THE EFFECT OF DENTAL TREATMENT ON WEIGHT GAIN IN CHILDREN IN SOUTH AFRICA

Veerasamy Yengopal

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THE EFFECT OF DENTAL TREATMENT ON WEIGHT GAIN IN CHILDREN IN SOUTH AFRICA

V Yengopal, Faculty of Dentistry, University of the Western Cape

Background: There is an increased interest in understanding the effects of severe tooth decay on the physical, anthropometric, psychosocial, functional, and oral health related quality of life (OHRQoL) among children. Children who have severe tooth decay are thought to have lower weight, height, Body Mass Index (BMI), Haemoglobin (Hb) levels and poorer OHRQoL compared to children who are caries free. Comprehensive dental treatment under general anaesthesia (GA) appears to significantly improve these variables to levels equivalent to healthy caries free children. However, there is a paucity of high quality evidence that has demonstrated these gains in the anthropometric (Height, Weight BMI), clinical and oral health related quality of life (OHRQoL) measures following extensive dental treatment under GA. This trial sought to determine the impact of the treatment of severe dental caries on weight, height, body mass index (BMI), Hb levels and oral health related quality of life (OHRQoL) among a group of young children who had access to immediate care compared to a control group of children who waited 6 months before treatment

Methodology: This was a Community based prospective, randomized controlled intervention trial conducted in the peri-urban town of Worcester in the Western Cape Region of South Africa. The study population consisted of crèche going children, aged 2-6 years old who had severe tooth decay with a pufa score ≥ 1and attended public dental facilitates in the town. Simple random sampling using an existing lottery draw system at the clinic was used to divide the children into an immediate treatment group and a delayed treatment group (6 months later). Baseline height, weight, BMI, Hb levels were compared between treatment and no treatment groups at 6 months. OHRQol was measured from both the child and parent/caregiver perspective at baseline, 6 months later (in delayed group) and 6 months post treatment in both groups. Anthropometric variables were reported as unadjusted means and z-scores which were determined by transforming the unadjusted means against a reference group to determine the weight-for-height (WAH), weight-for-age (WAZ) and BMI-for –age (BAZ) in both groups after treatment. OHRQoL scores were dichotomized and/or categorized into high, low and no impacts.

Descriptive statistics (means), correlation analyses (by age, gender) and multilevel mixed regression model analysis was undertaken to determine the effect of the treatment on the outcome variables using SPSS version 23.

Results: 126 children in the immediate group (mean age 4.4 years, SD 1.2) and 125 children (mean age 3.75 years, SD 1.3) completed this trial. Comparative baseline measures significantly favoured children in the immediate group for age, height, and weight. The average number of teeth extracted under GA was 7.4 (SD 3.53) in the immediate group and 8.55 (SD 3.94) in the delayed group. Unadjusted mean scores for height, weight, BMI and Hb showed significant improvements within the groups at 6 months follow-up. When the group were compared (treatment vs. no treatment) using unadjusted or z-scores, statistically significant gains were noted for height and weight but not for BMI or Hb. Multilevel Regression modelling confirmed these findings implying that the intervention alone was not a factor in the improved Hb or BMI levels. OHRQoL significantly improved from both the child and parent/caregivers' perspective after treatment was received. In the delayed group, there was no improvement in OHRQoL scores during the 6 month waiting period but these significantly improved to comparable levels seen in the immediate group 6 months after treatment.

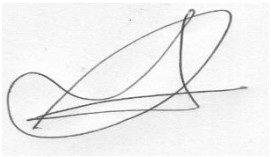
Conclusion: This randomised controlled trial found that children with severe tooth decay who received treatment under general anaesthesia had significantly better height and weight gains than those children who has no treatment. Although gains were also noted in the BMI and Hb levels, these gains were not statically significant and their improvements could not be explained by the intervention alone (dental treatment under general anaesthesia).

OHRQoL outcomes showed significant improvement from both the child and parental/caregiver perspective when comparing children who received treatment against those who did not have treatment. Children who had to wait for treatment had similar negative impacts on OHRQoL at 6 months follow-up compared to baseline. However, once they received treatment (delayed group), similar significant improvements for OHRQoL as reported in the immediate group was also found in the delayed group.

KEYWORDS: South Africa, Children, Weight Gain, Dental Treatment

DECLARATION

I declare that the thesis entitled *The effect of dental treatment on weight gain in children in South Africa* is my own work, that it has not been submitted before for any degree or examination at any other university, and that all the sources I have used or quoted have been indicated and acknowledged as complete references.



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Veerasamy Yengopal **Date**

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LIST OF TABLES

LIST OF FIGURES

Table of Contents

CHAPTER 1: INTRODUCTION

1.1 Background

Tooth decay is amongst the most common diseases in the world affecting more than 90% of the world population (Bagramian *et al*, 2009 Elderstein, 2006). Dental caries in adult and child populations thus remains a major public health problem in most communitites around the world despite a significant input of resources in the last few decades (Peterson, 2003). Much of the caries burden is bourne by children with untreated caries in the primary dentition being the 10th most prevalent health condition worldwide, affecting an estimated 621 million children (Kassebaum, 2015). The World Health Organization's geographical estimation of disease burden indicates that children in the South-East Asia region suffered the greatest burden of caries in 2012 (36% of the total global caries disability-adjusted life years (DALYs) burden for ages 0-14 years), followed by children in the Western Pacific region (19%) and the Africa region (18%), and to a lesser extent by children in the Eastern Mediterranean region (11%), region of the Americas (9%), and the European region (7%) (WHO, 2014a).

According to the World Health Organization's estimation of disease burden by World Bank region, children from high income countries collectively accounted for only 6% of the total global caries DALYs burden in 2012. Of the six low and middle income World Bank regions, children in South Asia suffered the greatest DALYs burden of caries in 2012 (35% of global total), after which followed East Asia and Pacific (25%) and Sub-Saharan Africa (19%), before notably dropping for children in Latin America and Caribbean (7%), the Middle East and North Africa (5%), and Europe and Central Asia (3%) (WHO, 2014b).

In developing countries, the problem of tooth decay among children is of even greater concern due to the combination of high prevalence and limited resources presenting substantial access barriers to oral healthcare services. Children in South Africa, especially those from poor communities, already facing an unprecedented quadruple burden of disease [communicable, non-communicable, perinatal and

maternal, and injury-related disorders] (Mayosi et al, 2009) that is impacting significantly on child morbidity, mortality and quality of life indicators, face the added burden of a significantly huge untreated caries burden (van Wyk *et al*, 2002)

The results of the most recent National Children's Oral Health Survey (NCOS) provides evidence of this (Tables A-D) with children from the Western Cape (the focus of this research report) being the most affected.

Table A: Percentage of tooth decay (dental caries) and untreated decay by age group and province, South Africa, 2004

Age group	4–5 years*		6 years*		12 years		15 years	
	% Decay	% Untreated decay	% Decay	% Untreated decay	% Decay	% Untreated decay	% Decay	% Untreated decay
Weighted national mean	50,6	46,6	60,3	55,1	36,9	30,3	51,0	42,2
Western Cape	**77**	**72**	**82**	**75**	**62**	**52**	**81**	**71**
Northern Cape			72**	71**	47	44	63	55
Eastern Cape	59	54	68	64	49	33	64	48
Free State	60	58	59	57	37	33	55	51
KwaZulu Natal	52	51	65	60	39	35	51	46
Gauteng	49	38	60	51	34	27	50	31
North West	41	40	52	48	28	25	39	36
Mpumalanga	40	35	56	48	30	27	41	37
Limpopo	31	31	37	34	16	14	28	24

Source: National Children's Oral Health Survey, 2004

***Primary/Milk teeth **Age adjusted figures**

With approximately 6.11.million people (11.3% of the population) (Statistics South Africa, 2015), the Western Cape is a province that models the inequities and inequalities that makes South Africa one of the most consistently unequal countries in the world (GINI index, World Bank estimates, 2014). The oral health disease profile reflects this with Postma *et al* (2008) reporting that children from coloured communities (the focus of this trial) had an increased risk for early childhood caries (ECC) and this risk was further increased with unemployment of the parents and /or child caregiver (Postma *et al*, 2008).

The high caries prevalence, untreated caries and high dmft is almost exclusively due to the rampant levels of dental caries in the coloured population in the Western Cape province (National Children's Oral Health Survey, 2004; van Wyk *et al*, 2003; Van Wyk and Van Wyk, 2004) with the provincial data for 4-5 and 6 year olds being the highest in the country (Tables A-D).

The prevalence of dental caries is also strongly associated with deprivation, whereby children from low income families suffer a greater component of the burden of decay than children from more affluent backgrounds (Rugg-Gunn 2013; Thomson 2012). This trend of social inequality continues into adulthood, and independent of deprivation-level, children who suffer from caries are also at an increased risk of developing adult decay (Thomson 2012; Thomson 2004).

Table B: Distribution of the mean dmft and its components in South Africa for the 4- to 5-year-old group.

	dmft	d	m	f
Weighted National mean	**2.44**	**1.95**	**0.35**	**0.16**
Western Cape	4.81	3.66	1.04	0.1
Eastern Cape	3.36	2.55	0.73	0.07
Free State	2.96	2.60	0.31	0.05
KwaZuluNatal	2.52	2.30	0.19	0.03
Gauteng	1.96	1.06	0.20	0.66
North West	1.52	1.39	0.09	0.04
Mpumalanga	2.05	1.58	0.24	0.23
Limpopo	0.84	0.82	0.1	0.1

*Primary Dentition

Dental caries can have a substantial impact on children's quality of life (QoL); not only causing pain and difficulties eating, but also affecting school attendance and disrupting sleep patterns, and consequently resulting in adverse growth development and educational performance (Finucane 2012; Guarnizo-Herreño 2012; Naidoo et al, 2001).

Many studies have investigated the psycho-social and physical consequences of severe early childhood caries in young children and the concomitant negative effects on oral health related and general quality of life, growth, school attendance and performance, nutrition, sleeping patterns and weight gain (Tsakos et al 2012, Ramos-Jorge et al 2014 Naidoo et al, 2001 Mota-Veloso et al, 2016).

Table C: Distribution of the mean dmft and its components in South Africa for the 6-year-old group.

	dmft	d	m	f
Weighted National mean	**2.88**	**2.24**	**0.51**	**0.12**
Western Cape	5.51	3.81	1.57	0.12
Northern Cape	4.25	3.62	0.61	0.01
Eastern Cape	3.86	2.89	0.86	0.09
Free State	2.48	2.16	0.27	0.05
KwaZuluNatal	2.82	2.39	0.38	0.05
Gauteng	2.53	1.74	0.41	0.34
North West	2.13	1.85	0.25	0.03
Mpumalanga	2.27	1.79	0.31	0.17
Limpopo	1.33	1.13	0.09	0.11

*Primary Dentition

Table D: Percentage distribution of care needed and the mean number of teeth needing care for dental caries per age group in South Africa.

Source: National Children's Oral Health Survey, 2004

Age group	**4-5***		**6**		**12**		**15**	
	% children needing care	**Mean number of teeth**	**% children needing care**	Mean number of teeth	**% children needing care**	Mean number of teeth	**% children needing care**	**Mean number of teeth**
Weighted national mean	45.59	2.06	**59.05**	**2.97**	**45.28**	**2.59**	**49.85**	2.91

Western Cape	**73.2**	**3.93**	86.3	5.24	80.5	5.3	85.2	**6.2**
Northern Cape			85.1	4.73	57.4	1.84	62.2	**2.79**
Eastern Cape	**54.4**	**2.5**	66.6	3.17	38.5	0.94	49.7	**2.33**
Free State	**59.7**	**2.7**	65.9	3.11	58.2	5.87	66.6	**4.63**
KwaZuluNatal	**43.7**	**2.07**	62.3	3.15	52.3	3.23	59.0	**3.74**
Gauteng	**43.00**	**1.40**	62.50	2.79	61.60	4.04	47.10	**2.69**
North West	33.6	2.00	39.6	2.35	29.8	2.067	31.3	2.57
Mpumalanga	**36.9**	**2.2**	**51.3**	**3.0**	**39.2**	**1.79**	**44.9**	**1.89**
Limpopo	**30.1**	**0.82**	**35.5**	**1.45**	**14.1**	**0.35**	**24.1**	**0.83**

Mota-Veloso and colleagues (2016) reported from Brazil on the Impact of untreated dental caries and its clinical consequences on the oral health-related quality of life of 587 schoolchildren aged 8-10 years in Brazil. Oral health-related quality of life (OHRQoL) was evaluated using the Child's Perception Questionnaire (CPQ8-10). They correlated clinical measures such as dmft/DMFT and pufa/PUFA with subjective measures (CPQ8-10) and showed that untreated caries was significantly associated with the total CPQ8-10 score and all subscale scores. Additionally, the clinical consequences of untreated dental caries (PUFA/pufa index >0) were significantly associated with the total CPQ8-10 as well as the oral symptoms and functional limitations' subscales.

Similar findings were reported in other settings and child and adolescent populations, regardless of the quality of life (Qol) instrument used (Chukwumah *et al*, 2016; El-Meligy *et al*, 2016; Feldens *et al*, 2016; de Souza *et al*, 2016; Wong *et al*, 2016; Cantekin *et al*, 2014; Jankauskiene *et al*, 2014; Ramos-Jorge *et al*, 2014; Duijster *et al*, 2013). Jankauskiene and Narbutaite (2010) assessed changes in oral health-related quality of life among children following dental treatment under general anaesthesia in a systematic review and concluded

that dental treatment under GA resulted in the immediate improvement of children's oral health and physical, emotional and social quality of life. It also had a positive impact on the family.

There is an increased interest in the relationship between caries and growth in young children and mechanisms whereby caries may affect growth. Evidence linking caries in primary teeth and children's anthropometric outcomes in recent cross-sectional studies conducted across the globe is contradictory in terms of both the presence and the direction of the association (Liang *et al,* 2016 [China]; Pikramenou *et al,* 2016 [Greece]; Bafti *et al,* 2015 [Iran]; Qadri *et al,* 2015 [Germany]; Alkarimi *et al,* 2014 [Saudi Arabia]; Bener *et al,* 2013 [Qatar]; Norberg *et al,* 2012 [Sweden]; Sakeenabi *et al,* 2012 [India]; Köksal *et al,* 2011 [Turkey]; Benzian *et al,* 2011 [Philippines]; Tramini *et al,* 2009 [France]).

A number of studies report a relationship between untreated caries and poor growth which contributes to children's low weight gain and failure to thrive (FTT) (Alkarimi *et al,* 2014; Acs *et al,* 1999; Benzian *et al,* 2011; Miller *et al,* 1982; Monse *et al,* 2012; Sheller *et al,* 1997; Sheiham 2006; Hooley *et al,* 2012). Two theories may explain this relationship. The first theory is that the direct impact of extensive untreated caries and associated pain and inflammation on the child's ability to eat may result in undernutrition and growth impairment (Acs *et al,* 1992; Acs *et al,* 1999; Alkarimi *et al,* 2014; Boyd *et al,* 1998; Duijster *et al,* 2013; Hannaway, 1970; Monse *et al,* 2012; Tang *et al,* 2013).

The second theory includes the indirect effects of untreated caries and different body responses to chronic dental infection. Three mechanisms are suggested. The first concerns immune responses. Infected dental pulp may affect immunity and erythropoiesis (Hahn *et al,* 200; Plitnick *et al,* 1998; Means Jr, 2003, Means and Krantz, 1992) which may result in anemia (Means Jr, 2003) and influence bone remodeling (Machado *et al,* 2015; Stephensen,

1999), sleep patterns, (Kelly *et al,* 2003; Takahashi *et al,* 1968) and food intake (Plata-Salamán, 1996).

Dental sepsis and inflammation which are common clinical symptoms of severe untreated dental caries can affect growth through chronic inflammation via a metabolic pathway where cytokines affect erythropoiesis. Interleukin-1 (IL-1), which has a wide variety of actions in inflammation, can induce inhibition of erythropoiesis. This suppression of haemoglobin (Hb) can lead to anaemia which is a chronic disease arising from depressed erythrocyte production. Clinically this can be seen as lowered blood Hb levels which is postulated to return to normal or increase with treatment of the disease (caries) (Beltrame *et al*, 2016; Bansal *et al*, 2016; Means Jr, 2003; Means & Krantz, 1992). This association between severe untreated dental caries and low Hb and/or mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration, and packed cell volume (PCV) has been reported in a few recent studies (Beltrame *et al,* 2016; Bansal *et al,* 2016; Schroth *et al,* 2013) which imply that this may be a risk marker for the development of anaemia. The second mechanism is related to endocrine responses. The interruption of slow-wave sleep due to pain and infection may lead to impairment of growth hormone secretion (Phillip *et al,* 1998; Takahashi *et al,* 1968) and the subsequent negative effects of low height and weight. The third mechanism is linked to metabolic responses. Infections and related inflammation might result in micronutrient undernutrition through increasing energy expenditure and metabolic demands and impaired nutrient absorption (Semrin *et al,* 2006; Stephensen, 1999).

Only three randomized clinical trials have investigated the impact of dental treatment on body growth (weight or weight gain) and the authors reported conflicting findings. (Alkarimi *et al,* 2012; van Gemert-Schriks *et al,* 2011; Monse *et al,* 2012). Both Alkarimi et al (2012) in Saudi Arabia (Middle East) and van Gemert-Schriks *et al* (2011) in Suriname (South America) reported no significant

differences in anthropometric outcomes between children receiving or not receiving comprehensive dental treatment. Monse *et al* (2012) in the Philippines, however, found that the treatment of severe dental caries significantly improved growth of underweight young children.

1.2 Study Rationale

Based on these conflicting findings of both randomized clinical trials and cross-sectional studies, this clinical trial sought to answer the following research question:-

Is immediate tooth extraction under general anaesthesia in preschool children with severe dental decay followed by an increased velocity of weight gain and improvement in "oral health related quality of life" (OHRQoL) compared to delayed treatment in a control group of children?

This study builds on research showing that extraction of decayed teeth increased rate of growth in children. Stunting and underweight and untreated caries are very common in South Africa where study will be conducted. The Global food nutrition report (2015) reports an almost 25% prevalence of stunting among children under 5 in South Africa. If a common condition like severe caries affects growth and wellbeing of millions of children, then dental treatment to eradicate inflammation and pain could be important for enhancing growth in undernourished children.

CHAPTER 2: SYSTEMATIC LITERATURE REVIEW OF THE RESEARCH QUESTION

Research Question: Is immediate tooth extraction under general anaesthesia in preschool children with severe dental decay followed by an increased velocity of weight gain and improvement in "oral health related quality of life" (OHRQoL) compared to delayed treatment in a control group of children?

2.1 Introduction & Context

Most experts agree that the higher up the hierarchy the study design is positioned, the more rigorous the methodology and hence the more likely it is that the study design can minimize the effect of bias on the results of the study (Hoffman *et al*, 2013). In most evidence hierarchies current, well designed systematic reviews and meta-analyses are at the top of the pyramid, and expert opinion and anecdotal experience are at the bottom. A systematic review synthesizes the results from all available studies in a particular area, and provides a thorough analysis of the results, strengths and weaknesses of the collated studies (Cook, 1997). Systematic reviews continue to gain prominence as the premier source of evidence to guide decisions (clinical and policy) regarding the effectiveness of therapies for improved oral health [Yengopal & Mickenautsch, 2009]. Well done systematic reviews, are generally considered to provide the best evidence for all question types as they are based on the findings of multiple studies that were identified in comprehensive, systematic literature searches (National Health and Medical Research Council (NHMRC), 2009).

The following image represents the hierarchy of evidence provided by the National Health and Medical Research Council (NHMRC) (2009)

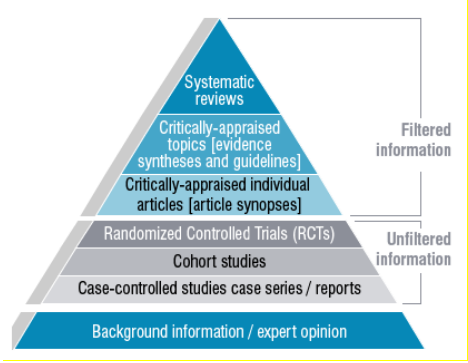


Figure 2.1 Hierarchy of evidence guiding clinical decision making

Of even more value are systematic reviews, if they include a meta-analyses of clinical and methodologically homogeneous trials that are combined to provide a cumulative weight of evidence for or against a particular therapy. The advantages of meta-analysis over narrative or qualitative synthesis of the literature are that it provides the chance to detect a treatment effect as statistically significant ($p<0.05$) and to improve estimation of the effect by quantifying its outcome; thus making its estimation more precise [Higgins & Green, 2011]. Since the research question for this study was focused, a systematic review of the evidence was undertaken rather than a traditional review because it provided the opportunity to employ a rigorous methodology/study design to minimise the effect of bias when synthesizing the current "state of the art" information on this topic. The traditional narrative reviews (often just called "Reviews" or in the case of Masters or PhD dissertations these are called "literature review") are opinion-based with selective illustrations from the literature. They do not qualify as adequate evidence to answer clinical questions (for e.g., the research question in this study is a clinical question). Rather than answering a specific clinical question, they provide an overview of the research landscape on a given topic and so maybe useful for only background information and are usually not publishable. Narrative reviews usually lack systematic search protocols or explicit criteria for selecting and appraising evidence and are therefore very prone to bias (Cook *et al*, 1997) (Table 2.1)

Differences between systematic reviews and narrative reviews[5]

Feature	Systematic review	Narrative review
Question	A focused clinical question	Often broad in scope
Sources and search	Comprehensive sources and explicit search strategy	Not usually specified, potentially biased
Selection	Criterion-based selection, uniformly applied	Not usually specified, potentially biased
Appraisal	Rigorous critical appraisal	Variable
Synthesis	Qualitative summary that often includes statistical synthesis (meta analysis)	Often a qualitative summary
Inferences	Evidence-based	Sometimes evidence-based

Table 2.1 Differences between systematic reviews and narrative reviews

Based on the above information, it was felt that a systematic review would be a more rigorous and better exploration of the literature pertaining to the research question under investigation in this study.

2.2 The effects of dental treatment on Anthropometric and Oral health related quality of life (OHRQol) measures among young children with severe untreated caries: A Systematic Review and Meta-analysis

2.2.1 Background

Malnutrition and poor diets constitute the number-one driver of the global burden of disease. Globally, in 2014, it was estimated that there were about 159 million children (23.8% prevalence) under the age of 5 that were stunted (low height-for-age) and approximately 16 million (2.4% prevalence) suffered from severe wasting (low weight-for-height) (Global Food nutrition report, 2016). A number of studies report a relationship between untreated caries and poor anthropometric outcomes (weight, height, body mass index [BMI]) which contributes to children's low weight gain and failure to thrive (FTT) (Alkarimi et al, 2014; Acs et al, 1999; Benzian et al, 2011; Miller et al, 1982; Monse et al, 2012; Sheller et al, 1997; Sheiham 2006;) and this is postulated to contribute to the incidence and prevalence of low weight (underweight – low weight for age), stunting and wasting. Two theories may explain this relationship. The first theory is that the direct impact of extensive untreated caries and associated pain and inflammation on the child's ability to eat may result in undernutrition and growth impairment (Acs et al, 1992; Acs et al, 1999; Alkarimi et al, 2014; Boyd et al, 1998; Duijster et al, 2013; Hannaway, 1970; Monse et al, 2012; Tang et al, 2013). The second theory includes the indirect effects of untreated caries and different body responses to chronic dental infection. Three mechanisms are suggested. The first concerns immune responses. Infected dental pulp may affect immunity and erythropoiesis (Hahn et al, 200; Plitnick et al, 1998; Means Jr, 2003, Means & Krantz, 1992; which may result in anemia (Means Jr, 2003) and influence bone remodeling (Machado et al 2015; Stephensen, 1999), sleep patterns, (Kelly, et al, 2003; Takahashi et al, 1968) and food intake (Plata-Salamán, 1996). Dental sepsis and inflammation which are common clinical symptoms of severe untreated dental caries can affect growth through chronic inflammation via a metabolic pathway where cytokines affect erythropoiesis. Interleukin-1 (IL-1), which has a wide variety of actions in inflammation, can induce inhibition of erythropoiesis. This suppression of haemoglobin (Hb) can lead to anaemia of chronic disease from depressed erythrocyte production. Clinically this can be seen as lowered blood Hb levels which is postulated to return to normal with treatment of the disease (caries) (Bansal et al, 2016; Means Jr, 2003; Means & Krantz, 1992).

This association between severe untreated dental caries and low Hb and/or mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration, and packed cell volume (PCV) has been reported in a few recent studies (Bansal et al, 2016; Schroth et al, 2013) which imply that this may be a risk marker for the development of anaemia. The second mechanism is related to endocrine responses. The interruption of slow-wave sleep due to pain and infection may lead to impairment of growth hormone secretion (Phillip et al, 1998; Takahashi et al, 1968). The third mechanism is linked to metabolic responses. Infections and related inflammation might result in micronutrient undernutrition through increasing energy expenditure and metabolic demands and impaired nutrient absorption (Semrin et al, 2006; Stephensen, 1999).

Evidence linking caries in primary teeth and children's anthropometric outcomes in recent cross-sectional studies conducted across the globe is contradictory in terms of both the presence and the direction of the association (Liang et al, 2016 [China]; Pikramenou et al, 2016 [Greece]; Bafti et al, 2015 [Iran]; Qadri et al, 2015 [Germany]; Alkarimi et al, 2014 [Saudi Arabia]; Bener et al, 2013 [Qatar]; Norberg et al, 2012 [Sweden]; Sakeenabi et al, 2012 [India] ; Köksal et al, 2011 [Turkey]; Benzian et al, 2011 [Philippines]; Tramini, et al, 2009 [France]). Only three randomized clinical trials have investigated the impact of dental treatment on body growth (weight or weight gain) and the authors reported conflicting findings. (Alkarimi et al, 2012; van Gemert-Schriks et al, 2011; Monse et al, 2012). Both Alkarimi et al in Saudi Arabia (Middle East) and van Gemert-Schriks et al, in Suriname (South America), reported no significant differences in anthropometric outcomes between children receiving or not receiving comprehensive dental treatment. Monse et al (2012), in the Philippines, however, found that the treatment of severe dental caries significantly improved growth of underweight young children.

Additionally, dental caries can have a substantial impact on children's quality of life (QoL); not only causing pain and difficulties eating, but also affecting school attendance and disrupting sleep patterns, and consequently resulting in adverse growth development and educational performance (Finucane 2012; Guarnizo-Herreño 2012; Naidoo et al, 2001). Jankauskiene and Narbutaite (2010) concluded in their systematic review that assessed changes in OHRQoL among children following dental treatment under GA that there was an immediate improvement of children's oral health and physical, emotional and social quality of life and it had a positive impact on the family.

