.00	29	11.6	11.6	57.6
2.00	36	14.4	14.4	72.0
3.00	18	7.2	7.2	79.2
4.00	25	10.0	10.0	89.2
5.00	12	4.8	4.8	94.0
6.00	5	2.0	2.0	96.0
7.00	6	2.4	2.4	98.4
8.00	3	1.2	1.2	99.6
10.00	1	.4	.4	100.0
Total	250	100.0	100.0	

**Table 7.2: Total missing (primary teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	236	94.4	94.4	94.4
1.00	5	2.0	2.0	96.4
2.00	6	2.4	2.4	98.8
3.00	2	.8	.8	99.6
4.00	1	.4	.4	100.0
Total	250	100.0	100.0	

**Table 7.3: Total fillings (primary teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	244	97.6	97.6	97.6
1.00	6	2.4	2.4	100.0
Total	250	100.0	100.0	

**Table 7.4: Total dmft (primary teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	114	45.6	45.6	45.6
1.00	28	11.2	11.2	56.8
2.00	36	14.4	14.4	71.2
3.00	15	6.0	6.0	77.2
4.00	21	8.4	8.4	85.6
5.00	16	6.4	6.4	92.0
6.00	5	2.0	2.0	94.0
7.00	9	3.6	3.6	97.6
8.00	3	1.2	1.2	98.8
9.00	2	.8	.8	99.6
10.00	1	.4	.4	100.0
Total	250	100.0	100.0	

**Table 7.5: Total Decayed (permanent teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	225	90.0	90.0	90.0
1.00	19	7.6	7.6	97.6
2.00	5	2.0	2.0	99.6
4.00	1	.4	.4	100.0
Total	250	100.0	100.0	

**Table 7.6: Total Missing (permanent teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	249	99.6	99.6	99.6
2.00	1	.4	.4	100.0
Total	250	100.0	100.0	

**Table 7.7: Total Fillings (permanent teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	248	99.2	99.2	99.2
1.00	2	.8	.8	100.0
Total	250	100.0	100.0	

**Table 7.8: Total DMF (permanent teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	223	89.2	89.2	89.2
1.00	19	7.6	7.6	96.8
2.00	7	2.8	2.8	99.6
4.00	1	.4	.4	100.0
Total	250	100.0	100.0	

**CONTROL GROUP**

**Table 7.9: Total decayed (primary teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	71	28.4	28.4	28.4
1.00	23	9.2	9.2	37.6
2.00	50	20.0	20.0	57.6
3.00	42	16.8	16.8	74.4
4.00	20	8.0	8.0	82.4
5.00	20	8.0	8.0	90.4
6.00	14	5.6	5.6	96.0
7.00	8	3.2	3.2	99.2
8.00	2	.8	.8	100.0
Total	250	100.0	100.0	

**Table 7.10: Total missing (primary teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	234	93.6	93.6	93.6
1.00	7	2.8	2.8	96.4
2.00	3	1.2	1.2	97.6
3.00	3	1.2	1.2	98.8
4.00	1	.4	.4	99.2
6.00	1	.4	.4	99.6
8.00	1	.4	.4	100.0
Total	250	100.0	100.0	

**Table 7.11: Total fillings (primary teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	250	100.0	100.0	100.0

**Table 7.12: Total dmft (primary teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	71	28.4	28.4	28.4
1.00	22	8.8	8.8	37.2
2.00	47	18.8	18.8	56.0
3.00	40	16.0	16.0	72.0
4.00	21	8.4	8.4	80.4
5.00	18	7.2	7.2	87.6
6.00	16	6.4	6.4	94.0
7.00	7	2.8	2.8	96.8
8.00	4	1.6	1.6	98.4
9.00	2	.8	.8	99.2
10.00	2	.8	.8	100.0
Total	250	100.0	100.0	

**Table 7.13: Tot Decayed (permanent teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	201	80.4	80.4	80.4
1.00	27	10.8	10.8	91.2
2.00	9	3.6	3.6	94.8
3.00	10	4.0	4.0	98.8
4.00	2	.8	.8	99.6
5.00	1	.4	.4	100.0
Total	250	100.0	100.0	

**Table 7.14: Total Missing (permanent teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	244	97.6	97.6	97.6
1.00	5	2.0	2.0	99.6
2.00	1	.4	.4	100.0
Total	250	100.0	100.0	

**Table 7.15: Total Fillings (permanent teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	250	100.0	100.0	100.0

**Table 7.16: Total DMF (permanent teeth)**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid .00	199	79.6	79.6	79.6
1.00	29	11.6	11.6	91.2
2.00	8	3.2	3.2	94.4
3.00	8	3.2	3.2	97.6
4.00	4	1.6	1.6	99.2
5.00	2	.8	.8	100.0
Total	250	100.0	100.0	