However, besides doing a qualitative assessment of the included papers, no information was provided as to exactly how they reached this conclusion. It appears though that they based their findings on the cumulative weight of evidence of the number of individual studies that reported positive findings rather than attempting to pool together trials. More recently, Knapp and colleagues (2016) updated the 2010 review by Jankauskiene and Narbutaite and were critical of this paper as these authors did not undertake a quality assessment of included papers. The Knapp *et al*, systematic review also sought to assess change in OHRQoL in children following treatment under GA for the management of dental caries. They included all types of study designs in their inclusion criteria. Twenty studies were included, included, which demonstrated significant heterogeneity. Most studies employed a pre-test-post-test design. All but one study relied on proxy reports of OHRQoL and all reported improved OHRQoL overall, However, no meta-analysis was attempted and the broad inclusion criteria meant that the concluding remarks by the authors need to be interpreted with caution.

The disadvantage of qualitative synthesis in systematic reviews is that bias may be introduced if the outcomes of some studies are inappropriately stressed over others (Higgins & Green, 2011). The advantages of a meta-analysis over qualitative synthesis is that it provides the opportunity to identify a treatment effect as statistically significant ($p<0.05$) and to improve estimation of the effect by quantifying its outcome; thus making its estimation more precise (Higgins & Green, 2011). Therefore, whilst methodological weaknesses limit what can be inferred in terms of efficacy, the cumulative weight of evidence (as highlighted where possible, in a meta-analysis) provides a more objective assessment of a systematic analysis of the literature This has been the case in a number of systematic reviews where individual studies have had varied outcomes but the cumulative weight of the evidence (elicited through pooling together trials with similar outcomes) has been found to be conclusive for that particular outcome [Clarkson *et al* 2007*;* Marinho *et al*, 2003, Weil *et al*, 2007, Yengopal & Mickenautsch, 2012]. To date no systematic review with meta-analysis has reported on the effects of severe untreated caries on Anthropometric and Oral health related quality of life (OHRQol) measures among young children with severe untreated caries. This review sought to answer the following question:-

Is immediate tooth extraction under general anaesthesia in preschool children with severe dental caries followed by improved Anthropometric outcomes (height, weight, BMI) and oral health related quality of life (OHRQoL) outcomes compared to delayed or no treatment?

2.2.2 Methods

2.2.1.1 Systematic literature search

Both authors searched the following electronic databases independently: (1) General international databases: CENTRAL accessed via Cochrane Library, MEDLINE accessed via PubMed; (2) Open access sources: Biomed Central, Database of Open Access Journals (DOAJ); (3) Regional databases: [a] Africa: Sabinet, [b] India: IndMed; (4) Grey-Literature sources: OpenSIGLE, Google Scholar. Reference check of all included trial reports was conducted. Search terms included the following terms adjusted for the search engine/database used:

- dental caries AND growth AND children
- "dental caries" AND body growth AND children
- "dental caries" AND body growth AND children (custom range 1996 – 2016)
- "dental caries" AND body growth AND children NOT "ncbi.nlm.nih.gov" (custom range 1996 – 2016)

. Citations were eligible for possible inclusion if in line with the following criteria:

- Clinical trials (trials on animals, in-situ, in-vitro trials not included);
- Controlled trials: including control- and test group(s) (1-arm longitudinal trials not included);
- Trial focus relevant to PICO question;
- Prospective trials (retrospective trials not included);
- Full trial reports (abstracts without full reports not included);
- Follow-up period similar in test and control groups month;
- Trial participants are children less than 10 years of age (pre=pubertal children)

Articles were further excluded according to the criteria:

- No computable data reported;
- Test and control groups not evaluated the same way;
- Trials published in any other language than English.

Titles and abstracts of identified citations from data sources were scanned by the two authors (Veerasamy Yengopal (VY), Steffen Mickenautsch (SM)) in duplication, for possible inclusion in line with the inclusion criteria. Articles with a suitable title but without listed abstract were retrieved in full copy. All included articles were judged separately by authors for possible exclusion with reason or for acceptance, in line with the exclusion criteria. Disagreements between authors were solved through discussion and consensus with the other two authors (Esan Temitope (ET) & Sudeshni Naidoo (SN).

2.2.1.2 Data collection from accepted trials and analysis

Two authors (VY, SM) extracted data from accepted trials independently without being blinded to authors, institutions, journal name and trial results. Disagreements between authors concerning data extracted were solved through discussion and consensus. All data were entered in specifically designed data sheets and were reported in the Table of Included Studies. The following data were extracted:

(i) General important information: Article's first author; year of publication and full article reference; place of trial; age; trial participant characteristics; type of study design.

(ii) Information per test- and control group: details of intervention; numbers included, loss to follow-up

(iii) Verbatim quotes relevant to selection-, performance- and detection bias risk: Selection bias: Random sequence generation, concealment of the sequence allocation; Performance bias: Operator blinding; patient blinding; Detection bias: Evaluator blinding. Risk of Bias Table was completed as per RevMan version 5.3 and included as a Risk of Bias Table

There were two outcome measures assessed:

(1) **Effect of intervention (dental treatment under GA) on** :-

a. Mean weight, height, BMI, before and after treatment between intervention and control groups [continuous variables]

b. Rate of change (velocity of change) mean weight, height, and BMI [unadjusted values] before and after treatment between intervention and control groups

c. Rate of change of transformed height, weight and BMI data. The weight and height data are transformed into the weight-for-height (WAZ), weight-for-age (WAZ) and BMI-for –age (BAZ) and reported as Z-sores. The Z-score system expresses the anthropometric value as a number of standard deviations or Z-scores below or above the reference mean or median value (WHO standard references, 2007). A fixed Z-score interval implies a fixed height or weight difference for children of a given age. For population-based uses, a major advantage is that a group of Z-scores can be subjected to summary statistics such as the mean and standard deviation and can be used to pool data from different trials into a meta-analysis. In effect, Z-scores for different ages can be compared as the unit of interest and is the amount of "deviation" (positive or negative) from a reference standard ((WHO standard references for age, weight, height and BMI, 2007). The formula used for calculating the Z-score was:

Z-score (or SD-score) = (observed value - median value of the reference population) / standard deviation value of reference population (WHO standard references 2007).

(2) Oral Health Quality of Life (OHRQoL) Measures

Two approaches were used for data capture and analyses:-

(a) Details of the instrument used were included in the "Table of Included Studies". Attempts were made to pool the summed impact scores (mean with standard deviation) only if the same instrument was used in different trials and the impact scores were summed using the same methodology.

(b) Responses to similar questions from different quality of life instruments were dichotomized (Yes/No) and reported as the number of positive responses at the follow-up in both groups at a similar time interval. This in effect provided evidence of the improvement or the lack of improvement in patients' subjective responses in the intervention and control groups. For QoL instruments that had Likert-type responses (e.g., "not at all"; "very little"; "some"; "a lot";" very much"), these were also grouped into 2 categories (dichotomized) : little or no improvement (combined "not at all", "very little", "some" responses) and a lot of improvement (combined "a lot" and "very much" responses)

For included studies, datasets were created to facilitate pooling of similar outcomes into a meta-analysis. A dataset was defined as any extracted set of n / N for test- and control group. For comparisons of continuous variables (changes in height weight BMI), the mean with the standard deviation (SD) was used. If the mean was reported without a SD, then attempts were made to obtain a SD from either the standard error of the mean or the 95% confidence intervals. If the standard error (SE) was reported instead of the SD, then the following formula was used:-

$SD = SE \times \sqrt{N}$ [Higgins & Green, Cochrane Handbook, 2011]

When making this transformation, the standard errors were from means calculated from within an intervention group and not standard errors of the difference in means computed between intervention groups.

If included trials reported the 95% confidence intervals, then the following formula was used to calculate the SD:-

$SD = \sqrt{N} \times (\text{upper limit} - \text{lower limit}) / 3.92$

The above formula applies to larger sample sizes (>60). If the sample size is small (say less than 60 in each group) then the divisor, 3.92, in the formula above was replaced by 4.128. Again, when making this transformation, the confidence intervals were from means calculated from within an intervention group and not standard errors of the difference in means computed between intervention groups. ([Higgins & Green, Cochrane Handbook, 2011]

For each dataset the Relative Risk or Risk Ratio (RR) for dichotomous data and the Mean Difference (MD) for continuous data with 95% Confidence intervals (CI) and p-values were computed using a fixed effects model which assigned a Mantel-Haenszel weight for dichotomous data or used the inverse variance for continuous data to include studies directly proportionate to their sample size. Statistical significance was set at alpha 5%. For computation of all point estimates, the statistical software programme RevMan version 5.3 was used.

In order to fulfill the criteria of clinical and methodological homogeneity which allows for pooling of data for meta-analyses, datasets from the accepted trials did not differ in the following minimum set of characteristics: Length of follow-up period; baseline characteristics of children similar, assessment criteria similar in both groups, data collection and measurements similar in both groups.

2.2.1.3 Pooling of datasets

The I^2 – test with 95% CI was used to establish, whether any statistical heterogeneity existed between datasets that were assumed to be clinically and methodologically homogenous. Thresholds for I^2 point estimates (in %) and its upper confidence values were used in order to interpret the test results [Higgins & Green, 2011]: 0-40% = might not be important; 30-60% = may represent moderate heterogeneity; 50-90% = may represent substantial heterogeneity; 75-100% = considerable heterogeneity.

Identified (clinically/methodologically/statistically) homogenous datasets were pooled using fixed-effects meta-analysis with RevMan 5.3 software.

2.2.1.4 Assessment of bias risk

A risk of bias table was completed for each included trial as contained in the Cochrane Handbook (Higgins & Green, 2011). The criteria used to assess the risk of bias (internal validity) of each of the included trials is shown in Table 2.2. Two authors (VY & SM) conducted assessments independently. Disagreements were resolved by discussion and consensus. Each domain could be scored as “low risk” [coded green]; “high risk” [coded red] or “unclear risk” [coded yellow]

Table 2.2: The Cochrane Collaboration's tool for assessing risk of bias		
Domain	**Support for judgement**	**Review authors' judgement**
Selection bias.		
Random sequence generation.	Describe the method used to generate the allocation sequence in sufficient detail to allow an assessment of whether it should produce comparable groups.	Selection bias (biased allocation to interventions) due to inadequate generation of a randomised sequence.
Allocation concealment.	Describe the method used to conceal the allocation sequence in sufficient detail to determine whether intervention allocations could have been foreseen in advance of, or during, enrolment.	Selection bias (biased allocation to interventions) due to inadequate concealment of allocations prior to assignment.
Performance bias.		
Blinding of participants and personnel Assessments should be made for each main outcome (or class of outcomes).	Describe all measures used, if any, to blind study participants and personnel from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective.	Performance bias due to knowledge of the allocated interventions by participants and personnel during the study.
Detection bias.		
Blinding of outcome assessment *Assessments should be made for each main outcome (or class of outcomes).*	Describe all measures used, if any, to blind outcome assessors from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective.	Detection bias due to knowledge of the allocated interventions by outcome assessors.
Attrition bias.		
Incomplete outcome data *Assessments should be made for each main outcome (or class of outcomes).*	Describe the completeness of outcome data for each main outcome, including attrition and exclusions from the analysis. State whether attrition and exclusions were reported, the numbers in each intervention group (compared with total randomized participants), reasons for attrition/exclusions where reported, and any re-inclusions in analyses performed by the review authors.	Attrition bias due to amount, nature or handling of incomplete outcome data.
Reporting bias.		
Selective reporting.	State how the possibility of selective outcome reporting was examined by the review authors, and what was found.	Reporting bias due to selective outcome reporting.
Other bias.		
Other sources of bias.	State any important concerns about bias not addressed in the other domains in the tool. If particular questions/entries were pre-specified in the review's protocol, responses should be provided for each question/entry.	Bias due to problems not covered elsewhere in the table.

2.2.1.5 Assessment of publication bias risk

Funnels plots were derived from pooled datasets using the Cochrane Revman 5.3 software. Symmetrical funnels plots indicated no publication bias and asymmetrical plots were an indication of publication bias.

2.2.2 Results

2.2.2.1 Literature Search

Table 2.3 provides details of the search results per database and the search terms used for both anthropometric and oral health related quality of life (OHRQOL) measures.

Table 2.3: Results of Database Search at 12 August 2016

Search term number	Electronic database	Number of Citations found
BMC search strategy: 12.008.2016 Online: http://www.biomedcentral.com/search/boolean		
[1]	dental caries AND growth AND children	227
	Number of Articles for possible inclusion	**17**
CENTRAL search strategy: 12.08.2016 Online: http://onlinelibrary.wiley.com/cochranelibrary/search/		
[1]	dental caries AND growth AND children	24
	Number of Articles for possible inclusion	**9**
DOAJ search strategy: 12.08.2016 Online: http://www.doaj.org		
[1]	dental caries AND growth AND children	19
	Number of Articles for possible inclusion	**9**
GoogleScholar search strategy: 12.08.2016 Online: http://scholar.google.co.za/		
[1] [2] [3]	dental caries AND growth AND children "dental caries" AND body growth AND children "dental caries" AND body growth AND children (custom range 1996 – 2015) **"dental caries" AND body growth AND children NOT "ncbi.nlm.nih.gov" (custom range 1996 – 2015)**	41 300 results 19 000 results 13 700 results **380 results**
	Number of Articles for possible inclusion	**18**
PubMed search strategy: 12.08.2016 Online: http://www.pubmed.org		
	dental caries" AND body growth AND children	151
	Number of Articles for possible inclusion	**19**
SABINET search strategy: 12.08.2015 Online: http://sabinet.worldcat.org/advancedsearch		
[1]	"dental caries"+"growth"+children (SANB)	10
	Number of Articles for possible inclusion	**0**
	Reference check of included trial reports	**3**
	Total articles/documents considered for inclusion	**22**
Pubmed Search: OHRQOL		
[1]	**caries in children AND ('quality of life' OR Qol) [12.08.2016]**	**418**
	Number of Articles for possible inclusion	**17**
	No. of articles in total	**39**
	Less 3 overlaps	**36 final total**

Tables 2.4 & 2.5 provide further details of PRISMA flow diagrams for anthropometric (Table 2.4) and OHRQoL measures (Table 2.5). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) is an evidence-based minimum set of items for reporting in systematic reviews and meta-analyses. PRISMA focuses on the reporting of reviews evaluating randomized trials, but can also be used as a basis for reporting systematic reviews of other types of research, particularly evaluations of interventions (Moher et al, 2009).

Table 2.4: PRISMA 2009 Flow Diagram- for Anthropometric measures and caries in children

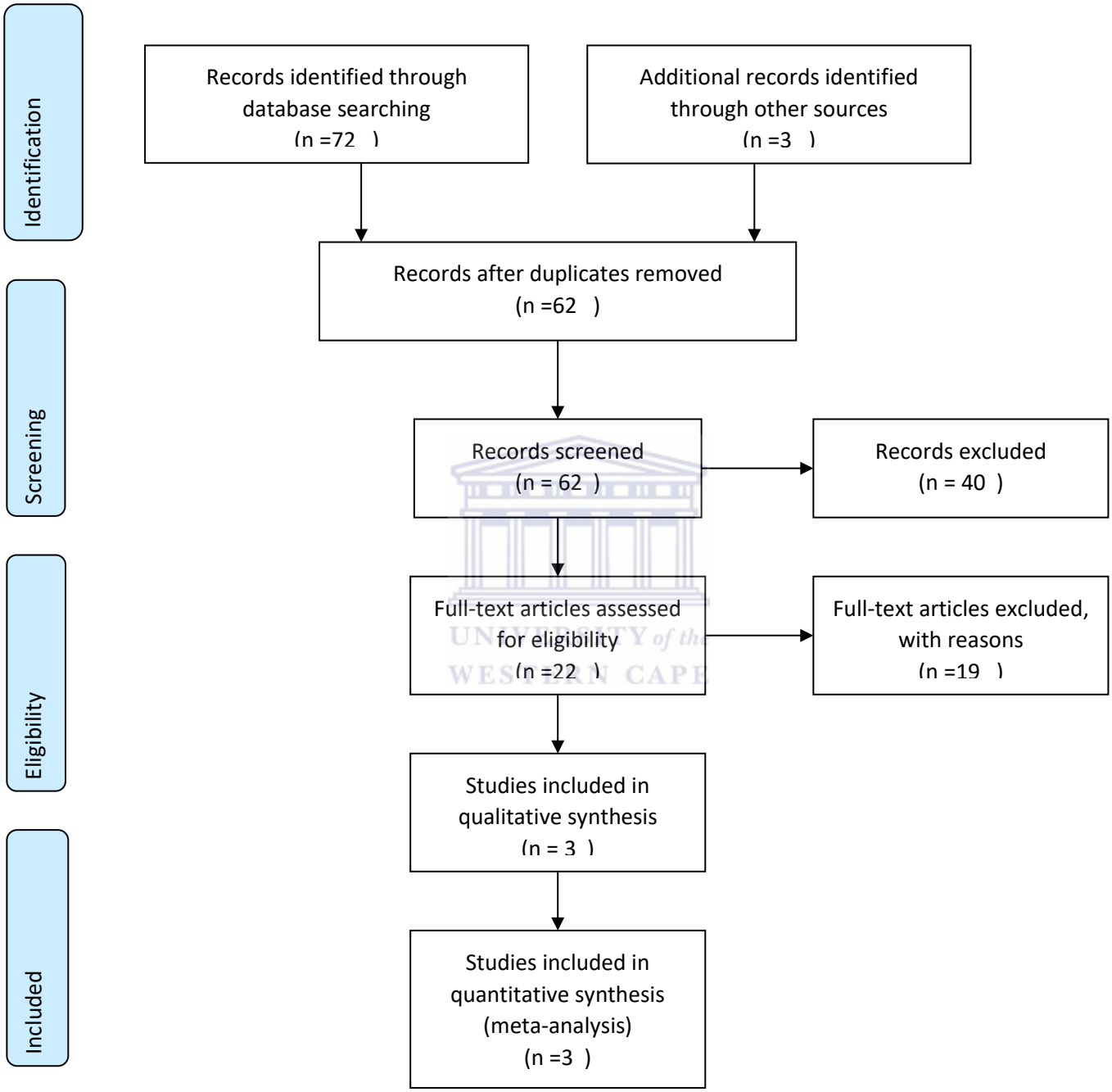
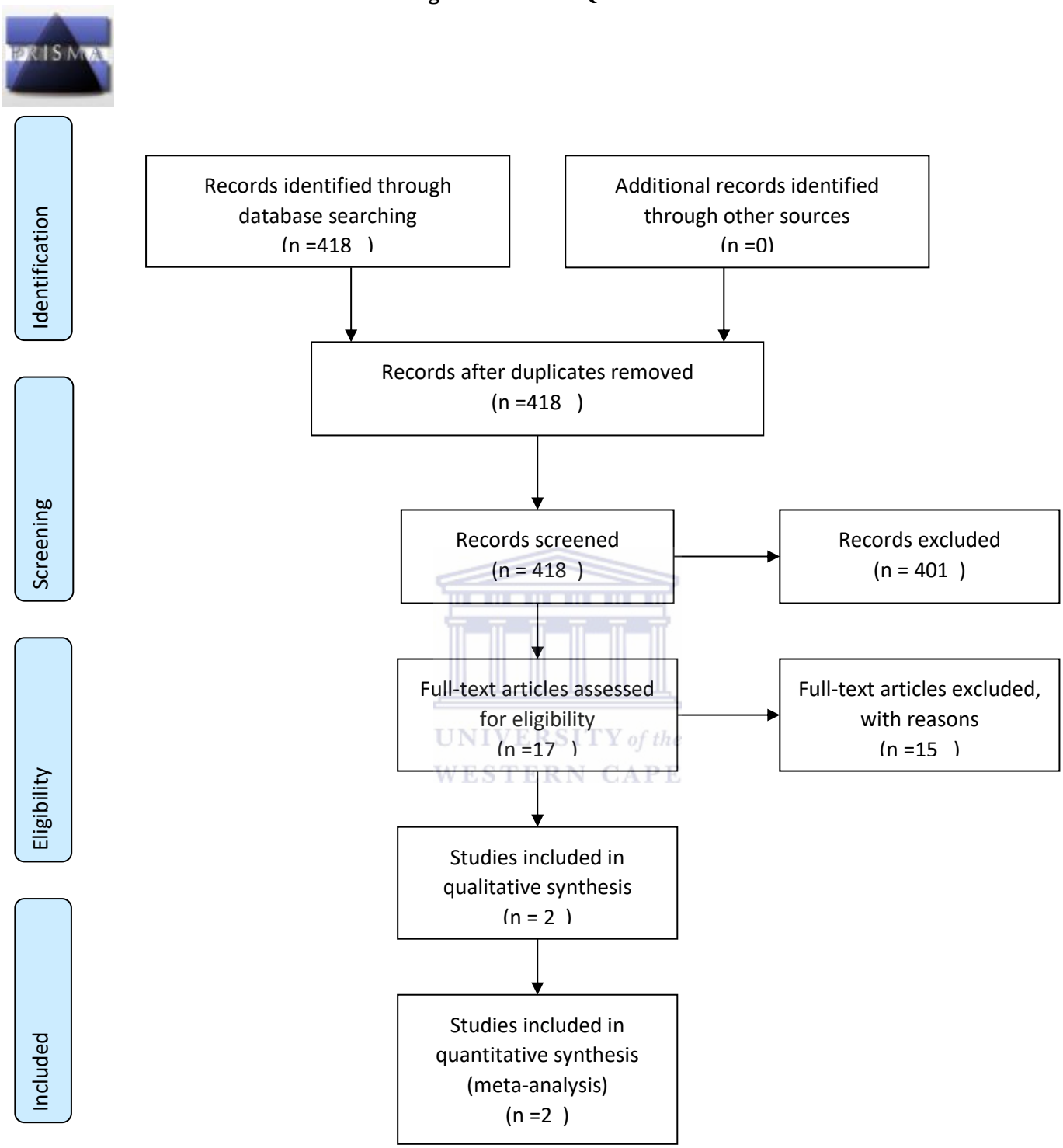


Table 2.5: PRISMA 2009 Flow Diagram- for OHRQoL measures and caries in children



For the ***anthropometric measures***, 22 papers were considered for inclusion of which 19 were eventually excluded. Three trials, Monse *et al*., 2012. Alkarimi *et al*, 2012 and van Gemert-Schriks et al (2011) met the inclusion criteria and were further analysed in this review (Table 2.6).

For the OHRQoL measures, 17 papers were considered of which, two trials (Klaassen et al, 2009 & Alkarimi et al, 2012) reported on the effects of severe caries on the quality of life of affected children and/or caregivers in a randomized clinical trial (Table 2.3).

The reasons for the exclusion of 36 papers (some studies overlapped the outcomes under investigation but were reported once in the table of excluded studies) are contained in Table 4. The most common reason for exclusion was that most trials were single arm, pre and post-test studies that had no control group (Table 2.7).

The Alkarimi *et al.,* 2012 trial reported both quantitative and qualitative data (OHRQoL) and datasets were extracted from this trial that were used for both types of outcomes. Pooled data from the included trials were combined based on the criteria described under the methods section.

Table 2.6 : Table of included studies

Article	Type of study Brief details	Participants & inclusion criteria	Test (Rx under GA)	Control	Outcome measures
Monse et al, 2012	Community based Cluster RCT Setting was in day care centres, Philippines	These were children aged between 4- and 68 months who were underweight (BMI was below 5th percentile in CDC charts) and had one or more pulpally infected primary teeth as a result of severe dental decay. Children were excluded if they had active TB	Children received Dental Treatment under GA N= 100; n=85 LTF= 15 Follow-up: 4 months	Children received no treatment; N=100; N= 102; n=79 LTF = 23 Follow up 4 months	Primary outcome was improvements in children's weight, height and BMI using unadjusted means and transformed means (Z-Scores) based on WHO reference population of same age
Alkarimi et al, 2012	Community based Cluster RCT. Setting was in schools in Saudi Arabia	417 children were screened and 122 were considered for inclusion but 86 were eventually randomized into 2 groups: 42 in test (early) treatment; 44 in regular treatment group.	Test group (n=42): 39 received full dental treatment, 2 discontinued treatment, 1 did not show for treatment	In control group (n=44): 0 received full dental treatment, 4 received partial treatment for acute infections. Loss to follow-up was 0 in test and 1 in the control group.	Outcomes were assessed at baseline and 6 months. The primary outcome variable was Weight-for-age Z-score (WAZ). Secondary outcomes included Height-for-age Z-score (HAZ), BMI-for-age Z-score (BAZ, dental pain, dental sepsis, satisfaction with teeth and smile and child's appetite.
van Gemert-Schriks et al, 2011	Community based 4-arm parallel group study of 6 year old children from rainforests of Surinam	414 6-year old school children with dental decay and no history of dental treatment were randomised into 4 groups.	**Group 1** (n=104) received full dental treatment (extraction + ART fillings); LTF = 8; analysed= 88 **Group 2** (n=104); had extractions only; LTF= 6; analysed 85 **Group 3** (n=103); had ART fillings only; LTF=7; analysed 89	**Group 4** (control); n=103; received no treatment; LTF = 4; analysed 93	Primary outcome was body growth over 3 year follow-up. Mean height, weight, BMI compared before and after in the groups (within & between) and mean scores transformed to Std. deviation scores (SDS height & BMI) using Dutch reference population.
Klaassen, et al 2009	RCT 4-srm parallel group study of children less than 7 years old in Netherlands	144 children referred to specialist paediatrics clinic were randomised into 4 groups. Children were < 7; had severe caries; had high dental fear & behavioural management problems.	Group 1 [Rx: post-test only] (n=35) occurred 3 weeks after GA Rx (LTF=19; analysed=16 Group 2 [Rx: Pre- and post-test] Received QoL test before GA and 1 month after GA (n= 36; LTF=6; analysed 36	Group 3 [control post- test only] only filled out Qol test before GA (n=40; LTF=10; analysed 30] Group 4 [control- pre-test and post-test] filled out Qol test at screening and before GA Rx (n=33; LTF=5; analysed 28]	Primary outcome was improvement in OHRQoL after treatment under GA. Study instrument used was Early Childhood Oral Impact Scale (ECOHIS)

Table 2.7: Table of Excluded Studies			
Author	Reason for Exclusion	***Author***	Reason for Exclusion
Acs 2001	Clinical trial with only one group - pre-test-post test	*Lakshman 2013*	systematic review
Alkarimi 2014	Cross-sectional survey	*Low 1999*	Clinical trial with only one group - pre-test-post test
Amin 2006	Clinical trial with only one group - pre-test-post test	*Malden 2008*	Clinical trial with only one group - pre-test-post test
Anderson 2004	Clinical trial with only one group - pre-test-post test	*Merkiel 2014*	Single group study with no treatment
Baens-Ferrer 2005	Clinical trial with only one group - pre-test-post test	*Merkiel 2014a*	Single group study with no treatment
Benzian 2011	Cross-sectional analytical study	*Miller 1982*	Retrospective records based study between children who had treatment under GA and those that had routine dental care with no extraction
dos Santos Junior 2014	cross-sectional analytical study	*Monse 2013*	single arm longitudinal study with no treatment
Duijster 2013	Clinical trial with only one group - pre-test-post test	*Mulu 2014*	Cross-sectional analytical study
Ghasempour 2009	Cross-sectional case-control study with no treatment arm	*Schroth 2013*	Case- control study
Heinrich-Weltzien 2013	Cross-sectional one arm study	*Schroth 2013a*	Case- Control study
Hooley 2012	systematic review	*Silva-Sanigorski 2010*	Single arm longitudinal study design
Jafari-Adli 2014	systematic review	*Thomas 2002*	Clinical trial with only one group - pre-test-post test
Jankauskiene 2010	systematic review	*Versloot 2006*	Clinical trial with only one group - pre-test-post test
Kay 2010	Longitudinal single arm study with no treatment	*White 2003*	Clinical trial with only one group - pre-test-post test
Klaassen 2008	Clinical trial with only one group - pre-test-post test	*Wigen & Wang 2012*	Review paper
Kutesa 2013	cross-sectional analytical study	*Wolde 2015*	Cross-sectional analytical study

Quantitative data results from the included trials

The data from the 3 trials (Monse *et al*., 2012; Alkarimi *et al.*, 2012 and van Gemert-Schriks *et al*., 2011) were used for pooling or comparisons of the following variables.

Mean changes in Weight between treated and untreated children with severe caries

Two analyses regarding weight were done:-

Mean rate of change in weight [unadjusted] in treatment versus no treatment groups

For this outcome only the Monse *et al* (2012 trial data could be used. Alkarami *et al.* (2012) only provided mean weights for the test and control groups and baseline and did not report on this variable post- treatment. Gemert- Schriks *et al.*,(2012) reported these mean weight changes graphically but these numbers could not be extrapolated from the graphs.

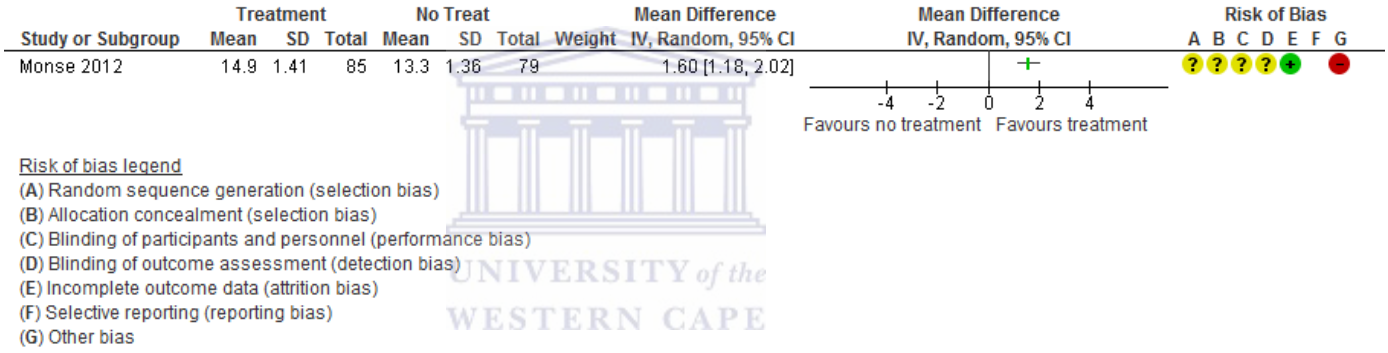


Figure 2.2 Mean rate of change in weight [unadjusted] in treatment versus no treatment groups

The mean weight gain the treatment group was significantly greater than that for the untreated group implying that treatment had a significantly positive effect on weight gain (Figure 2.2)

Mean change in Weight-for-age (WAZ) in treated vs. no treatment group

For this analysis, the log transformed weight data (z-scores) were compared between the immediate and delayed treatment groups. Figure 2.3 provides details of the trials used to pool data for this meta-analyses. The Monse *et al*, 2012 found significant differences in the two treatment arms (mean difference 0.5; 95% CI 0.28- 0.72) whilst the Alkarimi *et al*, 2012 reported no significant differences between the immediate and delayed treatment groups. .

The pooled effect favoured the treatment groups but the heterogeneity score (I^2 = 86%) was significant implying differences between the groups.

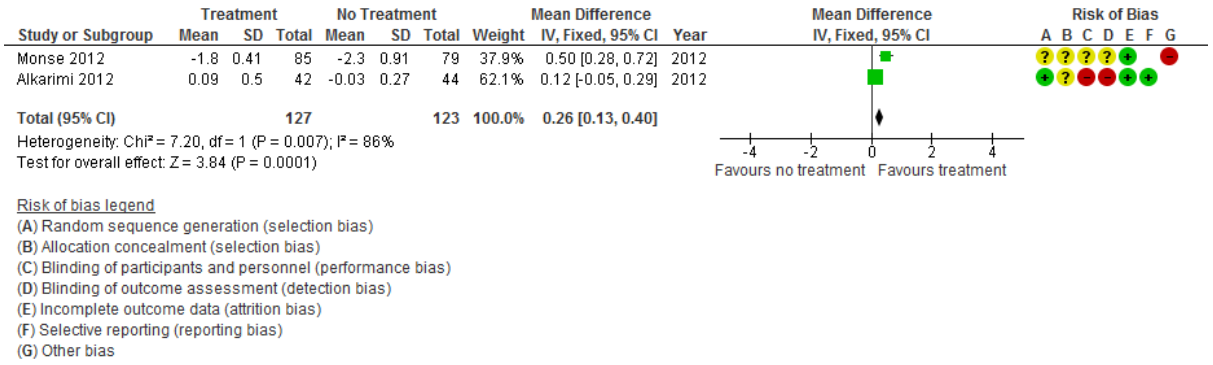


Figure 2.3 Mean change in Weight-for-age (WAZ) in treated vs. no treatment group

Mean changes in Height between treated and untreated children with severe caries

Two analyses regarding Height were done:-

Mean rate of change in height between treated and untreated groups

Two studies (Monse *et al.*,2012 & van Gemert-Schriks *et al*, 2012 provided the data for this meta-analysis.

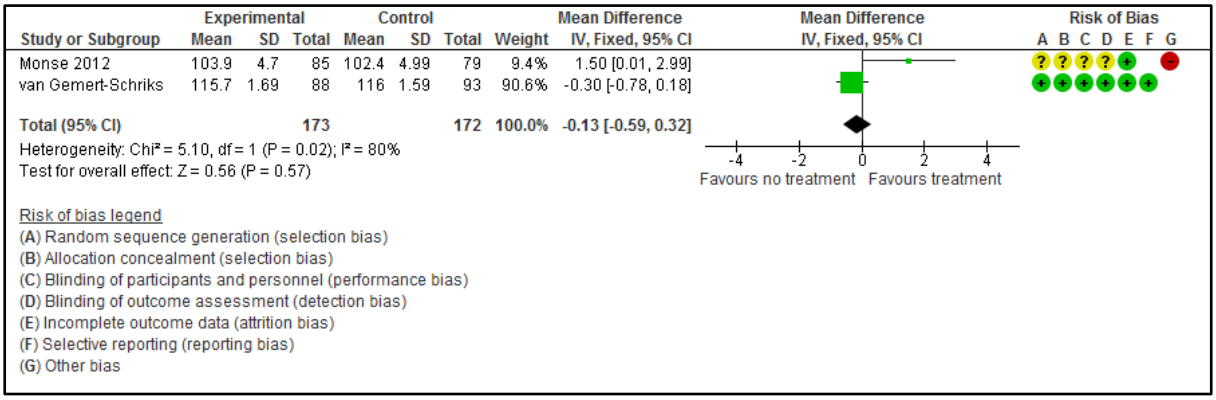


Figure 2.4 Mean rate of change in height between treated and untreated groups

Conflicting results were obtained in the individual trials with the van Gemert-Schriks trail contributing more to the weighted mean difference due to the greater sample sizer and lower Risk of Bias score which showed that for each item assessed, there was little of no bias (Figure 2.4). The Monse *et al.*, trial reported significant differences which favoured the immediate treatment group but the pooled effect [mean difference -0.13 95% CI -0.59-.032; p = 0.57) was not statistically significant.

Mean changes in the Height-for-age (HAZ) scores between treated and untreated children

Similarly, the pooled effects for the log transformed scores (Z-scores) for Height-for- Age (HAZ) which is a more accurate measure than simply using the unadjusted mean height values was also not statistically significant [Mean Difference 0.02 95% CI -004-0.07;p=0.21]. Datasets from the Monse *et al*. and Alkarimi *et al.* trials contributed to this meta-analysis.

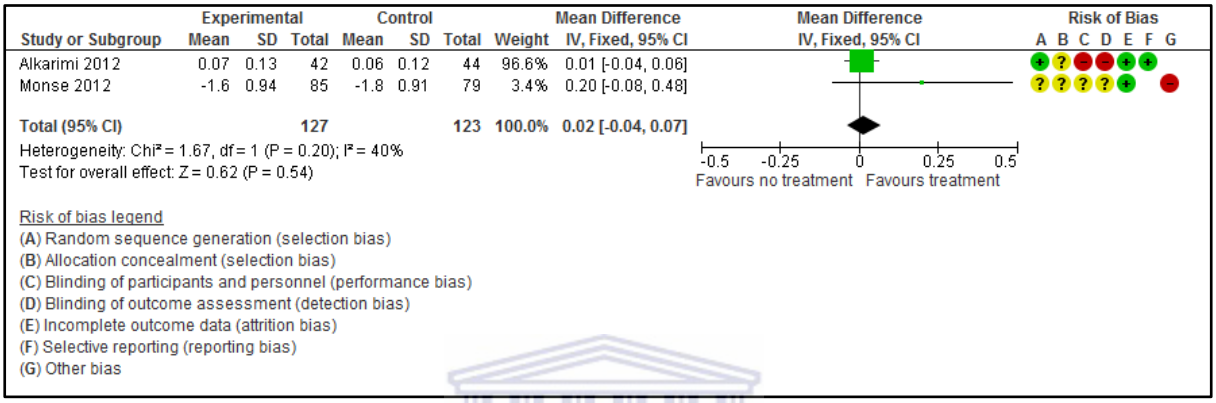


Figure 2.5 Mean changes in the Height-for-age (HAZ) scores between treated and untreated children

Mean changes in BMI between treated and untreated children with severe caries

Two analyses regarding BMI were done:-

Mean rate of change in BMI [unadjusted] in treatment versus no treatment groups

Data for this analysis was only available from the Monse *et al.* trial which reported significant improvements in the BMI scores between the immediate treatment and delayed groups (Figure 2.6).

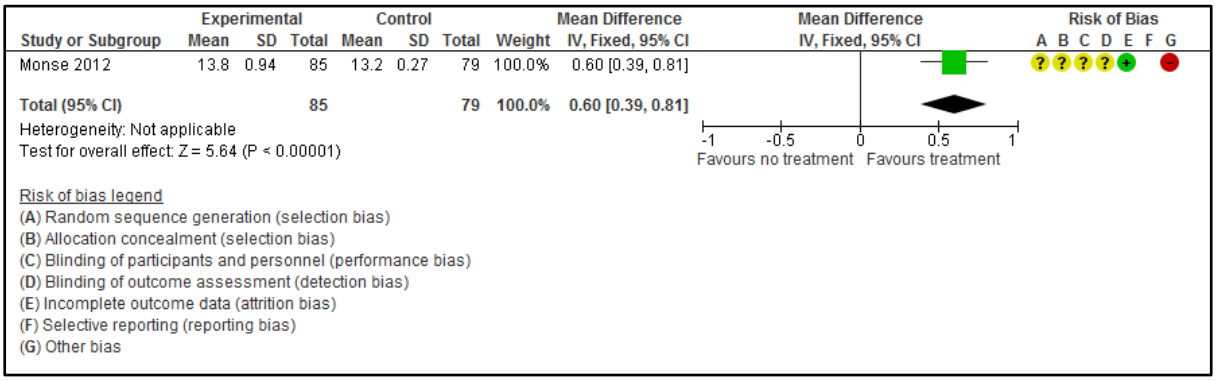


Figure 2.6 Mean rate of change in BMI [unadjusted] in treatment versus no treatment groups

Mean changes in the BMI-for-age (BAZ) between treated and untreated children with severe caries

Both the Alkarimi *et al.* and the Monse *et al.* reported significant improvements in the BAZ scores between the treated and untreated groups in the respective trials. The pooled mean difference was 0.35 [95% CI 0.24-0.46; p= 0.001). Significant heterogeneity was noted when the data from the two trials were pooled (I^2= 90%; Figure 2.7)

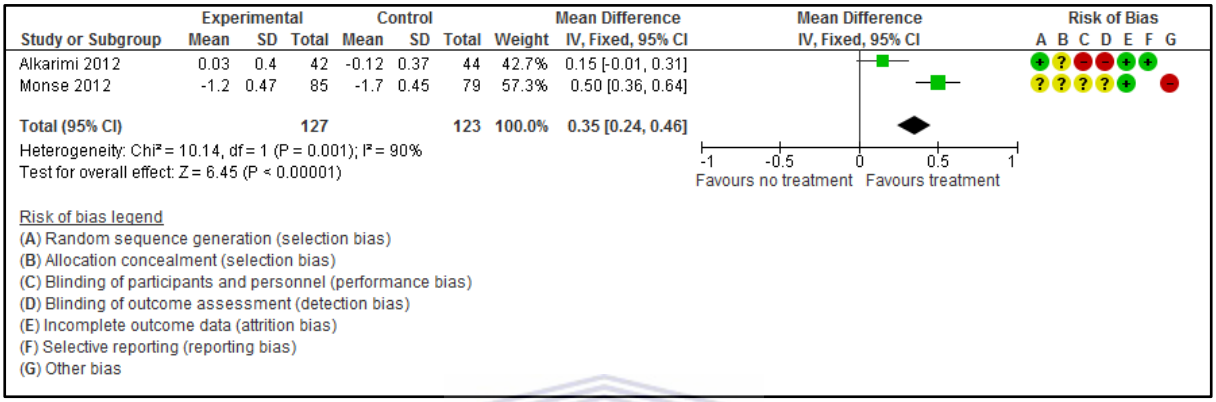


Figure 2.7 Mean changes in the BMI-for-age (BAZ) between treated and untreated children with severe caries

2.2.1.6 Qualitative data results from included trials

There were only two trials reported on changes in Quality of life (Qol) between children who had immediate treatment and those that had no/delayed treatment. Alkarimi *et al*,.2012 reported on both quantitative and qualitative outcomes whilst Klaassen *et al,* 2009 reported only the OHRQoL outcomes among 144 children aged less than seven years old who had presented for treatment under GA. The dichotomised data is presented below:-

Improvement in Dental Pain/ No Dental Pain [Immediate Treatment versus Delayed treatment]

Patients who received immediate treatment reported less pain than those who received delayed treatment at the respective follow up periods (Figure 2.8).

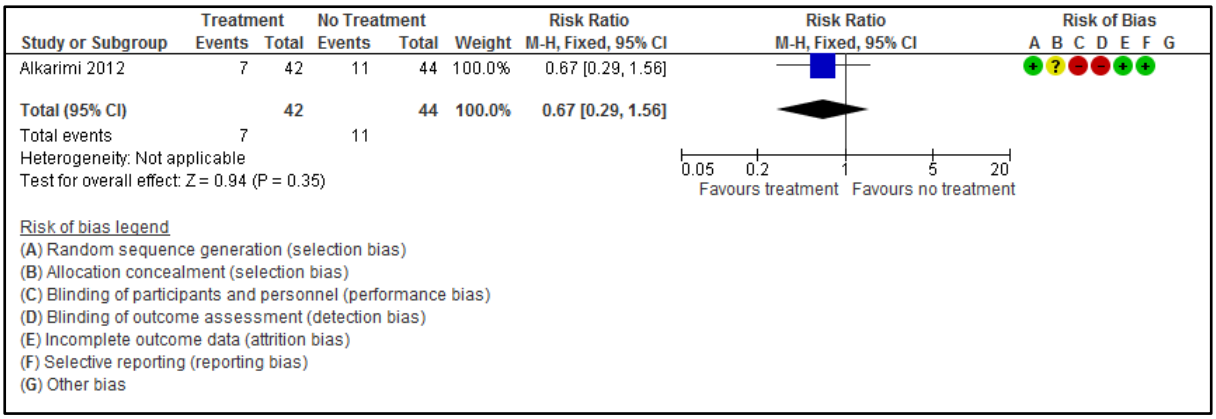


Figure 2.8 Improvement in Dental Pain/ No Dental Pain [Immediate Treatment versus Delayed treatment]

Dental sepsis improvement rate in treatment versus no treatment group

I

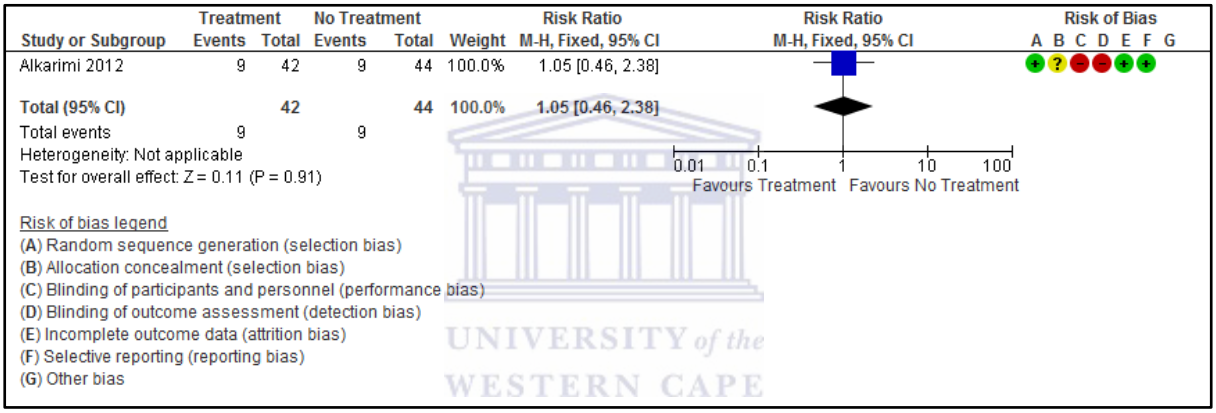


Figure 2.9 Dental sepsis improvement/absence in treatment versus no treatment group

Figure 2.9 shows no difference in the dental sepsis improvement rate between the groups. Due to the small sample (only one trial reporting this), this result must be interpreted with caution.

Improvement in overall satisfaction in immediate treatment versus delayed treatment group

Children who received immediate treatment were more than 2.66 times likely (Figure 2.10) to report overall satisfaction with their treatment than those that had to wait for treatment. There was insignificant heterogeneity (p= 0.76; I^2=0) between the two trials for this outcome.

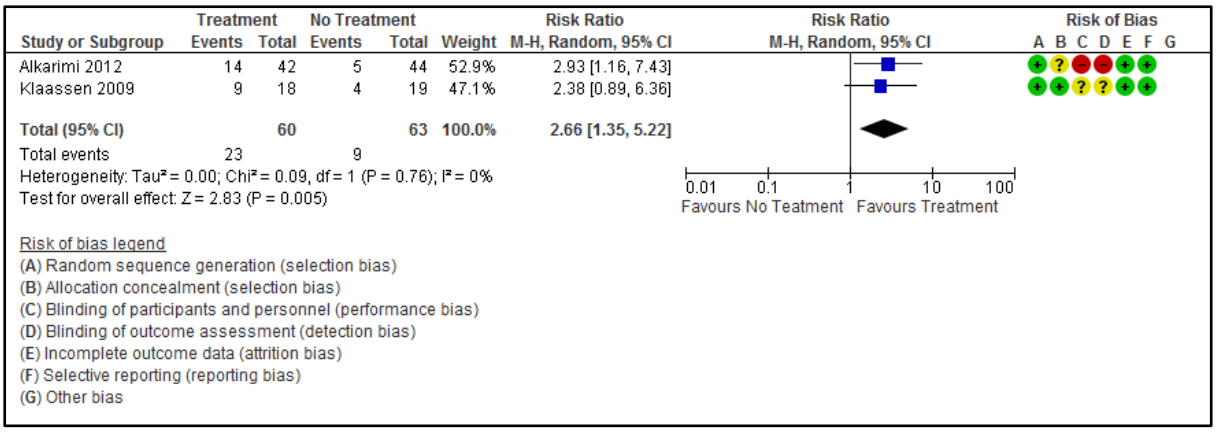


Figure 2.10 Improvement in overall satisfaction in treatment versus no treatment group

Improvement in child's appetite between immediate treatment and delayed treatment groups

Data from only the Alkarimi *et al.* study was available for this variable. Children who received immediate treatment were more than twice as likely to report an improved appetite as those who had delayed treatment (Figure 2.11).

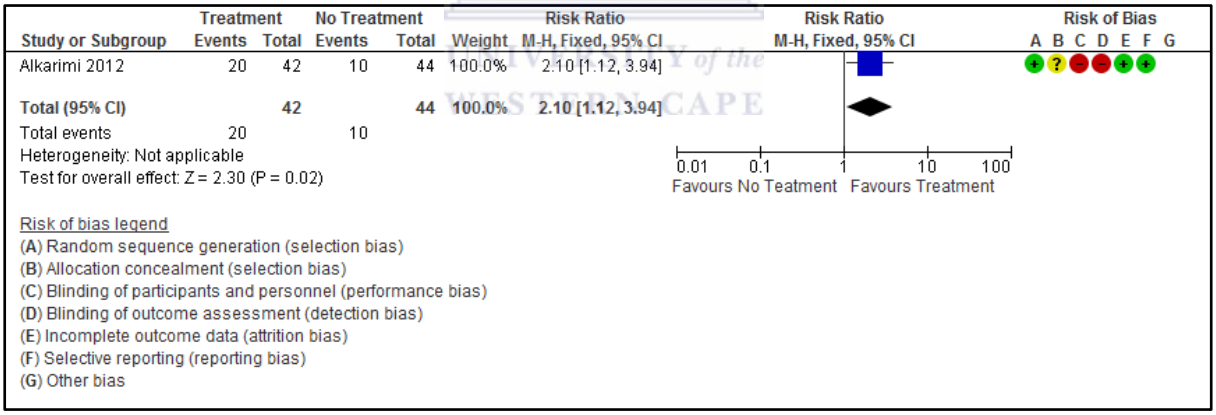


Figure 2.11 Improvement in child's appetite between immediate treatment and delayed treatment groups

Assessment of Risk Bias in included studies

Table 2.8: Risk of Bias Table for Included studies		
Author: Alkarimi *et al.* 2012		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	Authors used tables of random numbers to randomise
Allocation concealment (selection bias)	Unclear risk	not described
Blinding of participants and personnel (performance bias)	High risk	blinding was not feasible given the nature of the study
Blinding of outcome assessment (detection bias)	High risk	blinding ws not feasible given the nature of the study
Incomplete outcome data (attrition bias)	Low risk	loss to follow was reported in both groups and analyses was done on an intention to treat basis
Selective reporting (reporting bias)	Low risk	study followed the CONSORT format
Author: Klaassen *et al.* 2009		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Children were randomised using a Solomon 4-group design
Allocation concealment (selection bias)	Low risk	random allocation sequence generated by SPSS version 14.0
Blinding of participants and personnel (performance bias)	Unclear risk	not reported
Blinding of outcome assessment (detection bias)	Unclear risk	not reported
Incomplete outcome data (attrition bias)	Low risk	Loss to follow with reasons were reported
Selective reporting (reporting bias)	Low risk	trail was report in a CONSORT format
Other bias	Unclear risk	

Author: Monse *et al.* 2012		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	This was a clustered trial and clusters were randomly allocated to treatment or control but the sequence used is not described.
Allocation concealment (selection bias)	Unclear risk	no information reported
Blinding of participants and personnel (performance bias)	Unclear risk	not reported
Blinding of outcome assessment (detection bias)	Unclear risk	not reported
Incomplete outcome data (attrition bias)	Low risk	follow-up rates reported
Selective reporting (reporting bias)	Unclear risk	
Other bias	High risk	Data was analysed without an intention-to-treat-analyses. Possible high risk of treatment effect over-estimate.
Author: van Gemert-Schriks *et al, 2011*		
Bias	**Authors' judgement**	**Support for judgement**
	Low risk	Authors used a computerised random list to generate randomization schedule
Allocation concealment (selection bias)	Low risk	The children were collected from their classroom by one of the participating health care workers who were not familiar with the sequence of group allocation of the children.
Blinding of participants and personnel (performance bias)	Low risk	All dental treatments at baseline were performed by four Dutch dentists. At the time of the evaluations, dental treatments, according to the initially allocated group, were performed by other Dutch dentists.
Blinding of outcome assessment (detection bias)	Low risk	The examination of the children at baseline and at the follow-up sessions was performed by the same person not participating in the dental treatments.
Incomplete outcome data (attrition bias)	Low risk	Loss to follow up reported and reasons for loss to follow -up reported
Selective reporting (reporting bias)	Low risk	Trial follows CONSORT format
Other bias	Unclear risk	

The extent to which a systematic review can draw conclusions about the effects of an intervention depends on whether the data and results from the included studies are valid. In particular, a meta-analysis of invalid studies may produce a misleading result, yielding a narrow confidence interval around the wrong intervention effect estimate. The evaluation of the validity of the included studies is therefore an essential component of any good quality systematic review, and should influence the analysis, interpretation and conclusions of the review (Higgins & Green, 2011). Figures 2.13 and 2.14 together with Table 2.2 provides a comprehensive summary of the risk of bias of each of the included studies used in this review.

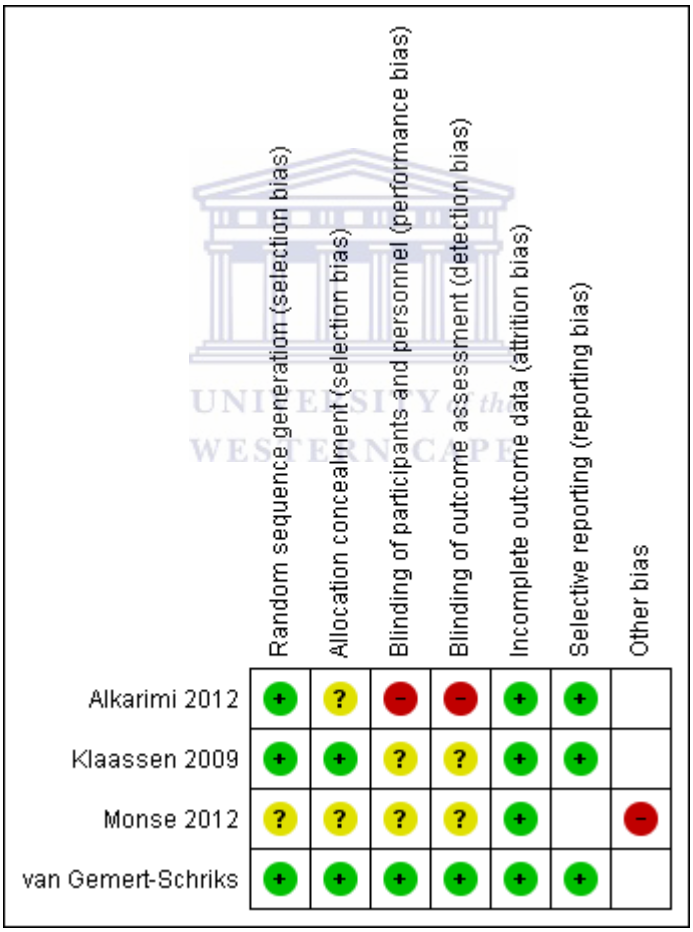


Figure 2.12 Risk of Bias Summary of Included Trails using Cochrane Revman 5.3 software

The Van Gemert-Schriks *et al.* trial has the lowest risk of bias for all the items assessed. This trial followed the CONSORT format of reporting. The Monse *et al.* trial showed the highest risk of bias (Figure 2.12).

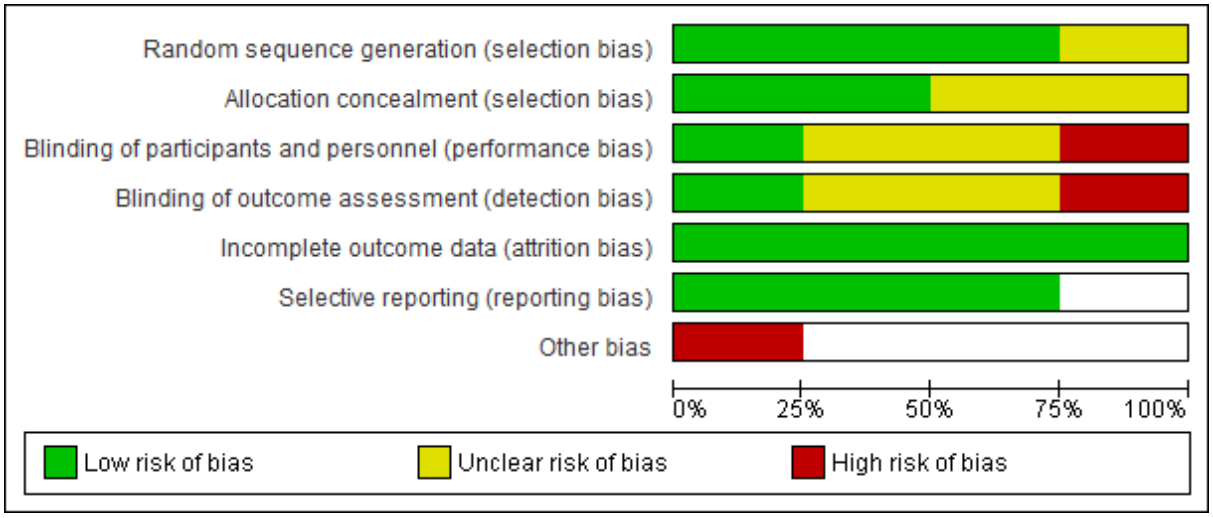


Figure 2.13 Summary of Risk of Bias of Included Trails for seven domains

Figure 2.13 provides a summary of the risk of bias of the four trials used in this review. Three of the papers showed a moderate to low risk of bias [Alkarimi *et al*, 2012*;* Klaassen *et al.*, 2009. Monse *et al*, 2012*)* whilst the van Gemerts-Schriks *et al*, 2011 trial had the lowest risk of bias.

Assessment of Publication Bias

Due to the small number of trials included in this review (n=4), funnel plots were only done to illustrate an example of "symmetry" implying no publication bias (both positive and negative results reported). This is shown in Figure 2.14.

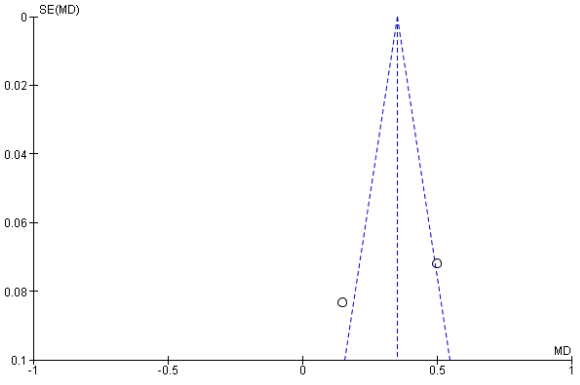


Figure 2.14 Funnel plot of comparison: Mean changes in BMI between treated and untreated children with severe caries, outcome: Mean changes in the BMI-for-age (BAZ) between treated and untreated children with severe caries.

2.3 Discussion

There is an increased interest in understanding the effects of severe tooth decay on the physical, anthropometric, psychosocial, functional, and oral health related quality of life (OHRQoL) among children (Alkarimi *et al.*, 2014*;* Benzian *et al.,* 2011; Hooley *et al*, 2012, Jankaukiene & Narbutaite, 2010; Kragt *et al.*, 2016). Only data from studies published in English language, were considered for this review. The reason for the language restriction was the consideration that the inclusion of non-English trials may have had little effect on summary treatment effect estimates but rather may be assumed as confirmatory (Jüni et al, 2002; Moher *et al,* 2000).The research question that this systematic review sought to answer has been also extensively covered in the published literature but there is a paucity of literature that has used the appropriate study design to provide conclusive evidence of the benefits of early treatment for both anthropometric and quality of life outcomes. Evidence of this is provided in the search results (Table 2.3) where a number of potential studies were identified but were excluded on the basis that they were NOT randomized controlled trials (Table 2.7). Of the 32 studies excluded, 14 (44%) were clinical trials with only a single arm (pre-test-post-test-). These are often referred to as uncontrolled clinical trials and are defined as trials with one single treatment arm during which all patients receive the same intervention and whose outcomes are followed up over a certain period of time [Wang & Bakhai, 2006; Huitema, 2011]. The conduct of uncontrolled clinical trials has been considered to be less expensive, more convenient and faster than that of randomised control trials (RCT) [Wang & Bakhai, 2006]. Uncontrolled clinical trials are further recommended as pilot studies for the exploration of associations between variables and outcome measures, as well as for the estimation of effect sizes as basis for sample size calculation in subsequent RCTs (White & Ernst, 2001)

However, uncontrolled clinical trials have been criticized as being based on the logical *post hoc ergo propter hoc* ("After this, therefore because of this" = false cause) fallacy [Türp &, Schwarzer, 2003] – which can be considered as a subset of the common 'Affirming the consequent' fallacy [Kaye, 2012] - and its results are considered to be unreliable, due to regression to the mean, particularly with increasing follow-up period [James, 1973]. Since regression to the mean is related to continuous measurements (e.g. that of body height, weight or BMI), this problem may be less prevalent in uncontrolled clinical trials with binary (success/failure) outcomes that investigate the clinical of treatment on dichotomous outcomes (improvement/no improvement, pain/no pain, etc.) in dentistry.

However, the logical *post hoc ergo propter hoc* fallacy may be considered as the main reason not to rely on uncontrolled trial results for clinical guidance. For example, in the Duijster *et al*. (2013) trial sought to assess whether rate of weight gain after extraction of severely decayed teeth in 145 underweight preschool Filipino children (mean age 61.4 months) was related to reductions in oral health-related impacts and dental pain from severe dental caries affecting eating and sleeping. These authors used a one-group pre-test post-test study design, where all children received treatment and associations between changes in oral health-related impacts and weight-for-age ***z***-scores before and after treatment in the same cohort was investigated. They reported that there was a significant association between oral health-related impacts and rate of weight gain after extraction of pulpally involved teeth (p=0.02). Children free of impacts on sleeping related to having severely decayed teeth extracted gained significantly more weight compared to children who reported sleeping problems after dental treatment. The problem with these types of trials is that once successes are established, these are then ascribed to the particular intervention and this is immediately recommended and dire warnings are given about the severe consequences on clinical and quality of life outcomes should this not become standard practice. Similar pronouncements are made in the other single arm (no control) trials that were excluded (Table 2.7).

Since the causal relationship of intervention (e.g., dental treatment) to the outcome (e.g., weight gain or improved appetite) is uncertain in uncontrolled trials, the very utility of such trials for the exploration of associations between variables and outcome measures, as well as for the estimation of effect sizes as basis for sample size calculation is negated. The exploration of associations between variables and outcome measures is undertaken by sub-grouping subjects according to specific variables and then established whether the outcome per subgroup lies above or below the total average of the study sample (White & Ernst, 2001). However, the result of such exploration is again challenged by the uncertainty regarding which of the potentially influencing factors is cause for the outcome per subgroup as each subgroup would differ not only in the variable under investigation but also in the set of other influencing variables. The differences in the latter and not in the former may then be cause for the observed difference of the subgroup from the total average.

Additionally, in uncontrolled trials estimated effect sizes may not be useful for sample size calculation in subsequent RCTs either, because the real set of factors that have affected the measured effect size may substantially differ in the RCT sample of subjects.

As the uncontrolled trial design does not include any control group, it is simply not able to eradicate such possible confounder influence, which thus render uncontrolled trials not useful even as pilot studies. Instead, prospective cohort studies (with test and control groups) and smaller, less expensive randomised control trials would appear more suitable as pilot studies, particularly for the exploration of associations between variables and outcome measures and for the estimation of effect sizes as basis for sample size calculation in subsequent larger RCTs, respectively.

These findings from the Duijster *et al.* (2013) trials and the other single arm studies excluded in this review (Table 2.7) are directly in contrast to the finding of Alkarimi *et al.,* (2012) who, in a parallel group randomized controlled study design found that dental treatment of severe dental caries did not significantly improve the anthropometric outcomes but did improve children's appetite and their satisfaction with their teeth. The three words for this method of clinical testing - randomized controlled trial (RCT) - represent important elements of the scientific design:

- Randomized - the decision about whether a patient in the trial receives the new treatment or the control treatment (or placebo) is made randomly [Higgins & Green, 2011]
- Controlled - the trial uses a control group for comparison or reference. In the control group, the patients do not receive the new treatment being tested, but receive a reference treatment or placebo instead [Higgins & Green, 2011]
- Trial - the drug or treatment is on trial during an RCT; it will be approved for wider use only if the results of the testing program indicate that there is a worthwhile level of efficacy, which must be balanced against an acceptable level of adverse effects (safety). [Higgins & Green, 2011]

Thus the decision to only use RCTs to answer the research question in this review is fully justified. The four trials included in the systematic review differed with respect to a number of criteria such as age of participants, length of follow-up, baseline characteristics, inclusion criteria, etc., and these are summarised in the Table of included studies (Table 2.6). Thus caution was applied when extracting datasets for the meta-analyses to ensure heterogeneity was minimised. Three types of heterogeneity are identified in systematic reviews – these are clinical, methodological and statistical heterogeneity [Higgins & Green, 2006). The first two are related to the study design and methods employed and these are dealt with in the methods section (inclusion criteria and risk assessment) whilst the latter is obtained after the pooled meta-analyses are calculated using the Cochrane RevMan 5.3 software program.

The presence of statistical heterogeneity must be explained and this occurs usually due to variation in the size of the treatment effects among the included datasets or trials (Higgins & Green, 2011). The greater the variation in treatment effect, the more likely is the presence of heterogeneity which is reflected by the p- values ($p< 0.05$) and high I^2 scores. This is shown in Figures 2.3; 2.4; and 2.7. The individual included trails showed variations in outcomes for anthropometric and quality of life outcomes (Table 2.6)

Risk of Bias Assessment

The strict inclusion criteria (RCTs only) and the use of the powerful Cochrane tools for assessing Risk of Bias provided evidence that all four of the included trials used in this review had overall low to moderate risk of bias (Table 2.2; Figures 2.13;2.14; 2.15). Individual trails used in each of the forest plots used had a summarised version of risk of bias reflected on the forest plot. This allows the reader to make a quick judgement call about the quality of the papers used in the analyses and is important because poor quality papers simply mean that there is high risk of bias and the results of these meta-analyses must be interpreted with caution. Publication bias was not done because of the small number of trials considered for this review.

Analyses of meta-analysis for both anthropometric and OHRQol outcomes

Although the methodology followed in this systematic review closely followed the format of a Cochrane Systematic Review with Meta-analysis (Higgins & Green, 2011), this review was disadvantaged in two ways:-

a. There were only a few included trials that addressed the research question
b. There were only a few datasets that could be extracted and pooled for meta-analysis because of differences between the trials.

These key differences and the small number of trials meant that the pooled meta-analyses themselves reflected the pooled estimates of relatively small patient numbers. Thus whilst some of the analyses show significance for quantitative (Figure 2.3 and Figure 2.7) and OHRQoL (Figure 2.10) outcomes, one cannot interpret this to mean that conclusive evidence is presented because of the small number of trails included and the small numbers of patients that contributed to these pooled estimates. Thus, at best with the current evidence, one can say, for example, that there is evidence that treatment of severe dental caries impacts positively on the mean change in weight-for age (WAZ) [Figure 2.3] and BMI-for age (BAZ) [Figure 2.7] scores in children who have dental treatment when compared to those that do not

have dental treatment after 4-6 months follow-up and there is limited evidence to suggest that dental treatment also improves overall satisfaction among children who have treatment versus those that do not [Figure 2.8]. There are no comparative published systematic reviews that have employed meta-analyses of data to answer the research question used in this review.

Recommendations for further research

The lack of high quality randomized clinical trials that address this research question is of concern as much has been written in the literature about the negative impacts of oral diseases, especially severe caries, on the clinical and quality of life outcomes of young children. Whilst two of the included trials (Alkarimi *et al.* 2012 & van Gemert-Schriks *et al*, 2011) mentioned that had they followed the CONSRT format of trail reporting (Moher *et al.*, 2001), the presentation of the results (data) provided much difficulties during the data extraction process of this review. van Gemert-Schriks *et al.* (2011) presented a series of graphs that required extrapolation of results which in itself led to performance bias and was not ideal. It is thus suggested that future trials should conform to the CONSORT format and provide much more detailed information on the results section- especially measures such as standard deviations (SDs), sample sizes before and after follow-up, mean values at baseline and post-treatment in simple formats that allow for inclusion into meta-analyses. This is important because the pooled effects of high quality trials into meta-analyses could provide the indisputable answer to the research question which then could form the basis of clinical practice guidelines or policy (Higgins & Green, 2011).

2.4 Conclusions

This systematic review with meta-analysis provided limited evidence of the benefits of immediate tooth extraction under general anaesthesia in young (pre-school) children with severe dental caries compared to delayed or no treatment as regards improved Anthropometric outcomes (height, weight, BMI) and oral health related quality of life (OHRQoL) outcomes. The need for more randomized clinical trials that address this question is urgently needed in dentistry.

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HAPTER 3: AIMS AND OBJECTIVES

3.1 Study Hypotheses

- After treatment of severe dental caries, there is an improvement in the anthropometric (height, weight, BMI) and Haemoglobin levels, and oral health related quality of life measures between children who have immediate treatment under GA (Immediate Group) compared to children who wait 6 months for treatment (Delayed or No treatment group)
- There will be a significant improvement in anthropometric (height, weight, BMI) and oral health related quality of life measures in the Delayed group between Day of treatment and follow-up (Time T_1- T_2; time lag 6 months) and baseline and day of treatment (Time T_0 – T_1; time lag 6 months)

3.2 Aim

To determine the impact of the treatment of severe dental caries on weight, height, body mass index (BMI) and oral health related quality of life (OHRQoL) among a group of young children who had access to immediate care compared to a control group of children who waited 6 months before treatment

3.3 Objectives

1. To assess the relationship between severe dental caries, weight, height, BMI and OHRQoL in children who have immediate treatment versus those that have delayed (6 months later) treatment at 6 and 12 months follow-up.
2. To access the changes in anthropometric (height, weight and BMI) and OHRQoL measures among children with severe untreated caries who underwent immediate treatment under general anesthesia (GA) compared to a group of children with severe dental caries that did not have treatment immediately.

3. To assess the impact of comprehensive dental rehabilitation under general anaesthesia among children who have severe dental caries on OHRQoL from both the child and caregiver perspective.

4. To investigate whether surgical extraction of severely decayed teeth (SDD) in children is followed by greater increase in weight gain (growth velocity), height gain, BMI gain and improvement in haemoglobin levels than in the delayed treatment (control) group from baseline to 6 months follow-up.

CHAPTER 4: RESEARCH DESIGN AND METHODOLOGY

4.1 Introduction

This section describes the methodological aspects of this study and is written in accordance with the CONSORT 2010 guidelines for reporting parallel group randomised trials (Schulz et al, 2010)

4.2 Study Design

This was a Community based prospective, randomized controlled intervention trial conducted in the peri-urban town of Worcestor in the Western Cape Region of South Africa. Randomized controlled trials are used to examine the effect of interventions on particular outcomes such as death or the recurrence of disease. Some consider randomized controlled trials to be the best of all research designs or "the most powerful tool in modern clinical research", mainly because the act of randomizing patients to receive or not receive the intervention ensures that, on average, all other possible causes are equal between the two groups. Thus, any significant differences between groups in the outcome event can be attributed to the intervention and not to some other unidentified factor (Harald et al, 2004)

4.3 Study Population

The study population consisted of crèche going children who attended public dental facilitates in the town of Worcester for dental treatment. These children were screened and assessed by dentists and then referred to the study site (Maria Pieterse Clinic, Worcester) for further assessment. Children were then given an appointment for treatment of severe dental caries under general anaesthetic (GA) at the local provincial hospital.

4.4 Study Sample

4.4.1 Sample Size Calculation

The variables of interest in this trial were individual weight and height values measured against a reference population adjusted for age and sex which allowed for the calculation of a Z score (expressed in standard deviation units from the reference median). These weight-for-age (WAZ) and height-for-age (HAZ), Z scores indicate the level of ***underweight and stunting*** respectively when compared to the reference population. The prevalence of ***underweight, and stunting*** worldwide is based on analysis of 288 national surveys from 139 countries, applying the WHO Child Growth Standards (Black *et al*, 2008).The most commonly-used cut-off with Z-scores is -2 standard deviations, which means that children with a Z-score for underweight, stunting or wasting below -2 SD are considered moderately or severely malnourished (WHO, 1995; Anthropometric Indicators Measurement Guide, 2001), with the risk of death increasing with descending Z-scores (Black *et al*,2008). Additionally, the BMI-for-age (BAZ) was calculated.

We postulated improvements of 0.4 for all the Z scores (WAZ, HAZ, & BAZ) when immediate treatment was compared against delayed treatment and used then following formula for sample size calculation.

Since we were **Comparing Two Independent Group Means, t**he following formula was used to calculate the sample size

$$patients\ \textbf{per group} = f(\alpha,\beta) \times \frac{2 \times SD^2}{(d)^2}$$

- Where $f(\alpha,\beta)$ = 7.85 or 10.5 for 80% or 90% power respectively with 5% significance. Significance (risk of type I error) is almost always set at 5%.
- d=0.4 (effect size)
- SD = 1 (standard deviation)

$$Then\quad patients\ \textbf{per group} = f(\alpha,\beta) \times \frac{2 \times SD^2}{(d)^2}$$

$$= 7.85 \times \frac{2 \times (1)^2}{(0.4)^2}$$

$$= 7.85 \text{ X } 12.5 = 98.125$$

For the secondary outcome of OHRQoL, we also postulated 0.4 standardized OHRQoL score improvement in treated versus controls, assuming same level of significance and power of study of $p< 0.05$ and 80% power respectively. Hence the same formula and numbers applied. The sample size per group was approximately 99 but we aimed for about 120 per group to account for the expected attrition bias especially in the Delayed treatment group which had two follow up time intervals, T_1 (6 months from baseline) and T_2 (6 months post treatment).

4.4.2 Randomization & Group allocation

Randomization ensures that each patient has an equal chance of receiving any of the treatments under study and generates comparable intervention groups which are alike in all the important aspects except for the intervention each groups receives. It also provides a basis for the statistical methods used in analyzing the data. The basic benefits of randomization are as follows: it eliminates the selection bias, balances the groups with respect to many known and unknown confounding or prognostic variables, and forms the basis for statistical tests, a basis for an assumption of free statistical test of the equality of treatments (Suresh, 2011). In general, a randomized experiment is an essential tool for testing the efficacy of the treatment.

Randomization requires generating randomization schedules, which should be reproducible. The generation of a randomization schedule usually includes obtaining the random numbers and assigning random numbers to each subject or treatment conditions. Random numbers can be generated by computers or can come from random number tables (Suresh, 2011). It was the intention to use computer generated random tables in 4- block sequences for randomization and group allocation but the researchers had to use the simple system that had been in use at the clinic to facilitate logistic and follow-up purposes. Basically the system employed at the clinic was that they sent out

general notices to all the crèches in the surrounding area for a screening date for appointments into hospital for GA extractions of children with severe dental caries.

This message was also sent to surrounding dental clinics so that dentists could refer potential patients for GA to the study clinic where screening could be done. Details of patients and their parents/caregivers were recorded on the morning of the screening and they were asked to draw numbers from a box. This was done as a lottery system to give the huge number of patients/caregivers/parents all an equal chance of getting an appointment immediately or 6 months later as the capacity for treatment was limited mainly due to the large numbers of patients that usually arrived for these screening appointments (usually more than 200). Patients who drew numbers between 0-100 were given appointments for immediate treatment and those that drew numbers 101 to 200 were given appointments 6 months later. This system was deemed to be a form of simple random sampling and was used so as not to disturb the system that had been working for years here.

In terms of group allocation, it was not possible to blind the researcher who collected the baseline data at the day of the screening to the group allocation as the patients came in for baseline measures with their numbers. However, the clinicians treating the patients under GA and the statistician analysing the data did not know the group allocation.

Patients were randomized into two groups:

Group 1: Immediate Treatment group - children with severe dental caries who received treatment under GA immediately.

Group 2: Delayed Control group - Later Treatment - children with severe caries given treatment 6 months after Group 1.

4.4.3 Inclusion criteria

a. Age: Children attending crèche between the ages 2-6 years old. This was to ensure follow-up which was done at the crèches.

b. Children with severe untreated Dental Decay. i.e., with one or more teeth with pulp involvement irrespective of number of teeth decayed.

Note: Choice of minimum of 1 pulpally involved tooth, regardless of number of decayed teeth as inclusion criterion is basis for extracting affected tooth/teeth and Pulp inflammation may affect haemoglobin level, the reason for blood sample.

4.4.4 Exclusion criteria

a. Children with high caries levels, but no pulpal involvement

[pufa score 0]

b. Children with systemic medical conditions and infectious diseases (e.g. active TB* infection)

*All children were tested for TB and that test positive where excluded and referred to the TB clinic for further treatment

c. Children whose parents/caregivers who did not provide informed consent

4.4 Study Instruments

This trial had two components:-

- Clinical Component
- Qualitative Component

4.4.1 Clinical Component

4.4.1.1 Collection of oral health status data and blood samples

Oral health data were collected using the standard guidelines as contained in the WHO reference manual for oral examination (WHO Basic Methods from 2007, WHO, 2007). One trained and calibrated dentist and an assistant who recorded the data carried out all the examinations. Children were examined sitting on a chair in a well-lit room aided by a LED headlamp and a wooden spatula was used to move away the cheeks and tongue to aid visibility. Diagnosis of caries was done by visual examination of the oral cavity. The dmft index was used to assess dental status and the caries experience was calculated by counting the number of decayed (d), missing (m) and filled (f) teeth. Intra-examiner variability was checked by randomly re-examining 10% of children in each of the groups. A kappa score of 0.84 was obtained which indicated excellent reliability. This was done also for the pufa index.

The PUFA/pufa index was used to assess the presence of oral conditions resulting from untreated caries including the presence of a visible pulp, ulceration of the oral mucosa due to root fragments, a fistula and or abscess. Lesions in the surrounding tissues that are not related to a tooth or caries were not recorded. Only one score was assigned per tooth. When both the primary tooth and its permanent successor tooth are present and both present stages of odontogenic infection, both teeth were scored. Uppercase letters are used for the permanent dentition and lowercase letters used for the primary dentition (Monse et al, 2010).

Blood samples were taken at baseline [taken by researcher using HemoCue ® Haemoglobin (Hb tester), at the hospital just before treatment (this was done by the nursing sisters and was recorded on the hospital card) and follow-up in the immediate and delayed treatment groups.

The HemoCue ® Haemoglobin (Hb) Testing meter (see Figure 1) which was designed for point –of –care testing was used. This handheld system provided quick and accurate results. The blood samples were collected last (after both clinical and qualitative data) as most children needed to be distracted for the finger prick procedure to obtain the blood droplet. This was placed on the test strip that was read by the Haemoglobin meter to obtain a reading. The reading was recorded on the data collection form.

Figure 4.1: Hemoglobin Meter

4.4.1.2 Collection of Anthropometric Data

4.4.1.2.1 Age and Gender

The date of birth was recorded from the Road to Health Card which every child who was registered at the clinic had to have. Gender was also recorded from this card.

4.4.1.2.2 Weight Determination

The Soehnle ® Linea Digital Scale was used with the following standardised protocol:

- The scale was placed on an even, uncarpeted area and was leveled with the aid of its in-built spirit level.
- After the scale was switched on, the researcher waited for the zero indication (0,0) as well as the stable indicator (0 in the top left hand corner of the display panel) to appear.
- The children were weighed (preferably after emptying their bladders) and with the minimum of clothing: underclothes for older children.
- The child was placed on the scale, standing still and upright in the middle of the platform, facing the fieldworker, looking straight ahead with their feet flat and slightly apart until the reading was taken.
- After the reading was recorded in the space provided on the questionnaire, the child was removed from the scale. The weight was recorded to the nearest 100g.

- After the child stepped down from the scale, the researcher repeated the process and retook the weight. The two readings could not vary by more than 100g. If they did, the scale was re-checked and the procedure repeated until the correct weight was obtained.

4.4.1.2.3 Height Determination

The standing height of the children was taken by means of a stadiometer. Two readings were taken and the measurement was repeated if the two readings varied by more than 0,5 cm. The following procedure was employed for each child:-

- The stadiometer was placed on an even, uncarpeted area.
- The child's shoes were removed.
- The child was positioned as follows: facing the researcher with shoulders relaxed, and shoulder blades, buttocks and heels touching the measuring board - arms relaxed at sides. - legs straight and knees together; and feet flat, heels touching together.
- With the child looking straight ahead (Frankfurt plane), the headpiece was slid down until it touched the crown of the head.
- The reading was taken to the nearest 0,1 cm.
- The measurement was recorded in the space provided on the questionnaire and repeated once to check for accuracy

4.4.2 Qualitative component

4.4.2.1 Oral Health Related Quality of Life (OHRQoL) Measures

In this trial, we used a new OHRQoL measure for 5 year-old children and their parents, which was developed by the University of Glasgow and the University College, London and recently validated by in Scotland by Tsakos *et al* (2012). This contains an interviewer-administered questionnaire for children that focused on the experience of toothache and ability of child to do key daily activities such as eating, speaking, playing, sleeping and smiling (see Appendix **3**).

For this trial the questions were dichotomized (Yes/No) and to minimize recall bias, the recall period was 1 month from the point of when the questions were asked. For example, the children were asked "Did you experience toothache in the last month?". This questionnaire has been used by Duijster *et al*, 2013 in her study that examined associations between oral health-related impacts and the rate of weight gain after extraction of pulpally involved teeth in underweight preschool Filipino children. It must be noted that this child questionnaire has been further refined and is now known as the Scale of Oral Health Outcomes for 5-year-old children (SOHO-5) (Tsakos *et al*, 2012). This version was not used in this trial.

In terms of parental/caregiver questionnaires for the OHRQoL of their children, 4 items were assessed from the parental or caregiver perspective:-

- The Child's oral health and well-being (1 question)
- Oral symptoms and discomfort related to the condition of the child's teeth (3 questions))
- Effects of the child's condition on their feelings and everyday activities
  (5 questions)
- Effects of child's condition on parents/caregivers (2 questions) or other family members.

Parents answered the OHRQoL questionnaire (Appendix 4) about their child at baseline and at follow-up in the immediate treatment group. In the delayed treatment group, parents answered the questionnaire at baseline, and at 6 months post treatment (the time lapse here was about 12 months). The child questionnaire was piloted among young children at a crèche not used in this present trial to ascertain the time it took to complete the form (approximately 5 minutes) and whether the children could reliably answer simple questions about pain/discomfort. Previous research shows this is feasible in developing countries, provided that the wording was appropriate for the age (Filstrup *et al*, 2003). Similarly, the parental questionnaire was also piloted to determine whether it was applicable to the local setting. The basic and simple nature of the questions made it easy to administer and no problems relating to understanding was encountered in the pilot testing. Both the child and parent instruments were interviewer-administered. The same questionnaires were used in the recall visits to assess the change in OHRQoL through a global subjective rating questions (Appendix 3& 4).

4.4.2.2 Socioeconomic measures

Socioeconomic score was reported for family possessions (1) or lack (0) of the following household items: toilets, house construction composing brick walls, concrete floors and tin roofs, toilets, bicycle, and radio. Children also were scored for presence or absence of shoes/slippers at interview. Socio-economic score was reported as individual items and also combined by summing scores (maximum 7, minimum 0). (APPENDIX 1C)

4.5 Data processing and statistical analysis

Demographic, clinical and OHRQoL qualitative data was collected by the researcher and entered into the Microsoft Excel spreadsheet. Data was coded to facilitate statistical analyses. The statistician was blinded to the groups for both clinical and qualitative data. The data was cleaned and re-checked for any errors before data analyses.

The mean weight, height and BMI of the Immediate Group 1 before and after treatment was compared with those measures in Delayed Group 2. The following analyses were done:-

- The mean height, weight, BMI, Hb level (unadjusted values) before and after treatment within and between the groups were calculated and compared.
- The heights and weights and age were transformed to height-for-age, weight-for-age and BMI Z scores (HAZ, WAZ and BAZ) using the statistical software package SPSS version 23. For each child, the z-score was calculated as the number of standard deviations from a reference population using WHO standard references 2007. Children with extreme z-scores (the z-score < -6SDs or > +6SDs) were excluded from the trial after first verifying no errors in measurement or data entry.
- Changes in z-scores within individuals (before and after study period) were tested by paired t-test, separately for treatment and control groups.
- Unpaired t-tests used to compare change in z-scores between groups

In this trial, the weight-for-height (WAZ), weight-for-age (WAZ) and BMI-for –age (BAZ) were interpreted by using the Z-score classification system. The Z-score system expresses the anthropometric value as a number of standard deviations or Z-scores below or above the reference mean or median value (WHO standard references 2007). A fixed Z-score interval implies a fixed height or weight difference for children of a given age. For population-based uses, a major advantage is that a group of Z-scores can be subjected to summary statistics such as the mean and standard deviation. The formula used for calculating the Z-score was:

Z-score (or SD-score) = (observed value - median value of the reference population) / standard deviation value of reference population (WHO standard references 2007).

The WHO Global Database on Child Growth and Malnutrition (1997) uses a Z-score cut-off point of <-2 SD to classify low weight-for-age, low height-for-age and low weight-for-height as moderate and severe undernutrition, and <-3 SD to define severe undernutrition. The cut-off point of >+2 SD classifies high weight-for-height as overweight in children. These were also used in this trial for data interpretation.

Pairwise testing was done to compare the rates of change (velocity) before (Time $T_0 - T_1$) and after treatment ($T_1 - T_2$) within and between the groups. ANOVA was done to determine differences within and between groups. Post -hoc testing using the Turkey T was done to further explore determine the differences or variations for individual items, e.g., variations in weight with the immediate treatment group. Pearson correlation analyses were undertaken for anthropometric (Height, Weight, BMI) and clinical variables versus oral health variables (dmft, pufa) in the groups. Multilevel mixed regression model analysis similar to that done in the Monse *et al.*, trial (2012) was undertaken to determine the effect of the treatment on the outcome variables.

OHRQoL was analyses in two ways: It was measured in terms summing of scores and prevalence of different key items.

- For the Child OHRQoL questionnaire, the 9 items were dichotomized into "YES", "NO" responses and were coded as 0= No and 1= Yes. The frequency of the responses before treatment and after treatment (6 months follow-up) were compared to gauge the level of improvement or no improvement noted. Additionally the dichotomized positive responses per group for the 9 items in the Child OHRQoL questionnaire were entered as n/N into the Revman Version 4.3 package for both test and control groups tabulated Relative Risk scores with 95% Confidence Intervals (CIs) were calculated using a random effects model in RevMan version 4.3
- For the Parental/Caregiver OHRQoL questionnaire, YES/NO questions were dichotomized and analysed as described above. The 5 item Likert type response for the item questions were group and coded as follows:
    - Responses "Never" was coded as 0 = no impact

- Responses “Once/Twice” or “Sometimes” was coded 1= little impact
- Responses “Often” or “Almost every day” was coded 2= high impact
- “Don’t’ know” responses were excluded

These item scores were compared before and after treatment at follow up to assess improvement and were summed for each item and compared before and after treatment at the follow-up visits. So, additionally, for the Likert-type responses, codes 0 and 1 were combined as “Little or no improvement” and code 2 was assessed as “a lot of improvement” so that dichotomized outcomes between the groups could be compared. These combined datasets were entered into the Revman 4.2 software program to create tables showing the before and after changes in the OHRQoL outcomes. A dataset was defined as any extracted set of n / N for test- and control group. A random effects model was used in Revman 4.3 package to obtain Relative Risk/Ratio (RR) scores with 95% confidence intervals.

Regression modelling was done to test the effect of treatment and controlling for potential confounders, which is small because of the design, and to test whether treatment differed in the two study populations. Logistic regression was used to model categorical outcomes and linear regression was used to model continuous dependent variables. In all models, the dependent variable represented change from baseline to end of study. Data was analysed using SPSS version 23.

4.6 Ethical Approval

This randomized clinical trial was conducted to highest ethical standards using Royal College of Paediatrics and Child Health guidelines (McIntosh *et al,* 2000). Ethical approval was obtained from the Senate Research Ethics Committee, University of the Western Cape (Reg No. 05/1/24) (Appendix 1A). Regional differences did not undermine uniformly high ethical standards of ethics. We have addressed three points:

1 The intervention planned: The intervention is clinically justified and not harmful to children.

2 Not offering treatment to group 2 until 6 month later: The intervention is not yet proved as useful and, therefore, we are not withholding a known efficacious treatment. This satisfies condition of equipoise.

3 Informed consent: Informed signed consent obtained at each site in the language of participant (Appendix 1B& 1D).

All children entering the study received dental treatment. Children from Group 2 suffering from acute toothache prior to their planned treatment time were free to use other services. Treatment in the frame of the study was offered to them 6 months later than Group1. Signed informed consent was also obtained from children's guardians if need be. Parents were free to withdraw their child at any time without penalty from the trial. This trail was unique in that it slotted into the normal routine procedure for treatment allocation that was in use for a number of years. No changes were needed to the routine running of services at the clinic as regards data collection. Follows up were done at the crèches where the children attended.

CHAPTER 5: RESULTS

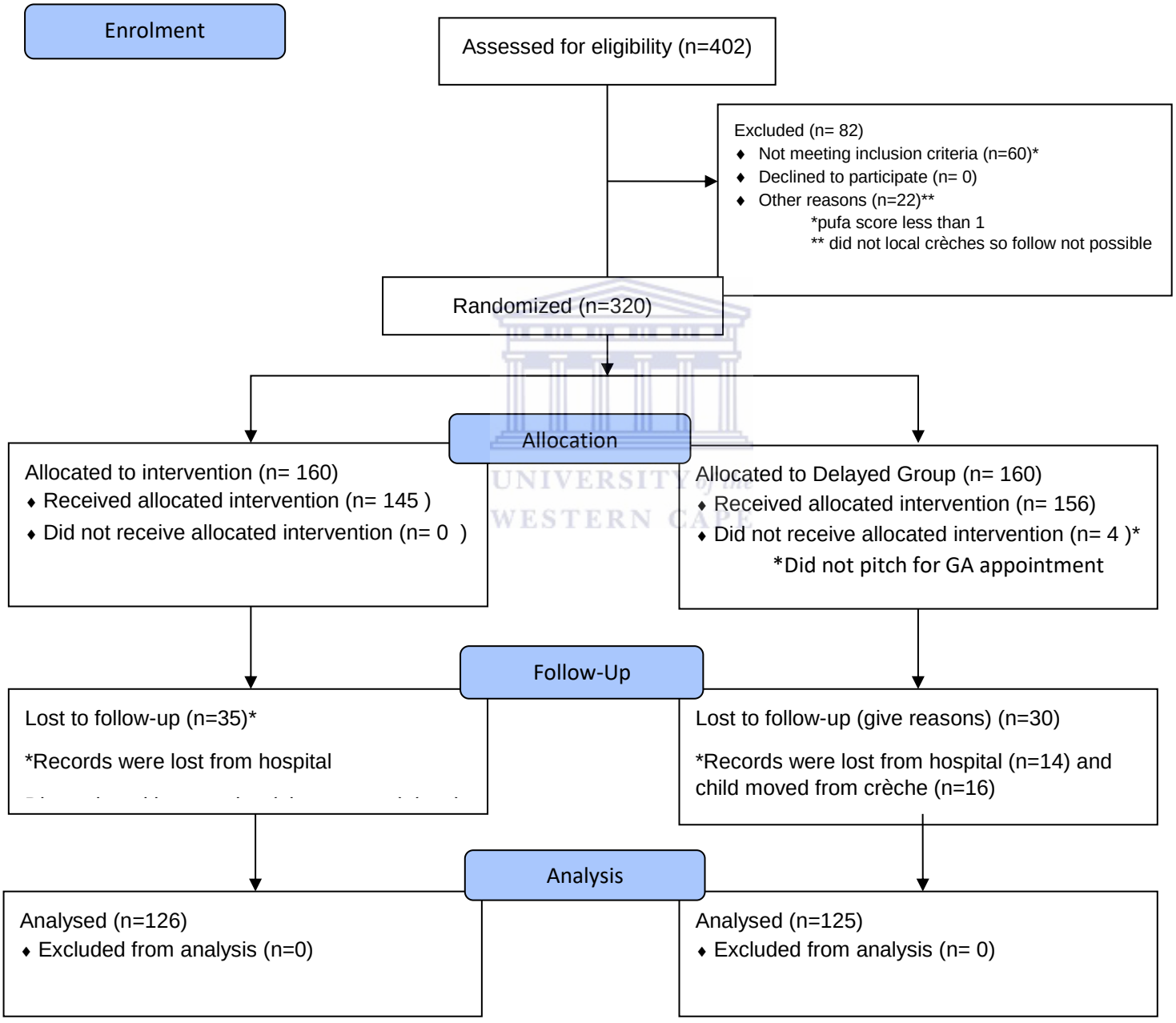
5.1 Introduction

This chapter is divided into five main parts:- .

- The first part presents a flow diagram using the template from the Consolidated Standards of Reporting Trials (CONSORT) group [Moher *et al*., 2001]
- The second part of the chapter describes the baseline socio-economic, clinical and anthropometric characteristics of the immediate and delayed treatment groups.
- The third part discusses the post-treatment follow-up characteristics of the immediate and delayed treatment groups and finally,
- The fourth part presents the OHRQoL analyses of the immediate and delayed treatment groups both at baseline and at follow-up.

CONSORT
TRANSPARENT REPORTING of TRIALS

5.1.1 CONSORT 2010 Flow Diagram



The flow diagram provides information on the number of patients involved in the trial enrolment, group allocation, follow-up and data analysis of this weight gain study. The calculated sample size (80% power) was approximately 99 patients per group. The final numbers analysed were 125 in the immediate group and 125 in the delayed treatment group

5.1.1 The baseline socio-economic, clinical and anthropometric characteristics of the immediate and delayed treatment groups.

Table 1: Demographic, socio-economic and education levels

	IMMEDIATE (n=126)	DELAYED (n=156)	
DEMOGRAPHY	**%**	**%**	**p-value**
Male	50.8	54.5	0.475
Female	49.2	45.5	0.527
SOCIO-ECONOMIC			
Living in brick house	86.4	90.3	0.117
House has concrete floor	83.3	86.6	0.151
House has tin roof	50.8	53.1	0.481
House has a toilet	85.1	91.7	0.116
House has a radio	95.9	96.5	0.962
House has a TV	98.1	95.5	
House has a fridge	100	98.1	
Child wearing shoes at interview	89.7	94.2	
Single parent household	61.9	69.2	0.107
Employed father	83.3	78.9	
Employed mother	59.5	56.7	
Receiving child support grant	54.75	58.02	

EDUCATION			
Mother's education: Primary	6.3	16.0	
Secondary	84.1	76.9	
Post-secondary	9.6	7.1	
Father's education: Primary	17.4	18.5	
Secondary	66.7	66.2	
Post-secondary	15.9	19.3	
Single parent household	61.9	69.2	0.107
Employed father	83.3	78.9	
Employed mother	59.5	56.7	
Receiving child support grant	54.75	58.02	

The socio-economic and educational levels of the parents of children that participated in this trial was compared and both groups were found to be balanced for all of the variables as shown in Table 1. It was disconcerting to note the significantly high number of single parent households in both the groups.

Table 2 provides information on the baseline characteristics of the Immediate Treatment Group in this trial. The mean age of the children was 4.41 years (SD 1.20); mean height was 105.44 cm (SD 9.71); and mean weight was 15.99 kg (SD 3.22). The high mean dmft score (dmft 9.58 SD 3.68), the high untreated d component (contributed almost 90% to the total dmft score) and high mean pufa score (pufa 2.5 SD 1.73) provides evidence of the huge untreated caries burden and the consequences of this burden in terms of its clinical consequences or manifestations as represent by the pufa score. The "untreated caries" pufa ratio was calculated and the score was 0.3 which means that almost every 1 in 3 untreated decayed tooth in the mouth had symptoms of pulpal, ulcerative, fistula or abscess- like symptoms.

It is a well-known fact that anthropometric measures (height, weight) differ significantly for males and females and for different ages. It is for this reason that growth reference charts for populations are categorized for age and gender (WHO, Growth reference charts for 5-19 years, 2007). Tables 3-8 provide details of the gender and age characteristics in the immediate treatment group. When the group was analysed as a whole, no significant differences were noted between males and females for all of the variables in Table 3 except for the number of abscesses that were present in the carious teeth at baseline which was significantly higher among males (p=0.012). However, the overall pufa scores for males and females in this group was not significant (p= 0.304). When the ages were separated into categories (ages 2, 3, 4, 5 & 6), no significant differences between males and females were noted for all of the variables compared (see Tables 4-8). However when age was compared against the other variables at baseline (height, weight, BMI, Hb, dmft, pufa) in an ANOVA analysis (see table 9), a significant age variation in baseline values of Height, weight and Hb (P=0.000) was noted between the age groups. However, no significant age variation was observed for BMI, dmft and pufa. Tukey post hoc analysis showed that a significant increase in the height occurred as the age increased (p=0.000) except for ages 5 and 6 (p=0.92). Also, post hoc analysis of weight for age did not show any significant weight increase between age group 2 and 3 (p=0.15), 3 and 4 (p=0.98), and 5 and 6 (0.18). There was, however, a significant weight difference between age 4 and 5 years (P<0.012). The only significant Hb difference was between age 2 and 4.

Table2: Baseline characteristics for immediate group (n=126)						
	N	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Age of children	124	5.00	2.00	7.00	4.4113	1.20306
Height before extraction	126	52.5	71.0	123.5	105.444	9.7144
Weight before extraction	126	18.70	9.10	27.80	15.9971	3.22276
Hb before extraction	126	9.6	5.7	15.3	11.515	1.4693
BMI baseline	126	12.41	9.57	21.98	14.3392	1.78253
Decay	126	17.0	3.0	20.0	8.579	3.6821
Missing	126	10.0	.0	10.0	.905	2.4574
Filled	126	2.0	.0	2.0	.016	.1782
dmft	126	17.0	3.0	20.0	9.579	3.6777
Pulpal exposure	126	6.0	.0	6.0	1.040	1.3048
Ulceration	126	1.0	.0	1.0	.071	.2586
Fistula	126	1.0	.0	1.0	.024	.1531
Abscess	126	6.0	.0	6.0	1.341	1.6597
pufa	126	7.0	1.0	8.0	2.484	1.7285

Table 3: Gender comparison of baseline variables for immediate group						
Variable	**Gender**	**n**	**Mean**	**Std. Deviation**	**t-test score**	**p-value**
Age of children	Male	62	4.4839	1.18380		
	Female	62	4.3387	1.22733	0.67	0.504
Height before extraction	Male	64	106.492	9.6652		
	Female	62	104.363	9.7241	1.233	0.22
Weight before extraction	Male	64	16.2775	2.97860		
	Female	62	15.7076	3.45724	0.992	0.323
Hb before extraction	Male	64	11.508	1.5729		
	Female	62	11.523	1.3669	-0.056	0.955
BMI baseline	Male	64	14.3388	1.68482		
	Female	62	14.3396	1.89194	-0.002	0.998
Decay	Male	64	8.563	3.7027		
	Female	62	8.597	3.6907	-0.052	0.959
Missing	Male	64	.844	2.6620		
	Female	62	.968	2.2468	-0.282	0.778
filled	Male	64	.031	.2500		
	Female	62	.000	.0000	0.984	0.327
dmft	Male	64	9.594	3.8780		
	Female	62	9.565	3.4906	0.044	0.965
Pulpal exposure	Male	64	.875	1.3274		
	Female	62	1.210	1.2693	-1.446	0.151
Ulceration	Male	64	.031	.1754		
	Female	62	.113	.3191	-1.788	0.076
Fistula	Male	64	.031	.1754		
	Female	62	.016	.1270	0.553	0.581
Abscess	Male	64	1.703	1.9080		
	Female	62	.968	1.2671	2.54	0.012
Pufa	Male	64	2.641	1.7216	1.033	0.304

Table 4: Gender comparison of baseline variables for 2 year-olds in Immediate Group						
Variable	**Gender**	**n**	**Mean**	**Std. Deviation**	**t-test score**	**p-value**
Height before extraction	Male	5	91.800	14.4810	0.857	0.416
	Female	5	85.800	5.9330		
Weight before extraction	Male	5	13.6860	2.45896	2.284	0.052
	Female	5	10.5900	1.77144		
Hb before extraction	Male	5	10.020	.7328	-1.468	0.18
	Female	5	10.960	1.2300		
BMI baseline	Male	5	16.5763	3.08193	1.619	0.144
	Female	5	14.2976	.63704		
decay	Male	5	9.200	3.3466	0	1
	Female	5	9.200	3.7014		
missing	Male	5	.000	.0000	-1	0.347
	Female	5	.600	1.3416		
filled	Male	5	.000	.0000[b]	0	1.000
	Female	5	.000	.0000[b]		
dmft	Male	5	9.200	3.3466	-0.277	0.789
	Female	5	9.800	3.4928		
Pulpal exposure	Male	5	1.000	1.7321	-0.232	0.822
	Female	5	1.200	.8367		
Ulceration	Male	5	.000	.0000	-1	0.347
	Female	5	.200	.4472		
Fistula	Male	5	.000	.0000[b]	0	1.000
	Female	5	.000	.0000[b]		
Abscess	Male	5	1.800	1.7889	1	0.264
	Female	5	.600	1.3416		
pufa	Male	5	2.800	1.3038	0.825	0.433
	Female	5	2.000	1.7321		

Table 5: Gender comparison of baseline variables for 3 year-olds in Immediate Group						
Variable	**Gender**	**n**	**Mean**	**Std. Deviation**	**t-test score**	**p-value**
Height before extraction	Male	8	100.938	9.4129	0.503	0.621
	Female	11	98.727	9.4878		
Weight before extraction	Male	8	14.5375	2.22064	-0.026	0.98
	Female	11	14.5682	2.79842		
Hb before extraction	Male	8	10.850	2.5100	-0.649	0.525
	Female	11	11.455	1.5559		
BMI baseline	Male	8	14.2927	1.31877	-0.965	0.348
	Female	11	14.9030	1.39055		
decay	Male	8	8.625	5.1530	-0.057	0.955
	Female	11	8.727	2.6492		
missing	Male	8	1.000	2.8284	0.09	0.93
	Female	11	.909	1.5783		
filled	Male	8	.000	.0000[b]	000	1.00
	Female	11	.000	.0000[b]		
dmft	Male	8	10.250	5.5227	0.338	0.74
	Female	11	9.636	2.1574		
Pulpal exposure	Male	8	.875	1.7269	-0.463	0.649
	Female	11	1.182	1.1677		
Ulceration	Male	8	.000	.0000[b]	0.00	1
	Female	11	.000	.0000[b]		
Fistula	Male	8	.000	.0000[b]	0	1
	Female	11	.000	.0000[b]		
Abscess	Male	8	2.500	2.1381	1.748	0.099
	Female	11	1.000	1.6125		
pufa	Male	8	3.375	1.9226	1.356	0.193
	Female	11	2.273	1.6181		

Table 6: Gender comparison of baseline variables for 4 year-olds in Immediate Group						
Variable	**Gender**	**n**	**Mean**	**Std. Deviation**	**t-test score**	**p-value**
Height before extraction	Male	19	103.947	6.4332	0.504	0.618
	Female	16	102.875	6.0759		
Weight before extraction	Male	19	14.9068	2.19698	-0.162	0.872
	Female	16	15.025	2.09865		
Hb before extraction	Male	19	12.274	1.0598	1.21	0.235
	Female	16	11.725	1.6064		
BMI baseline	Male	19	13.8141	1.75132	-0.673	0.506
	Female	16	14.2338	1.93597		
decay	Male	19	8.789	3.6451	0.578	0.567
	Female	16	8	4.4422		
missing	Male	19	0.947	2.8572	-0.957	0.346
	Female	16	2	3.6515		
filled	Male	19	0	.0000b		
	Female	16	0	.0000b		
dmft	Male	19	9.737	3.5721	-0.2	0.843
	Female	16	10	4.2269		
Pulpal exposure	Male	19	0.421	0.6925	-2.224	0.033
	Female	16	1.313	1.5798		
Ulceration	Male	19	0.053	0.2294	-0.746	0.461
	Female	16	0.125	0.3416		
Fistula	Male	19	0	.0000b		
	Female	16	0	.0000b		
Abscess	Male	19	2.316	2.029	1.965	0.058
	Female	16	1.188	1.1673		
pufa	Male	19	2.789	1.8732	0.264	0.793
	Female	16	2.625	1.7842		

Table 7: Gender comparison of baseline variables for 5 year-olds in Immediate Group						
Variable	**Gender**	**n**	**Mean**	**Std. Deviation**	**t-test score**	**p- value**
Height before extraction	Male	18	111.111	6.3883	0.715	0.479
	Female	19	109.711	5.5109		
Weight before extraction	Male	18	17.6583	2.3385	1.619	0.115
	Female	19	16.4247	2.29686		
Hb before extraction	Male	18	11.111	1.3724	-0.731	0.47
	Female	19	11.447	1.4241		
BMI baseline	Male	18	14.2779	1.23258	1.337	0.19
	Female	19	13.6417	1.624		
Decay	Male	18	7.889	3.1228	-1.529	0.135
	Female	19	9.632	3.7596		
missing	Male	18	0.556	2.357	0.61	0.546
	Female	19	0.211	0.7133		
Filled	Male	18	0.111	0.4714	1.028	0.311
	Female	19	0	0		
Dmft	Male	18	8.556	3.4338	-1.083	0.286
	Female	19	9.842	3.7751		
Pulpal exposure	Male	18	0.944	1.5136	-0.115	0.909
	Female	19	1	1.4142		
Ulceration	Male	18	0.056	0.2357	-0.988	0.33
	Female	19	0.158	0.3746		
Fistula	Male	18	0.056	0.2357	0.038	0.97
	Female	19	0.053	0.2294		
Abscess	Male	18	1.111	1.4507	0.013	0.99
	Female	19	1.105	1.2865		
Pufa	Male	18	2.167	1.6179	-0.246	0.807
	Female	19	2.316	2.029		

Table 8: Gender comparison of baseline variables for 6 year-olds in Immediate Group						
Variable	**Gender**	**n**	**Mean**	**Std. Deviation**	**t-test score**	**p-value**
Height before extraction	Male	14	112.429	7.1303	0.383	0.706
	Female	11	111.364	6.6072		
Weight before extraction	Male	14	18.2821	3.23815	-0.418	0.68
	Female	11	18.9273	4.48025		
Hb before extraction	Male	14	11.886	1.4379	0.424	0.675
	Female	11	11.682	0.7627		
BMI baseline	Male	14	14.3564	1.15288	-0.997	0.329
	Female	11	15.1545	2.71023		
Decay	Male	14	8.857	4.0735	1.048	0.306
	Female	11	7.273	3.2891		
Missing	Male	14	1.286	3.2917	0.254	0802 .
	Female	11	1	1.9494		
Filled	Male	14	0	.0000b		
	Female	11	0	.0000b		
Dmft	Male	14	10.5	4.1464	1.474	0.154
	Female	11	8.273	3.1652		
Pulpal exposure	Male	14	1.357	1.3363	-0.212	0.834
	Female	11	1.455	0.8202		
Ulceration	Male	14	0	0	-1.135	0.268
	Female	11	0.091	0.3015		
Fistula	Male	14	0.071	0.2673	0.882	0.387
	Female	11	0	0		
Abscess	Male	14	1.143	1.9945	0.9	0.378
	Female	11	0.545	1.0357		
Pufa	Male	14	2.571	1.6968	0.749	0.462
	Female	11	2.091	1.446		

Table 9: Table of ANOVA showing AGE compared to the baseline variables in the immediate group						
Variable		**Sum of Squares**	**df**	**Mean Square**	**F**	**p-value**
Height before extraction	Between Groups	5511.772	4	1377.943	26.531	.000
	Within Groups	6284.340	121	51.937		
	Total	11796.111	125			
Weight before extraction	Between Groups	430.073	4	107.518	14.985	.000
	Within Groups	868.199	121	7.175		
	Total	1298.272	125			
Hb before extraction	Between Groups	25.371	4	6.343	3.139	.017
	Within Groups	244.471	121	2.020		
	Total	269.841	125			
BMI baseline	Between Groups	26.688	4	6.672	2.179	.075
	Within Groups	370.489	121	3.062		
	Total	397.177	125			
Dmft	Between Groups	9.621	4	2.405	.173	.952
	Within Groups	1681.085	121	13.893		
	Total	1690.706	125			
Pufa	Between Groups	5.670	4	1.418	.466	.760
	Within Groups	367.798	121	3.040		
	Total	373.468	125			

The mean age of the children was 3.75 years (SD 1.30); mean height was 101.73 cm (SD 10.29); and mean weight was 14.67 kg (SD 3.26) (Table 10). The high mean dmft score (dmft 9.67 SD 4.14), the high untreated d component (contributed almost 91% to the total dmft score) and high mean pufa score (pufa 2.4 SD 2.37) provides evidence of the huge untreated caries burden. The "untreated caries" pufa ratio was calculated and the score was 0.27 which means that almost every 1 in 3 untreated decayed tooth in the mouth had symptoms of pulpal, ulcerative, fistula or abscess- like symptoms.

Table10: Baseline characteristics for delayed group (n=156)						
Variable	**n**	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Age	156	6.00	1.00	7.00	3.75	1.30
Height (cm)	156	50.00	72.00	122.00	101.73	10.29
Weight (kg)	156	18.80	7.20	26.00	14.67	3.26
Hb (g/dl)	123	12.90	5.70	18.60	10.15	2.03
BMI	156	10.87	10.29	21.16	14.09	1.82
D	156	18.00	2.00	20.00	8.79	4.17
M	156	16.00	0.00	16.00	0.88	2.47
F	156	0.00	0.00	0.00	0.00	0.00
dmft	156	18.00	2.00	20.00	9.67	4.14
Pulpal exposure	156	7.00	1.00	8.00	1.99	1.64
Ulceration	156	2.00	0.00	2.00	0.03	0.21
Fistula	156	2.00	0.00	2.00	0.01	0.16
Abscess	156	4.00	0.00	4.00	0.40	1.01
pufa	156	11.00	1.00	12.00	2.40	2.37

Similar to the analyses for the Immediate group, Tables 11-16 provide gender and age characteristics in the delayed treatment group. When the group was analysed as a whole, no significant differences were noted between males and females (Table 11). When the ages were separated into age categories, no significant differences between males and females were noted (Tables 12-16). However when age was compared against the other variables at baseline (height, weight, BMI, Hb, dmft, pufa) in an ANOVA analysis (Table 17), a significant age variation in baseline values of Height, weight and Hb ($p=0.000$) was noted between the age groups. However, no significant age variation was observed for BMI, dmft and pufa. Tukey post hoc analysis showed that a significant increase in the height occurred as the age increased ($p=0.000$) except between ages 4 and 6 and 5 and 6 ($p<0.05$). Also, significant age variations were found in baseline weight except between ages 2 and 3 ($p=0.55$), 3 and 4 ($p=0.82$, 4 and 6 ($p= 0.48$) and 5 and 6 (1.00) respectively. Hb levels showed significant variations with respect to ages 2 and 5, 3 and 5 and 4 and 5 ($p<0.05$) (Table 17).

Table 11: Gender comparison of baseline variables for delayed group (All ages included)						
Variable	**Sex**	**n**	**Mean**	**Std. Deviation**	**t- test score**	**p-value**
Age	Male	85	3.80	1.29	0.53	0.60
	Female	71	3.69	1.32		
Height (cm)	Male	85	101.85	10.13	0.15	0.88
	Female	71	101.59	10.54		
Weight (kg)	Male	85	14.90	3.25	0.96	0.34
	Female	71	14.40	3.26		
Hb (g/dl)	Male	67	10.31	2.33	1	0.32
	Female	56	9.95	1.59		
BMI	Male	85	14.25	1.61	1.21	0.23
	Female	71	13.90	2.04		
D	Male	85	9.13	4.47	1.12	0.27
	Female	71	8.38	3.76		
M	Male	85	0.81	2.54	-0.40	0.69
	Female	71	0.97	2.41		
F	Male	85	0.00	.000a	1	1
	Female	71	0.00	.000a		
dmft	Male	85	9.94	4.37	0.89	0.38
	Female	71	9.35	3.85		
Pulp exposed	Male	85	2.21	1.83	1.89	0.06
	Female	71	1.72	1.33		
Ulceration	Male	85	0.02	0.15	-0.55	0.58
	Female	71	0.04	0.26		
Fistula	Male	85	0.00	0.00	-1.10	0.28
	Female	71	0.03	0.24		
Abscess	Male	85	0.48	1.16	1.07	0.29
	Female	71	0.31	0.79		
pufa	Male	85	2.68	2.60	1.65	0.10
	Female	71	2.06	2.02		

Table 12: Gender comparison of baseline variables for 2 year-olds in Delayed Group						
Variable	**Sex**	**n**	**Mean**	**Std. Deviation**	**t- test score**	**p- value**
Height (cm)	Male	15	87.77	6.93	-0.538	0.595
	Female	17	89.35	9.28		
Weight (kg)	Male	15	11.29	1.88	-0.639	0.528
	Female	17	11.77	2.34		
Hb (g/dl)	Male	14	9.24	1.80	0.045	0.965
	Female	12	9.22	1.01		
BMI	Male	15	14.64	1.60	-0.205	0.839
	Female	17	14.80	2.49		
D	Male	15	9.07	4.03	-0.363	0.72
	Female	17	9.65	4.91		
m	Male	15	0.47	1.13	0.134	0.894
	Female	17	0.41	1.18		
f	Male	15	0.00	.000b	1	1
	Female	17	0.00	.000b		
dmft	Male	15	9.53	3.72	-0.35	0.729
	Female	17	10.06	4.64		
Pulp exposed	Male	15	1.87	1.51	0.323	0.749
	Female	17	1.71	1.31		
Ulceration	Male	15	0.00	0.00	-1.29	0.207
	Female	17	0.18	0.53		
Fistula	Male	15	0.00	.000b	1	1
	Female	17	0.00	.000b		
Abscess	Male	15	0.33	1.05	-0.868	0.392
	Female	17	0.65	1.00		
pufa	Male	15	2.13	2.13	-0.356	0.724
	Female	17	2.41	2.27		

Table 13: Gender comparison of baseline variables for 3 year-olds in Delayed Group						
Variable	**Sex**	**n**	**Mean**	**Std. Deviation**	**t-test score**	**p-value**
Height (cm)	Male	18	97.25	5.51	0.50	0.62
	Female	11	96.17	5.76		
Weight (kg)	Male	18	13.31	2.33	-0.05	0.96
	Female	11	13.36	2.50		
Hb (g/dl)	Male	16	9.81	1.79	-0.43	0.67
	Female	11	10.07	1.13		
BMI	Male	18	14.00	1.74	-0.53	0.60
	Female	11	14.35	1.68		
d	Male	18	10.39	5.77	1.55	0.13
	Female	11	7.45	3.08		
m	Male	18	0.33	1.41	-0.41	0.68
	Female	11	0.55	1.21		
f	Male	18	0.00	.000b		
	Female	11	0.00	.000b		
dmft	Male	18	10.72	5.42	1.49	0.15
	Female	11	8.00	3.41		
Pulp exposed	Male	18	1.94	1.59	1.55	0.13
	Female	11	1.18	0.41		
Ulceration	Male	18	0.06	0.24	0.78	0.44
	Female	11	0.00	0.00		
Fistula	Male	18	0.00	.000b		
	Female	11	0.00	.000b		
Abscess	Male	18	0.72	1.41	1.20	0.24
	Female	11	0.18	0.60		
pufa	Male	18	2.61	2.38	1.83	0.08
	Female	11	1.27	0.47		

Table 14: Gender comparison of baseline variables for 4 year-olds in Delayed Group						
Variable	**Sex**	**n**	**Mean**	**Std. Deviation**	**t-test score**	**p-value**
Height (cm)	Male	18	103.68	5.00	-1.31	0.20
	Female	20	105.70	4.48		
Weight (kg)	Male	18	14.81	1.85	-0.33	0.74
	Female	20	15.06	2.56		
Hb (g/dl)	Male	15	9.99	2.10	0.60	0.55
	Female	16	9.63	1.20		
BMI	Male	18	13.76	1.24	0.67	0.51
	Female	20	13.42	1.80		
d	Male	18	9.89	3.68	1.77	0.09
	Female	20	7.95	3.09		
m	Male	18	0.22	0.94	-0.92	0.36
	Female	20	0.70	2.00		
f	Male	18	0.00	.000b	1	1
	Female	20	0.00	.000b	1	1
dmft	Male	18	10.11	4.16	1.19	0.24
	Female	20	8.65	3.39		
Pulp exposed	Male	18	2.28	1.74	0.76	0.45
	Female	20	1.85	1.73		
Ulceration	Male	18	0.00	.000b		
	Female	20	0.00	.000b		
Fistula	Male	18	0.00	.000b		
	Female	20	0.00	.000b		
Abscess	Male	18	0.56	1.15	0.59	0.56
	Female	20	0.35	0.99		
pufa	Male	18	2.89	2.61	0.79	0.44
	Female	20	2.20	2.76		

Table 15: Gender comparison of baseline variables for 5 year-olds in Delayed Group						
Variable	**Sex**	**n**	**Mean**	**Std. Deviation**	**t-test score**	**p- value**
Height (cm)	Male	32	109.50	6.79	-0.06	0.95
	Female	21	109.62	6.90		
Weight (kg)	Male	32	17.32	2.75	1.16	0.25
	Female	21	16.31	3.53		
Hb (g/dl)	Male	22	11.58	2.67	0.86	0.40
	Female	15	10.86	2.19		
BMI	Male	32	14.41	1.64	1.92	0.06
	Female	21	13.47	1.90		
d	Male	32	8.31	4.22	-0.02	0.99
	Female	21	8.33	3.77		
m	Male	32	1.63	3.77	-0.36	0.72
	Female	21	2.00	3.61		
f	Male	32	0.00	.000b		
	Female	21	0.00	.000b		
dmft	Male	32	9.94	4.17	-0.35	0.73
	Female	21	10.33	3.81		
Pulp exposed	Male	32	2.56	2.17	1.16	0.25
	Female	21	1.95	1.28		
Ulceration	Male	32	0.03	0.18	0.81	0.42
	Female	21	0.00	0.00		
Fistula	Male	32	0.00	0.00	-1.24	0.22
	Female	21	0.10	0.44		
Abscess	Male	32	0.31	1.03	0.94	0.35
	Female	21	0.10	0.30		
pufa	Male	32	2.91	3.02	1.07	0.29
	Female	21	2.14	1.49		

Table 16: Gender comparison of baseline variables for 6 year-olds in Delayed Groups						
Variable	**Sex**	**n**	**Mean**	**Std. Deviation**	**t-test score**	**p-value**
Height (cm)	Male	2	110.00	12.73	-0.02	0.99
	Female	2	110.20	5.37		
Weight (kg)	Male	2	18.50	0.71	2.62	0.12
	Female	2	15.80	1.27		
Hb (g/dl)	Male		.	.		
	Female	2	9.40	2.26		
BMI	Male	2	15.53	2.99	0.91	0.46
	Female	2	13.11	2.32		
D	Male	2	4.50	0.71	-4.24	0.05
	Female	2	7.50	0.71		
M	Male	2	0.00	.000b		
	Female	2	0.00	.000b		
F	Male	2	0.00	.000b		
	Female	2	0.00	.000b		
dmft	Male	2	4.50	0.71	-4.24	0.05
	Female	2	7.50	0.71		
Pulp exposure	Male	2	1.00	.000b	1	1
	Female	2	1.00	.000b		
Ulceration	Male	2	0.00	.000b		
	Female	2	0.00	.000b		
Fistula	Male	2	0.00	.000b		
	Female	2	0.00	.000b		
Abscess	Male	2	1.50	2.12	1.00	0.42
	Female	2	0.00	0.00		
pufa	Male	2	2.00	1.41	1.00	0.42
	Female	2	1.00	0.00		

Table 17: Table of ANOVA showing AGE compared to the baseline variables in the delayed group						
Variable		**Sum of Squares**	**df**	**Mean Square**	**F**	**p-value**
Height (cm)	Between Groups	10065.608	4	2516.402	59.939	0.000
	Within Groups	6339.362	151	41.983		
	Total	16404.970	155			
Weight (kg)	Between Groups	661.132	4	165.283	25.396	0.000
	Within Groups	982.760	151	6.508		
	Total	1643.891	155			
Hb (g/dl)	Between Groups	76.057	4	19.014	5.273	0.001
	Within Groups	425.509	118	3.606		
	Total	501.567	122			
BMI	Between Groups	23.222	4	5.806	1.783	0.135
	Within Groups	491.581	151	3.256		
	Total	514.803	155			
dmft	Between Groups	68.164	4	17.041	.997	0.411
	Within Groups	2582.163	151	17.100		
	Total	2650.327	155			
pufa	Between Groups	9.048	4	2.262	.397	0.811
	Within Groups	860.311	151	5.697		
	Total	869.359	155			

Table 18 compares the baseline anthropometric and clinical characteristics of both the immediate and delayed groups. Significant differences between the groups were noted for age, height, weight, Hb and the “p” and “a” components of the pufa index. All these variables were higher in the immediate group except for the “a” component which was more prevalent among children from the delayed group.

Table 18 : Baseline comparison of anthropometric & clinical variables between immediate and delayed groups

Variable	Group	N	Mean	Std. Deviation	t-test score	p-value	Mean diff	CI 95%
Age (yrs)	Immediate	126	4.38	1.19	4.11	0.00	0.59	0.31-0.87
	Delayed	156	3.79	1.19				
BMI	Immediate	126	14.34	1.78	1.15	0.25	0.25	-0.18-0.67
	Delayed	156	14.09	1.82				
Height (cm)	Immediate	126	105.44	9.71	3.09	0.00	3.71	1.34-6.08
	Delayed	156	101.73	10.29				
Weight (kg)	Immediate	126	16.00	3.22	3.41	0.00	1.32	0.56-2.09
	Delayed	156	14.67	3.26				
Hb	Immediate	126	11.52	1.47	6.11	0.00	1.37	0.93-1.81
	Delayed	123	10.15	2.03				
decay	Immediate	126	8.58	3.68	-0.44	0.66	-0.21	-1.14 -0.72
	Delayed	156	8.79	4.17				
missing	Immediate	126	0.90	2.46	0.07	0.95	0.02	-0.56-0.60
	Delayed	156	0.88	2.47				
dmft	Immediate	126	9.58	3.68	-0.20	0.84	-0.09	-1.02-0.84
	Delayed	156	9.67	4.14				
Pulpal	Immediate	126	1.04	1.31	-5.28	0.00	-0.95	-1.30--0.59
	Delayed	156	1.99	1.64				
Ulceration	Immediate	126	0.07	0.26	1.41	0.16	0.04	-0.02-0.09
	Delayed	156	0.03	0.21				
Fistula	Immediate	126	0.02	0.15	0.58	0.56	0.01	-0.03-0.05
	Delayed	156	0.01	0.16				
Abscess	Immediate	126	1.34	1.66	5.85	0.00	0.94	0.62-1.25
	Delayed	156	0.40	1.01				
Pufa	Immediate	126	2.48	1.73	0.34	0.73	0.09	-0.41-0.58
	Delayed	156	2.40	2.37				
No. of teeth extracted	Immediate	126	7.40	3.53	-2.42	0.08	-1.15	
	Delayed	156	8.55	3.94				

5.1.2 The post-treatment follow-up characteristics of the immediate and delayed treatment groups

Table 19: Descriptive characteristics of children in immediate treatment group 6 months post – treatment (n=126) [Mean follow up 6.1 months SD 0.7]

	n	Range	Minimum	Maximum	Mean	Std. Deviation
Height after treatment (cm)	126	51.0	80.5	131.5	112.05	8.95
Weight after treatment (kg)	126	21.3	11.1	32.4	19.04	3.70
Hb after extraction (g/dL)	126	9.6	5.7	15.3	11.52	1.47
BMI after Treatment	126	11.50	10.41	21.91	15.13	2.05
No. of teeth extracted under GA	126	22.0	2.0	24.0	7.40	3.53

Table 19 provides details of the mean changes in anthropometric and clinical variables in the immediate treatment group at 6 months follow up [mean follow up 6.1 months SD 0.7]. The mean number of teeth extracted under GA was 7.4 (SD 3.53). The average weight, height and BMI (all unadjusted values) of the group was 19.04 kg, 112.05 cm and 15.13 respectively. Mean Hb was 11.52 g/dL. The group was then categorized by AGE and an analyses of the mean height, weight, BMI and Hb values at follow up is presented in Table 20.

Table 20: Characteristics of children by age group in immediate treatment group 6 months post-treatment

AGE 2 YEARS	n	Range	Minimum	Maximum	Mean	Std. Deviation
height after treatment (cm)	10	38.0	80.5	118.5	98.060	10.2134
weight after treatment (kg))	10	9.1	11.1	20.2	15.100	3.0037
Hb after extraction (g/dL)	10	3.4	9.1	12.5	10.490	1.0754
BMI after treatment	10	9.35	12.56	21.91	15.7934	2.88946
AGE 3 YEARS	**n**	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
height after treatment (cm)	19	28.9	94.8	123.7	106.274	8.6035
weight after treatment (kg)	19	12.2	14.0	26.2	17.553	2.8420
Hb after extraction (g/dL)	19	8.5	5.7	14.2	11.200	1.9720
BMI after treatment	19	7.41	12.35	19.76	15.5692	1.85960
AGE 4 YEARS	**n**	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
height after treatment (cm)	35	24.7	94.5	119.2	109.929	5.9365
weight after treatment (kg)	35	9.0	13.2	22.2	17.763	2.3126
Hb after extraction (g/dL)	35	6.0	9.3	15.3	12.023	1.3454
BMI after treatment	35	11.42	10.41	21.84	14.7391	1.96644
AGE 5 YEARS	N	Range	Minimum	Maximum	Mean	Std. Deviation
height after treatment (cm)	37	23.0	104.0	127.0	116.619	5.7251
weight after treatment (kg)	37	9.5	16.0	25.5	20.224	2.9172
Hb after extraction (g/dL)	37	5.8	8.8	14.6	11.284	1.3901
BMI after treatment	37	7.91	11.75	19.66	14.8606	1.82421
AGE 6 YEARS	**n**	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
height after treatment (cm)	25	27.5	104.0	131.5	118.244	6.0721
weight after treatment (kg)	25	17.2	15.2	32.4	21.796	4.5840
Hb after extraction (g/dL)	25	4.2	10.2	14.4	11.796	1.1717
BMI after treatment	25	8.37	12.50	20.87	15.4570	2.20931

Table 21a: Rate of Change (Velocity of change) in anthropometric and clinical variables 6 months after treatment in the immediate group (n=126) [Time $T_{0\ to}\ T_1$] [Baseline to follow-up]						
	N	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Height change (cm)	126	17.00	0.50	17.50	6.61	2.69
Weight change (kg)	126	6.32	0.48	6.80	3.05	1.30
Hb change (g/dL)	126	8.30	0.10	8.40	3.45	1.40
BMI change	126	5.79	-1.58	4.21	0.79	1.07

One of the key questions that this trial sought to investigate was the rate of change (velocity of change) of the anthropometric variables and Hb levels within and between the groups. Table 21a provides details of the mean rate of change (unadjusted values) that occurred ***within*** the immediate treatment group at 6 months follow-up. The mean increase in height, weight and BMI was 6.61 cm, 3.05 kg and 0.79 respectively. Mean Hb rate of change (improvement) was 3.45 g/dL. Table 21b provides a summary of the mean rate of change of the anthropometric variables (unadjusted values) and Hb levels by AGE in the immediate treatment group at 6 months follow-up. The largest mean change in height occurred in the 2 year old group (mean change 9.26 cm) whilst the least mean change in height (6.22 cm) occurred in the 5 year old group. The 6 year old group had the highest rate of weight gain (mean change 3.23 kg at 6 months follow up) with children in the 4 year old group gaining on average 2.80 kg at 6 months follow-up. BMI showed the largest mean rate of change (improvement) in the 3 year old group (0.923) with the smallest change occurring in the 2 year old group (0.356) The mean rate of change (improvement) in the Hb levels ranged from 2.75 g/dL for 2 year olds to 3.66 g/dL among 6 year olds (Table 21b)

Table 21b: Rate of Change (Velocity of change) by age category in anthropometric and clinical variables 6 months after treatment in the immediate group						
AGE 2 YEARS	**N**	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Rate of Height change (cm)	10	5.50	6.50	12.00	9.2600	2.08657
Rate of Weight change (kg)	10	4.30	1.70	6.00	2.9620	1.18907
Rate of Hb change (g/dL)	10	1.80	1.80	3.60	2.7500	.63289
Rate of BMI change	10	5.04	-.83	4.21	.3565	1.46085
AGE 3 YEARS	**N**	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Rate of Height change (cm)	19	9.50	2.00	11.50	6.6158	2.64097
Rate of Weight change (kg)	19	3.70	1.10	4.80	2.9974	.99254
Rate of Hb change (g/dL)	19	7.10	1.30	8.40	3.4579	1.83070
Rate of BMI change	19	3.38	-.68	2.70	.9231	1.13183
AGE 4 YEARS	**N**	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Rate of Height change (cm)	35	11.50	.50	12.00	6.4714	2.74939
Rate of Weight change (kg)	35	4.70	.80	5.50	2.8020	1.08813
Rate of Hb change (g/dL)	35	5.50	1.00	6.50	3.5743	1.32362
Rate of BMI change	35	4.18	-1.28	2.90	.7331	.96404
AGE 5 YEARS	**N**	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Rate of Height change (cm)	37	15.50	2.00	17.50	6.2270	2.83918
Rate of Weight change (kg)	37	5.42	.48	5.90	3.1995	1.48449
Rate of Hb change (g/dL)	37	8.20	.10	8.30	3.3622	1.41271
Rate of BMI change	37	4.41	-1.58	2.83	.9094	1.10534
AGE 6 YEARS	**N**	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Rate of Height change (cm)	25	9.00	3.20	12.20	6.2840	2.18302
Rate of Weight change (kg)	25	5.90	.90	6.80	3.2300	1.54933
Rate of Hb change (g/dL)	25	5.70	.90	6.60	3.6600	1.35031
Rate of BMI change	25	3.80	-.94	2.86	.7494	.94503

Table 22: Pearson correlation analyses for Anthropometric (Height, weight, BMI) and clinical variables (Hb) versus oral health variables (dmft, pufa) in the immediate group.

		Height change	Weight Change	Hb change	BMI change	dmft	pufa
Height change (cm)	Pearson Correlation	1	.225*	-.176*	-.365**	.080	.157
	Sig. (2-tailed) p-value		.011	.049	.000	.373	.080
	N	126	126	126	126	126	126
Weight Change (kg)	Pearson Correlation	.225*	1	.263**	.770**	-.102	-.115
	Sig. (2-tailed) p-value	.011		.003	.000	.256	.202
	N	126	126	126	126	126	126
Hb change (g/dL)	9 Pearson Correlation	-.176*	.263**	1	.330**	-.122	-.141
	Sig. (2-tailed) p-value	.049	.003		.000	.172	.116
	N	126	126	126	126	126	126
BMI change	Pearson Correlation	-.365**	.770**	.330**	1	-.112	-.162
	Sig. (2-tailed) p-value	.000	.000	.000	just	.212	.070
	N	126	126	126	126	126	126
dmft	Pearson Correlation	.080	-.102	-.122	-.112	1	.397**
	Sig. (2-tailed) p-value	.373	.256	.172	.212		.000
	N	126	126	126	126	126	126
pufa	Pearson Correlation	.157	-.115	-.141	-.162	.397**	1
	Sig. (2-tailed) p-value	.080	.202	.116	.070	.000	
	N	126	126	126	126	126	126

The association between the mean rate of change (velocity of change) for anthropometric and clinical variables versus oral health status as indicated by the dmft and pufa scores was investigated using the Pearson correlation test for the unadjusted values (Table 22). The following important observations can be made:-

- There was a significant negative correlation between the mean change in the height and the mean BMI change (p= 0.000). Given that the formula for BMI is mass (kg)/height^2 (cm), it is clear that the higher the mean height change, the lower will be the mean BMI change (negative association)
- A similar significant negative correlation between mean change in height and mean change in Hb was found (p=0.049) but there was a positive correlation between mean Hb change and mean weight gain (p= 0.003) and mean Hb change and mean BMI change (p=0.000).
- There was a significant positive correlation between mean dmft scores and mean pufa scores indicating that a higher mean dmft scores was significantly correlated with a higher pufa score (p=0.000)
- No significant correlations were noted for the changes mean anthropometric scores (height, weight, BMI) or Hb change and the oral health status (dmft, pufa) change in the immediate group

Table 23: Pairwise comparison of the anthropometric and clinical variables before and after treatment in the immediate group (n=126) Time from baseline to follow-up [$T_0 - T_1$] [Within group Comparison]

	BEFORE TREATMENT			AFTER TREATMENT		CI		p value
	n	Mean	Std. Deviation	Mean	Std. Deviation			
Height (cm)	126	105.44	9.71	112.05	8.95	-7.08	-6.13	0.00
Weight(kg)	126	15.99	3.22	19.04	3.70	-3.28	-2.82	0.00
Hb(g/dl)	126	8.07	1.31	11.52	1.47	-3.69	-3.20	0.00
BMI	126	14.34	1.78	15.13	2.05	-0.97	-0.60	0.00

The treatment received under GA by children in the immediate group resulted in significant improvement in the height, weight, BMI and Hb levels at the 6 month follow-up period (Table 23). The unadjusted mean scores before and after treatment is shown in Table 23.

DELAYED GROUP

Table 24: Descriptive characteristics of the anthropometric variables and clinical variables in the delayed group at baseline [T_0],, before treatment [T_1], and after treatment [T_2]

Variable	n	Minimum	Maximum	Mean	Std. Deviation
[T_0] Baseline Height (cm)	156	72.0	122.0	101.734	10.2878
Baseline Weight (kg)	156	7.2	26.0	14.672	3.2566
Baseline Hb (g/dL)	124	4.0	10.0	6.423	1.2739
BMI baseline	156	10.29	21.16	14.0905	1.82245
[T_1] Height (cm) **before** treatment	125	79.50	125.00	105.2392	9.28184
Weight (kg) **before** treatment	125	9.5	28.5	16.686	3.2638
Hb (g/dl) **before** treatment	123	5.7	18.6	10.147	2.0276
BMI **before** treatment	125	11.07	22.35	15.0180	1.93750
No. of teeth extracted under GA	125	2.0	20.0	8.55	3.94
[T_2] height (cm) **After** treatment	124	91.0	131.0	112.695	7.8393
weight (kg) **After** treatment	124	13.9	34.2	21.614	3.4515
Hb (g/dl) **After** treatment	125	6.6	17.4	11.425	1.5124
BMI **After** treatment	124	12.24	26.55	17.0132	2.15814

Unlike for the immediate treatment group where there was two data collection points (baseline (T_0) and follow-up at 6 months post-treatment [T_1]) [mean follow-up 6.05 SD 0.8], in the delayed group, there was three data collection opportunities:- (baseline [T_0], on the day of treatment 6 months later [T_1], and at follow-up 6 months later [T_2]) mean follow-up [6.5 months SD 1.1]. Thus data was collected over a 12 month period for children in the delayed group. The mean baseline, before and after treatment data is summarized in Table 24. The mean number of teeth extracted under GA when the delayed group received treatment 6 months after the immediate group was 8.55 (SD 3.94).

Table 25: Pairwise comparison of Anthropometric measures at baseline, first follow up (before treatment) and second follow-up (after treatment) in the delayed group

		Baseline [T_0]		First follow up [T_1]		p	Second follow up [T_2]		p
	n	Mean	Std. Deviation	Mean	Std. Deviation		Mean	Std. Deviation	
Height (cm)	125	100.83	10.20	105.24	9.28	0.00	112.70	7.84	0.000
Weight (kg)	125	14.38	3.20	16.69	3.26	0.00	21.61	3.45	0.000
Hb	122	6.43	1.28	10.114	2.00	0.00	11.41	1.52	0.000
BMI	125	14.06	1.85	15.018	1.94	0.00	17.01	2.16	0.000

Table 25 compares the anthropometric and clinical data collected between baseline [T_0] and day of treatment in the delayed group [T_1], and day of treatment [T_1] and follow-up 6 months later [T_2]. Data collected at the 3 points were compared and there were significant improvements in all variables between baseline [T_0], and day of treatment (6 month waiting period) [T_1], and between day of treatment [T_1], and follow-up (6 months later) [T_2] (Table 25). When these variables (height, weight, Hb, BMI) were compared by AGE, similar significant improvements were noted in all age categories (2,3,4 & 5). For age 6, where the sample size was only 2, no significant differences ($p > 0.05$) were noted except for the Hb levels between day of treatment (T_1] and at follow-up after treatment [T_2] (Table 26).

Table 26: Pairwise comparison of Anthropometric measure at baseline [T_0] and first follow up [T_1], first follow up [T_1] and second follow up [T_2] in the delayed group by AGE									
Age 2		Baseline **[T_0]**		Before treatment **[T_1]**			After Treatment**[T_2]**		
Variable	**n**	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviation**	**p**	**Mean**	**Std. Deviation**	**p**
Height (cm)	26	88.02	8.04	93.48	7.31	0.000	103.17	6.00	0.000
Weight (kg)	26	11.32	1.90	13.77	2.47	0.000	18.65	2.99	0.000
Hb (g/dl	26	6.48	1.46	9.23	1.46	0.000	11.19	1.46	0.000
BMI	26	14.68	2.13	15.76	2.27	0.000	17.51	2.33	0.000
Age 3	**n**	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviation**	**p**	**Mean**	**Std. Deviation**	**p**
Height (cm)	27	96.87	5.73	101.62	5.08	0.000	110.02	4.32	0.000
Weight (kg)	27	13.27	2.42	15.85	2.50	0.000	21.59	2.36	0.000
Hb (g/dl	27	6.23	1.15	9.92	1.54	0.000	11.44	1.61	0.000
BMI	27	14.06	1.71	15.30	1.79	0.000	17.83	1.65	0.000
Age 4	**n**	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviation**	**p**	**Mean**	**Std. Deviation**	**p**
Height (cm)	31	104.17	5.03	108.75	4.49	0.000	115.63	4.22	0.000
Weight (kg)	31	14.57	2.24	17.06	2.21	0.000	22.13	2.37	0.000
Hb (g/dl	31	6.24	1.29	9.80	1.68	0.000	11.36	1.48	0.000
BMI	31	13.40	1.61	14.40	1.40	0.000	16.53	1.31	0.000
Age 5	**n**	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviation**	**p**	**Mean**	**Std. Deviation**	**p**
Height (cm)	39	108.97	6.96	112.17	6.34	0.000	118.17	6.16	0.000
Weight (kg)	39	16.94	2.98	18.73	3.35	0.000	23.05	3.99	0.000
Hb (g/dl	36	6.61	1.14	11.21	2.46	0.000	11.54	1.57	0.450
BMI	39	14.22	1.82	14.83	2.06	0.000	16.50	2.71	0.000
Age 6	**n**	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviation**	**p**	**Mean**	**Std. Deviation**	**p**
Height (cm)	2	110.20	5.37	117.25	6.72	0.085	123.15	7.57	0.065
Weight (kg)	2	15.80	1.27	20.30	0.00	0.126	25.15	1.34	0.123
Hb (g/dl	2	8.00	2.83	9.40	2.26	0.177	12.10	2.12	0.024
BMI	2	13.11	2.32	14.84	1.70	0.159	16.62	1.15	0.135

Table 27: The mean rate of change (rate of velocity) in the anthropometric and clinical variables at baseline [T_0], and day of treatment and between day of treatment and follow-up (6 months later) in the delayed group

	BASELINE AND TREATMENT [T_0 vs T_1] (N=125)				TREATMENT AND FOLLOW UP [T_1 vs T_2] (N=124)				CI	
	Min	**Max**	**Mean**	**Std. Deviation**	**Min**	**Max**	**Mean**	**Std. Deviation**		
Mean Rate of Height change (cm)	1.00	12.00	4.42	1.97	-.40	21.60	7.53	2.98	-3.62	-2.59
Mean rate of Weight change (kg)	-1.90	6.00	2.31	1.19	1.80	15.10	4.95	1.76	-2.94	-2.32
Mean rate of Hb change (g/dL)	-.20	10.60	3.69	1.88	-5.70	4.70	1.26	1.57	1.85	2.97
Mean rate of BMI change	-2.02	3.10	0.96	0.82	-1.67	9.90	1.99	1.39	-1.29	-0.78

The rate of change (velocity of change) of the anthropometric variables and Hb levels between the three data collection points (baseline (T_0), day of treatment ($T_{1)}$ and follow-up (T_2) was assessed. Table 27 provides details of the mean rates of change (unadjusted values) that occurred between baseline and treatment [time interval 6 months] and between treatment and follow-up [time interval 6 months]. Significantly greater rates of mean changes for height, weight, BMI and Hb levels were noted **after treatment ([T_1 vs T_2]** *versus* **before treatment [T_0 vs T_1])** which provides evidence of the significant positive impact that treatment made on the children in this group (p=0.000) (Table 27). When this analyses was done by AGE, significant improvements in the mean rates in growth measures (height, weight, BMI) and Hb levels for ages 2,3,4,and 5 but not for age 6 where no significant improvements were noted (Table 28).

Table 28: Pairwise comparison of rate of change before treatment [T0 to T1] and after treatment in the delayed group [T1 to T2] by AGE												
	Rate of change from baseline to Before treatment [T0 to T1]						Rate of Change from before treatment to after treatment [T1 to T2]					
Age 2	**n**	**Range**	**Min**	**Max**	**Mean**	**Std. Deviation**	**Range**	**Min**	**Max**	**Mean**	**Std. Deviation**	**p**
Rate of height change	26	6.5	2	8.5	5.4577	1.64467	19.9	-0.4	19.5	9.6923	4.03187	0.000
Rate of weight change	26	3.4	1	4.4	2.45	1.07154	4.6	2.9	7.5	4.8808	1.27123	0.000
Rate of Hb change	26	6.6	-0.2	6.4	2.75	1.60705	4.3	0.4	4.7	1.9615	0.96086	0.068
Rate BMI change	26	2.84	-0.28	2.56	1.0864	0.79883	5.06	-1.17	3.89	1.7489	1.33142	0.019
Age 3	**n**	**Range**	**Min**	**Max**	**Mean**	**Std. Deviation**	**Range**	**Min**	**Max**	**Mean**	**Std. Deviation**	**p**
Rate of height change	27	5.5	2	7.5	4.7556	1.40776	17.9	3.7	21.6	8.4	3.27919	0.000
Rate of weight change	27	3.5	1.1	4.6	2.5741	1.09671	5.7	2.9	8.6	5.7444	1.63056	0.000
Rate of Hb change	27	5.5	0.9	6.4	3.6926	1.35758	5.7	-2.4	3.3	1.5185	1.28872	0.000
Rate BMI change	27	2.84	0	2.84	1.2326	0.8202	6.77	-1.67	5.1	2.5382	1.49592	0.000

Age 4	**n**	**Range**	**Min**	**Max**	**Mean**	**Std. Deviation**	**Range**	**Min**	**Max**	**Mean**	**Std. Deviation**	**p**
Rate of height change	31	9.5	1.2	10.7	4.5871	1.96091	7.2	4	11.2	6.871	1.53562	0.000
Rate of weight change	31	5.2	0.8	6	2.4903	1.10826	5.7	1.8	7.5	5.071	1.35823	0.000
Rate of Hb change	31	5.5	1	6.5	3.5645	1.47457	4.3	-1.1	3.2	1.5548	0.90511	0.000
Rate BMI change	31	4.06	-0.96	3.1	1.0018	0.81576	3.53	-0.18	3.35	2.1356	0.86109	0.000
Age 5	**n**	**Range**	**Min**	**Max**	**Mean**	**Std. Deviation**	**Range**	**Min**	**Max**	**Mean**	**Std. Deviation**	**p**
Rate of height change	39	11	1	12	3.2	1.92066	6.2	3.8	10	6.0447	1.53406	0.000
Rate of weight change	39	6.1	-1.9	4.2	1.7821	1.17067	12.8	2.3	15.1	4.3263	2.22743	0.000
Rate of Hb change	36	10.1	0.5	10.6	4.5917	2.29613	8.6	-5.7	2.9	0.2541	2.03764	0.000
Rate BMI change	39	3.88	-2.02	1.86	0.6064	0.75079	10.02	-0.12	9.9	1.6641	1.63897	0.000
Age 6	**n**	**Range**	**Min**	**Max**	**Mean**	**Std. Deviation**	**Range**	**Min**	**Max**	**Mean**	**Std. Deviation**	**p**
Rate of height change	2	1.9	6.1	8	7.05	1.3435	1.2	5.3	6.5	5.9	0.84853	0.188
Rate of weight change	2	1.8	3.6	5.4	4.5	1.27279	1.9	3.9	5.8	4.85	1.3435	0.09
Rate of Hb change	2	0.8	1	1.8	1.4	0.56569	0.2	2.6	2.8	2.7	0.14142	0.144
Rate BMI change	2	0.89	1.29	2.17	1.7309	0.62624	0.77	1.4	2.17	1.7836	0.54307	0.535

Table 29: Comparison of mean change in variables at baseline and after treatment in the immediate group to mean change in variables between baseline and before treatment in the delayed group [{Time T_0 to T_1} Time lag : 6 months] [treatment vs. no treatment]

Variable	Group	n	Mean	Std. Deviation	t- test score	p-value
Height (cm)	Delayed group	125	4.41	1.97	-7.37	0.00
	Immediate group	126	6.61	2.69		
Weight (kg)	Delayed group	125	2.31	1.19	-4.67	0.00
	Immediate group	126	3.05	1.30		
Hb (g/DL)	Delayed group	122	3.69	1.88	1.15	0.25
	Immediate group	126	3.45	1.40		
BMI	Delayed group	125	0.96	0.82	1.42	0.16
	Immediate group	126	0.79	1.07		

There were two groups with severe untreated caries in this trial. The first group had treatment under GA immediately following baseline examinations (Immediate Group) whilst the second group (Delayed group) had to wait for a period of 6 months to access treatment under GA (Delayed group). This time interval was approximately 6 months in both groups and in effect compared treatment *versus* no treatment. Table 29 compares the mean changes that occurred in this 6 month period with respect to height, weight, BMI and Hb in the immediate and delayed groups – in effect Time intervals T_0 – T_1 in both the groups were compared. The results clearly show (Table 29) that there were significant height and weight gains in the group that received treatment (immediate group) compared to the group that was waiting for treatment (Delayed Group) during this time period of 6 months. No differences in Hb and BMI were noted (Table 29).

When these groups were compared by AGE (Table 30) several interesting observations were noted:-

- For ages 2,3 & 4, the mean improvements in height significantly favoured the children in the immediate group (p=0.00); No significant differences were noted for mean weight, BMI and Hb levels

- For age 5, mean height and weight was significantly greater in the immediate group (p=0.00, the BMI mean was not significant between the two groups (age 5) and the mean Hb levels were significantly greater in the delayed group
- For age 6, no significant differences in the mean weight, height and BMI were noted but the mean Hb levels were significantly higher in the delayed group. However the very small sample size of children in the delayed group (n=2) warrants that these findings for age 6 be interpreted with caution.

Table 30: Age Comparison of mean change in variables at baseline and after treatment in the immediate group to mean change in variables between baseline and before treatment in the delayed group [{Time T_0 to T_1} Time lag : 6 months]

Age = 2.00 years

Variable	Group	n	Mean	Std. Deviation	t-test score	p-value
Height (cm)	Delayed group	26	5.46	1.64	-5.77	0.00
	Immediate group	10	9.26	2.09		
Weight (kg)	Delayed group	26	2.45	1.07	-1.25	0.22
	Immediate group	10	2.96	1.19		
Hb (g/dL)	Delayed group	26	2.75	1.61	0.00	1.00
	Immediate group	10	2.75	0.63		
BMI	Delayed group	26	1.09	0.80	1.93	0.06
	Immediate group	10	0.36	1.46		

Age = 3.00 years

Variable	Group	n	Mean	Std. Deviation	t-test score	p-value
Height (cm)	Delayed group	27	4.76	1.41	-3.10	0.00
	Immediate group	19	6.62	2.64		
Weight (kg)	Delayed group	27	2.57	1.10	-1.34	0.19
	Immediate group	19	3.00	0.99		
Hb (g/dL)	Delayed group	27	3.69	1.36	0.50	0.62
	Immediate group	19	3.46	1.83		
BMI	Delayed group	27	1.23	0.82	1.08	0.29
	Immediate group	19	0.92	1.13		

Age = 4.00 years						
Variable	**Group**	**n**	**Mean**	**Std. Deviation**	**t-test score**	**p-value**
Height (cm)	Delayed group	31	4.59	1.96	-3.17	0.00
	Immediate group	35	6.47	2.75		
Weight (kg)	Delayed group	31	2.49	1.11	-1.15	0.25
	Immediate group	35	2.80	1.09		
Hb (g/dL)	Delayed group	31	3.56	1.47	-0.03	0.98
	Immediate group	35	3.57	1.32		
BMI	Delayed group	31	1.00	0.82	1.21	0.23
	Immediate group	35	0.73	0.96		
Age = 5.00 years						
Variable	**Group**	**n**	**Mean**	**Std. Deviation**	**t-test score**	**p-value**
Height	Delayed group	39	3.20	1.92	-5.47	0.00
	Immediate group	37	6.23	2.84		
Weight	Delayed group	39	1.78	1.17	-4.64	0.00
	Immediate group	37	3.20	1.48		
Hb	Delayed group	36	4.59	2.30	2.76	0.01
	Immediate group	37	3.36	1.41		
BMI	Delayed group	39	0.61	0.75	-1.40	0.16
	Immediate group	37	0.91	1.11		
Age = 6.00 years						
Variable	**Group**	**n**	**Mean**	**Std. Deviation**	**t-test score**	**p-value**
Height	Delayed group	2	7.05	1.34	0.48	0.63
	Immediate group	25	6.28	2.18		
Weight	Delayed group	2	4.50	1.27	1.12	0.27
	Immediate group	25	3.23	1.55		
Hb	Delayed group	2	1.40	0.57	-2.32	0.03
	Immediate group	25	3.66	1.35		
BMI	Delayed group	2	1.73	0.63	1.43	0.17
	Immediate group	25	0.75	0.95		

Table 31: Comparison of rate of change (unadjusted values) in anthropometric and clinical variables between the Immediate and Delayed treatment groups

	Change in Variables before and after treatment in Immediate group			Change in baseline and treatment variables in the delayed group			Change in Treatment and follow up variables in the delayed group	
	n	Mean	Std. Deviation	n	Mean	Std. Deviation	Mean	Std. Deviation
Rate of Height change (cm)	126	6.61	2.69*	124	4.42	1.97	7.53	2.98*
Rate of Weight change (kg)	126	3.05	1.30**	124	2.31	1.19	4.95	1.76**
Rate of Hb change (g/dL)	126	3.45	1.40^{+}	122	3.69	1.88	1.26	1.57^{+}
Rate of BMI Change	126	.79	1.07^{++}	124	0.96	0.82	1.99	1.39^{++}

*p<0.005 **p<0.000 +p<0.000 ++ p<0.000

The mean number of teeth extracted under GA in the immediate group was 7.4 (SD 3.53) and the mean number extracted in the delayed group under GA was 8.55 (SD 3.94). Group comparison for number of teeth extracted showed no significant difference (p=0.08).

When the mean rates of change (unadjusted values) were compared between the immediate and delayed treatment group when they both completed their treatment [Time T_0 _ T_1 in immediate group versus Time T_1-T_2 in Delayed group], significant differences were noted in the mean rates of change for height, weight, BMI and Hb which was greater in the delayed group except for Hb levels which showed significantly higher rates of mean change in the immediate group (Table 31). However when the mean rates of change where compared by age (Table 32) the following was noted:-

- For ages 2, 3 and 4, significant improvements in the rate of height change between the treated immediate group **(T_0 _ T_1)** and the delayed group **(T_0 _ T_1).** There was a gain in

weight was between treated and untreated groups but was not significant (p=0.22 age 2; p=0.19 age 3; p=0.25 age 4). Similarly no significant mean rates of change were found for Hb and BMI for times ($T_0 - T_1$) between the immediate and delayed groups. Significant gains in the mean rates for height, weight, Hb and BMI when the children in the delayed group received treatment and were assessed 6 months later ($[T_0 - T_1]_{\text{delayed group}}$ versus $[T_1 - T_2]_{\text{delayed group}}$]) for ages 2,3 and 4 occurred except for the Hb level at age 2 which was actually dropped slightly after treatment [p=0.07]

- For age 5, significant improvements in the rates of change for height, weight, Hb were found when the immediate group was compared to the delayed group who had no treatment [**IMMEDIATE ($T_0 - T_1$) vs DELAYED ($T_0 - T_1$)]** but not for the rate of change in the BMI score [0.91 vs. 0.6; p= 0.16]. Within the delayed group, significant improvements in the mean rates of change from baseline to day of treatment and from day of treatment to follow- up [Delayed group BEFORE treatment [($T_0 - T_1$)] versus. Delayed group AFTER treatment [($T_1 - T_2$)] for height, weight, Hb and BMI. This again provided evidence of the effect that treatment had on the anthropometric and Hb levels in this group.

- The significant improvements in the anthropometric and Hb levels in the **Delayed group** between "before treatment" and "after treatment" [Delayed group BEFORE treatment [($T_0 - T_1$)] versus. Delayed group AFTER treatment [($T_1 - T_2$)] is shown for ages 2,3,4,5 but not 6 (Table 32).
- For age 6, the mean rate of changes for height, weight, BMI and Hb level was not significant when the immediate group was compared with the delayed group that were untreated [**IMMEDIATE ($T_0 - T_1$) vs DELAYED ($T_0 - T_1$)]** and when the Delayed group was compared before and after treatment **[Delayed group BEFORE treatment [($T_0 - T_1$)] versus. Delayed group AFTER treatment [($T_1 - T_2$)].** However, only the mean rate of change in the Hb levels was significant between the immediate and delayed groups (p=0.030) [[IMMEDIATE ($T_0 - T_1$) vs DELAYED ($T_0 - T_1$)]

Table 32: Comparison of rate of change (unadjusted values) in anthropometric and clinical variables between the Immediate and Delayed treatment groups by AGE

	IMMEDIATE (T_0 – T_1)			p-value*	DELAYED					P**
					Before Treatment (T_0 – T_1)			After Treatment (T_1 – T_2)		
AGE = 2.00	N	Mean	SD		N	Mean	SD	Mean	SD	
Rate of change height	10	9.26	2.09	0.00	26	5.46	1.64	9.69	4.03	0.00
Rate of change weight	10	2.96	1.19	0.22	26	2.45	1.07	4.88	1.27	0.00
Rate of change Hb	10	2.75	0.63	1	26	2.75	1.61	1.96	0.96	0.07
Rate of change BMI	10	0.36	1.46	0.06	26	1.09	0.80	1.75	1.33	0.02
AGE = 3.00	N	Mean	SD	p	N	Mean	SD	Mean	SD	p
Rate of change height	19	6.62	2.64	0.00	27	4.76	1.41	8.40	3.28	0.00
Rate of change weight	19	3.00	0.99	0.19	27	2.57	1.10	5.74	1.63	0.00
Rate of change Hb	19	3.46	1.83	0.62	27	3.69	1.36	1.52	1.29	0.00
Rate of change BMI	19	0.92	1.13	0.29	27	1.23	0.82	2.54	1.50	0.00
AGE = 4.00	N	Mean	SD	p	N	Mean	SD	Mean	SD	p
Rate of change height	35	6.47	2.75	0.00	31	4.59	1.96	6.87	1.54	0.00
Rate of change weight	35	2.80	1.09	0.25	31	2.49	1.11	5.07	1.36	0.00
Rate of change Hb	35	3.57	1.32	0.98	31	3.56	1.47	1.55	0.91	0.00
Rate of change BMI	35	0.73	0.96	0.23	31	1.00	0.82	2.14	0.86	0.00
AGE = 5.00	N	Mean	SD	p	N	Mean	SD	Mean	SD	p
Rate of change height	37	6.23	2.84	0.00	38	3.21	1.95	6.04	1.53	0.00
Rate of change weight	37	3.20	1.48	0.00	38	1.78	1.19	4.33	2.23	0.00
Rate of change Hb	37	3.36	1.41	0.01	36	4.59	2.30	0.28	2.06	0.00
Rate of change BMI	37	0.91	1.11	0.16	38	0.60	0.76	1.66	1.64	0.00
AGE = 6.00	N	Mean	SD	p	N	Mean	SD	Mean	SD	p
Rate of change height	25	6.28	2.18	0.63	2	7.05	1.34	5.90	0.85	0.19
Rate of change weight	25	3.23	1.55	0.27	2	4.50	1.27	4.85	1.34	0.09
Rate of change Hb	25	3.66	1.35	0.03	2	1.40	0.57	2.70	0.14	0.14
Rate of change BMI	25	0.75	0.95	0.17	2	1.73	0.63	1.78	0.54	0.54

Table 33: Summary of transformed height, weight, and BMI scores into Z scores for IMMEDIATE GROUP						
Z scores	**N**	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Baseline Height	126	11.92	-5.26	6.66	.2466	1.66023
Baseline Weight	126	9.31	-4.38	4.93	-.5052	1.67960
Baseline BMI	126	17.29	-10.69	6.60	-1.1135	1.94644
After treatment Height	126	9.86	-2.68	7.18	.9832	1.52128
After treatment weight	126	10.32	-3.34	6.98	.8296	1.94897
After treatment BMI	126	11.77	-4.99	6.78	-.1974	1.98985
Δ Height	126	4.14	-.73	3.41	.7366	.70745
Δ Weight	126	4.01	-.34	3.67	1.3348	.85831
ΔBMI	126	10.14	-1.39	8.75	.9161	1.28534

One of the fundamental questions that this trial sought to answer was whether treatment of severe caries under GA resulted in significant improvements in anthropometric measures such as height, weight and BMI. The mean Z-scores before and after treatment within the immediate group is shown in Table 33. When these scores were compared before and after treatment using a simple pairwise comparison, there were significant improvements noted for height, weight and BMI (Table 34). This provides a clear indication of the effect of the intervention on the anthropometric measures among the children who received immediate treatment under GA.

Table 34: Pairwise comparison of Z-scores for height, weight, and BMI before and after treatment [Within group comparison; time interval = 6 months]							
	Mean	**n**	**Std. Deviation**	**t-test score**	**p**	**95%CI**	
Z-scores for weight before Rx	-0.5052	126	1.6796	-17.456	0.000	-1.47	-1.18
Z-scores for weight after Rx	0.8296	126	1.94897				
Z-scores for BMI before Rx	-1.1135	126	1.94644	-8	0.000	-1.14	-0.69
Z-scores for BMI after Rx	-0.1974	126	1.98985				
Z-scores for height before Rx	0.2466	126	1.66023	-11.687	0.000	-0.86	-0.61
Z-scores for height after Rx	0.9832	126	1.52128				

Table 35: Summary of transformed height, weight, and BMI scores into Z scores for DELAYED GROUP					
	n	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
BASELINE [T_0]					
Z-score weight	156	-4.17	3.78	-1.1415	1.52282
Z-score height	156	-5.29	4.63	-.5616	1.50224
Z-score BMI	156	-4.61	5.32	-1.1840	1.64198
BEFORE Rx [T_1]					
Z-score weight	126	-4.94	5.00	-.6369	1.73302
Z-score height	126	-4.34	2.87	-.4244	1.22424
Z-score BMI	126	-4.86	7.28	-.2993	1.92505
AFTER Rx [T_2]					
Z-score weight	126	-3.50	8.71	1.7668	1.99355
Z-score height	126	-2.52	4.32	.4586	1.18837
Z-score BMI	126	-2.63	11.43	1.6446	2.15427
Within Group-change[T_0-T_1]					
Δ Weight change	126	-4.18	2.71	.5730	.89996
Δ BMI change	126	-2.08	3.33	.9150	.88440
Δ Height change	126	-1.25	2.75	.2547	.61712
Within Group-change[T_1-T_2]					
Δ weight change	126	-1.44	9.28	2.4037	1.23567
Δ height change	126	-1.36	4.56	.8830	.83339
Δ BMI change	126	-1.73	10.00	1.9439	1.42456

Table 35 provides a summary of the z-scores for height, weight, and BMI in the Delayed Group. There were significant improvements in the ANOVA comparisons for height, weight and BMI in the delayed group (Table 36). A post hoc test of the variables comparing the time intervals T_0, T_1 and T_2 (Table 37) showed that there were no significant improvements in height between times T_0 and T_1 (time from baseline 6 months follow-up where there was NO treatment).

However, once treatment was done (at time T_1), there was a significant improvement in height (Time T_1 to T_2) again providing evidence of the benefits of treatment. There were significant improvements in weight and BMI between all 3 time intervals assessed (Tables 36 & 37)

Table 36: ANOVA comparison in DELAYED Group between baseline, before and after treatment [Z-scores]

		Sum of Squares	df	Mean Square	F	p value
Weight	**Between Groups**	644.602	2	322.301	105.982	.000
	Within Groups	1231.642	405	3.041		
	Total	1876.244	407			
Height	**Between Groups**	81.386	2	40.693	23.093	.000
	Within Groups	713.666	405	1.762		
	Total	795.053	407			
BMI	**Between Groups**	570.195	2	285.098	79.018	.000
	Within Groups	1461.235	405	3.608		
	Total	2031.430	407			

Table 37: Post Hoc test of the baseline, before treatment and after treatment in DELAYED GROUP						
Variable	**Delayed Group Time interval**		**Mean diff**	**p**	**95% CI**	
Weight	T_0	T_1	-.50*	0.043	-1.00	-0.01
		T_2	-2.91*	0.000	-3.40	-2.42
	T_1	T_0	.50*	0.043	0.01	1.00
		T_2	-2.40*	0.000	-2.92	-1.89
	T_2	T_0	2.91*	0.000	2.42	3.40
		T_1	2.40*	0.000	1.89	2.92
Height	T_0	T_1	-0.14	0.664	-0.51	0.24
		T_2	-1.02*	0.000	-1.39	-0.65
	T_1	T_0	0.14	0.664	-0.24	0.51
		T_2	-.88*	0.000	-1.28	-0.49
	T_2	T_0	1.02*	0.000	0.65	1.39
		T_1	.88*	0.000	0.49	1.28
BMI	T_0	T_1	-.88*	0.000	-1.42	-0.35
		T_2	-2.83*	0.000	-3.36	-2.29
	T_1	T_0	.88*	0.000	0.35	1.42
		T_2	-1.94*	0.000	-2.51	-1.38
	T_2	T_0	2.83*	0.000	2.29	3.36
		T_1	1.94*	0.000	1.38	2.51

Table 38: Student T test of the mean change in Z score of variables between the period before treatment and the period after treatment (T_0-T_1 and T_1 –T_2)								
Variable	**Period**	**n**	**Mean**	**Std. Deviation**	**t**	**p**	**95% CI**	
Height	T_0-T_1	125	0.25	0.62	-6.80	0.00	-0.81	-0.45
	T_1-T_2	125	0.88	0.83				
Weight	T_0-T_1	125	0.57	0.90	-13.44	0.00	-2.10	-1.56
	T_1-T_2	125	2.40	1.24				
BMI	T_0-T_1	125	0.92	0.88	-6.89	0.00	-1.32	-0.73
	T_1-T_2	125	1.94	1.42				

The mean changes between the two time intervals in the delayed group (T_0-T_1 and T_1 – T_2) for height, weight and BMI are shown in Table 38. It provides clear evidence that the mean changes that occurred AFTER treatment and follow-up (Time T_1 –T_2) were significantly greater than the mean changes in height, weight and BMI that occurred when the children were waiting for treatment over a 6 month period ((T_0-T_1). This again underscores the significant improvements in anthropometric outcomes when treatment was received.

Table 39: Test comparison between variable rate of change T_0-T_1 of immediate and T_0-T_1 of the delayed group								
Variable	**Group**	**n**	**Mean**	**Std. Deviation**	**t-test**	**p**	**95% CI**	
Weight	Immediate	126	1.33	0.86				
	Delayed	125	0.25	0.62	11.47	0.00	0.89	1.27
BMI	Immediate	126	0.92	1.29				
	Delayed	125	0.92	0.88	0.01	0.99	-0.27	0.27
Height	Immediate	126	0.74	0.71				
	Delayed	125	0.25	0.62	5.76	0.00	0.32	0.65

When TREATMENT versus NO TREATMENT was compared for the same time interval (T_0-T_1) between the groups, there were significant improvements in weight and height but no improvement in BMI (Table 39)

Table 40 provides information on the mixed, multilevel regression modelling that compared changes in the immediate and delayed (no treatment) group from baseline to 6 months. In effect this model assessed whether the antroprmeteric changes (height, weight, BMI) and changes in Hb were due to the intervention or other factors. The results of the analyses suggest that the intervention (dental treatment under GA) resulted in significant improvements in height and weight but this was not noted for BMI and Hb levels.

Table 40: Mixed Regression Model analysis of Anthropometric changes comparing Immediate and Delayed Treatment between baseline and first follow-up								
	Fixed Effects					Random Effects		
	Coefficient	Z score	SE	95% CI	P-value	estimate	SE	95% CI
Δ Height	-0.07	-3.16	0.04	-0.23, -0.53	0.002	0.07	0.14	0.001, 2.95
Δ HAZ	-0.14	-5.55	0.01	-0.09, -0.04	0.000	0.28	0.08	0.164, 0.478
SR	1.93	-29.18	0.06	1.80, 2.06	0.000	0.33	0.06	0.239, 0.465
Δ Weight	-0.06	-2.32	0.02	-0.10, -0.01	0.02	0.19	0.23	0.018, 2.055
Δ WAZ	-0.17	-5.22	0.33	-0.24, -0.11	0.000	0.15	0.08	0.05, 0.40
SR	1.82	27.68	0.065	1.69, 1.95	0.000	0.38	0.12	0.21, 0.71
Δ BMI	0.48	1.41	0.034	-0.02, 0.11	0.15	0.02	----------	----------
Δ BAZ	0.01	-0.38	0.03	-0.07, 0.05	0.70	0.006	0.09	
SR	1.46	31.48	0.05	1.38, 1.56	0.00	0.497	0.022	0.456, 0.542
Δ Hb	0.01	0.54	0.02	-0.03, -0.05	0.588	0.09	0.06	0.021, 0.356
SR	1.47	19.49	10.08	1.32, 1.61	0.00	0.49	0.02	0.44, 0.54
SR: standardized residuals, SE: Standard Error, CI= confidence intervals								

5.1.3 The OHRQoL analyses of the immediate and delayed treatment groups both at baseline and at follow-up.

Table 41: Comparison of Oral health related quality of life (OHRQoL) measures between baseline and follow-up in the Immediate Group			
CHILD ORAL HEALTH QUESTIONNAIRE [ANSWERED BY CHILD]			
Item / Question	**Baseline [before treatment]n=126** **Time T_0** **Yes responses (%)**	**6 months follow-up [after Treatment] (n=126)** **Time T_1** **Yes responses (%)**	**P < 0.05**
Tooth pain present in last month	19.5	1.6	Yes
Tooth pain currently	3.17	0	
Cried because of tooth pain	37.3	1.6	Yes
Tooth pain affected playing	38.1	1.6	Yes
Tooth pain affected eating	44.44	5.6	Yes
Tooth pain affected sleeping	38.89	5.6	Yes
Tooth pain affected other	1.0	0	
Get up at night because of tooth pain	23.81	1.6	Yes
Wake up parents because of tooth pain	18.25	1.6	Yes

While the anthropometric measures which has been presented in tables 1-29 have shown improvements when children were treated, their subjective responses on how their OHRQoL has changed is also very important. Children in the treatment group reported significant improvement for all of the items in the Child OHRQoL questionnaire except for “tooth pain currently” and “tooth pain affecting other activities” (Table 41) which were almost negligible at baseline (Table 41). For example, the percentage of children who cried because of tooth pain reduced significantly from 37.3% to only 1.6% after treatment at 6 months follow-up. Similar significant reductions were reported for tooth pain affecting daily activities such as playing, eating and sleeping (Table 41).

The percentage of children that reported getting up at night reduced from 23.81% to 1.6 % after treatment showing the significant impact of dental treatment on OHRQoL outcomes among children who received care for serve tooth decay. The percentage of parents who had to wake up due to their children's tooth pain also showed a drastic reduction from 18.25% to 1.6% in the immediate treatment group.

The delaying of treatment, because of limited capacity to offer immediate appointments to everyone who presented on the day of screening, also impacted on the OHRQoL of the children. This is reflected in Table 42 where the OHRQoL significantly worsened between baseline and the 6 months wait for treatment (T_0-T_1)] for all the items assessed (Table 42) but significantly improved ($p< 0.05$) at the 2nd follow-up 6 months after treatment. These prevalence scores were similar ($p> 0.05$) to the item prevalence scores reported 6 months after treatment in the immediate group providing evidence of the positive impact of treatment on OHRQoL ***within both*** groups following treatment under GA. (Table 41 & X2). For example, 37.2% of the children reported having tooth pain at baseline and this increased significantly to 53.5% at 6 months follow-up because these children had not had treatment (Time $T_0 – T_1$). However, when treatment was done (these children had to wait 6 months before they could access dental treatment under GA), only 4.1% reported having tooth pain at 6 months follow-up (Time $T_1 – T_2$). Similar significant increases were noted for items such as Tooth pain affecting playing, eating and sleeping, tooth pain causing children to cry or get up at night between baseline and 6 months follow-up without treatment ((Time $T_0 – T_1$). These item scores significantly decreased when treatment was offered and follow-up was done 6 months later (Time $T_1 – T_2$) [Table 42]. More than 20% of parents in the Delayed Treatment group reported that they had to get up at night because their child woken them up because of tooth pain and this increased to 26.5 % over the 6 months waiting period for treatment. When treatment was offered, there was a significant reduction from 26.5 % to 1.2% for this item score (Table 42).

Table 42:Comparison of Oral health related quality of life (OHRQoL) measures between baseline and follow-up in the Delayed Group			
CHILD ORAL HEALTH QUESTIONNAIRE [ANSWERED BY CHILD]			
Item	**Baseline n=156 Time T_0 Yes responses (%)**	**6 months follow-up [no Treatment] (n=137) Time T_1 Yes responses (%)**	**6 months follow up Post –treatment n=125 Time T_2 % Yes Responses (%)**
Tooth pain present in last month	37.2	53.5*	4.1**
Tooth pain currently	2.56	5.6*	0
Cried because of tooth pain	16.67	25.4*	1.2**
Tooth pain affected playing	10.9	13.5	1.3**
Tooth pain affected eating	11.54	10.3	1.2**
Tooth pain affected sleeping	12.18	19.5*	2.6**
Tooth pain affected other	7.05	4.5	0
Get up at night because of tooth pain	21.05	34.7*	2.1**
Wake up parents because of tooth pain	20.51	26.5*	1.2**
*T_0 vs T_1 [$p < 0.05$] **T_1 vs T_2 [$p < 0.05$]			

Table 43: Comparison of Oral health related quality of life (OHRQoL) measures between Treatment Group and No Treatment Group (Delayed group) at 6 months follow-up					
CHILD ORAL HEALTH QUESTIONNAIRE [ANSWERED BY CHILD]					
Item / Question	**Treatment Group (N=126) n**	**No Treatment Group (Delayed) N=137 n**	**Relative Risk (RR)**	**95% Confidence Intervals (CIs)**	**P < 0.05**
Tooth pain present in last month	2	74	0.03	[0.01-0.12]	Yes
Tooth pain currently	0	8	0.06	[0.00-1.1]	No
Cried because of tooth pain	2	35	0.06	[0.02-0.25]	Yes
Tooth pain affected playing	2	19	0.11	[0.03-0.48]	Yes
Tooth pain affected eating	7	14	0.54	[0.23-1.30]	No
Tooth pain affected sleeping	7	27	0.28	[0.13-0.62	Yes
Tooth pain affected other	0	6	0.08	[0.00-1.47]	No
Get up at night because of tooth pain	2	46	0.05	[0.01-0.19]	Yes
Wake up parents because of tooth pain	2	36	0.06	[0.01-0.25]	Yes

Table 43 compares the responses to the Child OHRQOL after 6 months follow-up in the immediate treatment group and the delayed group (no treatment) groups. The positive impact of the intervention (treatment of severe caries under GA) is clearly evident in the subjective responses of the children. There were significant improvements favouring the treatment group in the number of children who reported having tooth pain in the last month, tooth pain causing them to cry, tooth pain affecting playing, sleeping, and tooth pain disrupting both their parents and their own sleep. For example, children who had no treatment were 33.75 times more likely than children who had treatment ($RR_{no\ Rx/Rx} = 33.75$) to report tooth pain present in their mouths in the last month when compared to children who had treatment. Similarly, children who had no treatment were 16.67 times more likely to have cried because of pain in the previous month compared to those children who had treatment (Table 43). Routine daily activities such as playing, eating, and sleeping were 9.1, 1.86, and 3.57 times more likely to be affected by the presence of tooth pain respectively in the past one month among children who had no treatment when compared to those who had dental treatment. These RR scores were calculated from the inverse of the RR reported in Table 43 which reported RR scores of the treatment group (R_x group) over the no treatment (delayed group; No R_x group). Of concern was the finding that children who did not have dental treatment because of severe tooth decay were 20 times more likely to get up at night because of tooth pain (Table 43) when compared to children who had dental treatment and these children who had no treatment were 16.67 times more likely to wake up their parents because of tooth pain compared to those children who received dental treatment.

Table 44: Comparison of Oral health related quality of life (OHRQoL) measures between baseline and follow-up in the Immediate Group						
PARENTAL QUESTIONNAIRE [ANSWERED BY PARENT/CAREGIVER]						
Item / Question. Recall period: in the past 4 weeks	**Baseline [before treatment]n=126 Time T_0 ; Yes responses (%)**			**6 months follow-up [after Treatment] (n=126); Time T_1 Yes responses (%)**		
Section 1: Child oral health & well being	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact
Child's overall well-being affected by condition of teeth/mouth	22.22	69.05	8.73	82.50	17.5	0
Section 2: Symptoms and discomfort that children may experience due to their oral condition	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact
Difficulty drinking, eating	21.43	73.02	5.56	96.0	4.0	0
Difficulty chewing, biting food	23.81	66.67	9.52	89.5	10.5	0
Section 3: Condition of child's teeth/mouth on their feelings and everyday activities	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact
Condition of child's teeth/mouth upset them	27.78	65.08	7.14	98.5	1.5	0
Condition of child's teeth/mouth frustrate/irritate them	27,78	65.08	7.14	98.7	1.3	0
Condition of child's teeth/mouth affected talking	30.95	61.90	7.14	100	0	0
Condition of child's teeth/mouth affected sleeping	32.54	62.70	4.76	98.7	1.3	0
Condition of child's teeth/mouth affected smiling	33.33	61.9	4.76	98.7	1.3	0
Section 4: Effect of child's oral condition on parents & other family members	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact
Parents/family upset by child's oral condition	39.20	56.80	4.0	100	0	0
Parents/family sleep disrupted by child's oral condition	43.65	53.7	3.17	98.7	1.3	0
Your sleep disrupted by child's oral condition	45.60	51.20	3.20	98.7	1.3	0

There was also a significant and dramatic shift in the OHRQoL of the children as reported from the parental/caregiver perspective (Table 44). There was significant improvement in the number of "no impact" responses at the 6 months follow-up in the immediate group for all items assessed indicating that most of the signs and symptoms related to the presence of the condition (severe tooth decay) had now almost disappeared (See Table 44) 6 months after treatment. There was especially a significant shift ($p< 0.05$) from the "low impact" responses to the "no impact" responses and there were no parent/caregivers that reported "high impact" for any of the items assessed. In the delayed group, parents/caregivers reported a worsened OHRQoL among their children who had to wait 6 months for treatment (see Table X 5, time interval T_0 to T1) but this significantly improved (as was the case in the immediate group) once the children received treatment and parents/caregivers were interviewed 6 months later [Table 45, Time interval T_1 to T_2] again showing the beneficial effect of treatment on OHRQoL

Table 45: Comparison of Oral health related quality of life (OHRQoL) measures between baseline (T_0), before (T_1) and after treatment (T_2) in the DELAYED Group									
PARENTAL QUESTIONNAIRE [ANSWERED BY PARENT/CAREGIVER]									
Item / Question **Recall period: in the past 4 weeks**	**Baseline [before treatment]n=156** **Time T_0 Yes responses (%)**			**6 months follow-up [BEFORE Treatment]** **n=126 Time T_1 Yes responses (%)**			**6 months follow up [Post –treatment] n=125** **Time T_2 Yes Responses (%)**		
Section 1: Child oral health & well being	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact
Child's overall well-being affected by condition of teeth/mouth	22.22	69.05	8.73	38.55	54.11	7.34	98.4	1.6	0
Section 2: Symptoms and discomfort that children may experience due to their oral condition	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact
Difficulty drinking, eating	21.43	73.02	5.56	36.34	59.26	4.4	98.40	1.6	0
Difficulty chewing, biting food	23.81	66.67	9.52	27.52	69.20	2.86	98.40	1.6	0
Section 3: Condition of child's teeth/mouth on their feelings and everyday activities	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact
Condition of child's teeth/mouth upset them	27.78	65.08	7.14	36.45	58.31	5.24	96.8	3.20	0
Condition of child's teeth/mouth frustrate/irritate them	27.78	65.08	7.14	30.37	68.31	1.32	98.4	1.6	0
Condition of child's teeth/mouth affected talking	30.95	61.90	7.14	32.13	65.43	2.44	96.80	3.20	0
Condition of child's teeth/mouth affected sleeping	32.54	62.70	4.76	43.62	54.16	2.22	98.40	1.6	0
Condition of child's teeth/mouth affected smiling	33.33	61.9	4.76	27.45	70.70	1.85	98.40	1.6	0
Section 4: Effect of child's oral condition on parents & other family members	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact
Parents/family upset by child's oral condition	39.20	56.80	4.0	4.6	95.4	0	100	0	0
Parents/family sleep disrupted by child's oral condition	43.65	53.7	3.17	42.54	57.46	0	98.4	1.6	0
Your sleep disrupted by child's oral condition	45.60	51.20	3.20	45.32	51.48	3.20	98.4	1.6	0

Table 46: Comparison of Oral health related quality of life (OHRQoL) measures between Treatment and no Treatment groups (delayed) at 6 months follow-up.						
PARENTAL QUESTIONNAIRE [ANSWERED BY PARENT/CAREGIVER]						
Item / Question **Recall period: in the past 4 weeks**	**Treatment Group (Immediate Group)**			**No Treatment Group (Delayed Group)**		
Section 1: Child oral health & well being	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact
Child's overall well-being affected by condition of teeth/mouth	82.50	17.5	0	38.55	54.11	7.34
Section 2: Symptoms and discomfort that children may experience due to their oral condition	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact
Difficulty drinking, eating	96.0	4.0	0	36.34	59.26	4.4
Difficulty chewing, biting food	89.5	10.5	0	27.52	69.20	2.86
Section 3: Condition of child's teeth/mouth on their feelings and everyday activities	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact
Condition of child's teeth/mouth upset them	98.5	1.5	0	36.45	58,31	5.24
Condition of child's teeth/mouth frustrate/irritate them	98.7	1.3	0	30.37	68.31	1.32
Condition of child's teeth/mouth affected talking	100	0	0	32.13	65.43	2.44
Condition of child's teeth/mouth affected sleeping	98.7	1.3	0	43.62	54.16	2.22
Condition of child's teeth/mouth affected smiling	98.7	1.3	0	27.45	70.70	1.85
Section 4: Effect of child's oral condition on parents & other family members	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact	Never= No impact	Once/twice/ Sometimes =low impact	Often/ Everyday =high impact
Parents/family upset by child's oral condition	100	0	0	4.6	95.4	0
Parents/family sleep disrupted by child's oral condition	98.7	1.3	0	42.54	57.46	0
Your sleep disrupted by child's oral condition	98.7	1.3	0	45.32	51.48	3.20

When the parents or caregivers were interviewed 6 months after baseline examinations, there was a significant shift ($p < 0.05$) in the impacts reported between the groups. The OHRQoL of the children who had treatment, as reported by their parents or caregivers, significantly improved to an extent that "no impact" was reported in the range 82.50 – 100% for ALL of the items assessed (Table 46) compared to the range 4.6- 45.32% reported for "no impact" among parents/caregivers in the no treatment group. Similar "no impact" range scores were also seen in the delayed group only AFTER they also had treatment and were followed up for 6 months and this was reported by both the children (Table 42) and their parents/caregivers (Table 45). This again provides evidence of the effect of treatment on the OHRQoL of children who suffer the burden of severe caries. Similar significant shifts were noted for the "little impact" scores for all the items in the Parental Questionnaire (Table 46) between the treatment and no treatment groups. "High Impact" scores were reported by NONE of the parents/caregivers in the treatment group at 6 months follow (Table 46) and this also occurred in the delayed groups AFTER treatment again providing evidence of the impact of treatment versus no treatment on the OHRQoL as reported from both the Child's (Table 43) and parent/ caregiver perspective (Table.46)

CHAPTER 6: DISCUSSION

6.1 Introduction

This trial has added to the weight of evidence that has shown the devasting effects of severe untreated dental caries on children's well-being and the susequent improvement in anthropometric, clinical and oral health related quality of life (OHRQoL) measures folllowing extensive dental treatment (Monse *et al*, 2012, Alkarimi *et al,* 2012; van Gemert-Schriks *et al,* 2011; Klaassen *et al,* 2009; Duijster *et al*, 2013)

The confined setting of the town of Worcestor, (the site of the study), the homogenous nature of the study group in terms of socio-economic status, demographics, the high prevalence of oral disease, the huge untreated caries burden, the excellent infrastruture and the long established protocol of how to access treatment under GA made this clinic (Marie Pieterse Health Centre) an ideal setting to conduct this trial. Follow-up of the children was made easier by recording the creches where the children were enrolled at so that they could be easily traced. Addtionally, the excellent relationship between the clinic staff and the creches made the logistics related to follow –up (setting appointments, finding children, assisitance, etc) much easier than otherwise would have been the case.

Intially, in the planning phases of this randomized clinical trial, the study design was intended to be a stepped wedge cluster randomized trial similar to that effected in the Monse et al, trial (2012). With cluster randomized trials, complete clusters are randomized to treatment conditions and all subjects within a cluster receive the same treatment. So, a cluster randomized trial design made sense in our setting because the target group (young 2-6 year olds children) attended crèches which would have formed the unit of randomization and would have reduced logistical and administrative costs. Moerbeek and van Schie (2016) have noted that since the number of clusters in a cluster randomized trial is often low, the random assignment of clusters to treatment conditions does not always ensure the treatment groups are comparable at baseline with respect to all variables at the subject and cluster level that may have an effect on the outcome variable. In other words, it is likely there is "covariance imbalance" at baseline. They advised that this should be taken into account when calculating the sample size of a cluster randomized trial. This was seen in the Monse *et al* trial (2012) where there were

significant differences in the immediate and delayed treatment groups at baseline with respect to gender and weight. Additionally, Monse *et al* (2012) provided no information on sample size calculation or the power of their study. Both Alkarimi *et al* (2012) and van Gemert-Schriks *et al* (2011) who also undertook randomized clinical trials that investigated the impact of dental treatment on anthropometric and/or the quality of life measures in children reported no significant differences in the baseline characteristics of their study groups. In these trials, the child, rather than the school /crèche formed the unit of randomization.

When the logistics of how children got an appointment for treatment of severe dental caries was assessed in in the planning stages of this trial, it was found to meet the requirements of a simple randomization process (Suresh, 2011). It was then decided to rather use this system of recruitment and randomization as it fitted into the normal routine of how the clinic operated. This ensured that there was no change or disruption to a system that was deemed fair by the community and this made the logistics of follow-up easier. The intial screening of the children, their allocation into the two treatment groups by a lottery draw system (parents drew numbers from a closed box) was ths employed as it met the conditions of simple randomization (Suresh, 2011)

Group comparisions of the socio-ecomic variables (Table 1) between the groups confirmed the homogenous nature of the study poulation and the community in which they lived. It is typical of a poor Cape Coloured community in South Africa where income, education, employment and living conditions are amongst the lowest when compared to the other population groups in South Africa (Amberger, 2016; Adhikari, 2005). It was disconcerting to note the high number of children that lived in single parent households in this study (approximately 35% of the total sample).

Lisboa *et al* (2013) reported that children living with both biological parents were protective factors for the presence of dental caries, and consequently, curative dental needs. Whilst this factor alone does not explain the huge caries burden in this study population, the socioeconomic and family influences on dental treatment needs among children has been highlighted in a number of studies (Costa *et al,* 2012; Chankanka *et al*, 2011; McGrady *et al,* 2012; Chi *et al,* 2014; Narang *et al,* 2013)

It is a well-known fact that anthropometric measures (height, weight) differ significantly for males and females and for different ages. It is for this reason that growth reference charts for populations are categorized for age and gender (WHO, Growth reference charts for 5-19 years, 2007). The baseline analyses for both the immediate and delayed groups showed no significant gender differences within the groups for baseline mean weight, height, age, BMI, dmft and pufa (Tables 2 & 10). However as expected, there were significant differences when the children were grouped by age (2,3,4,5,& 6 years) for mean weight, height and Hb. The groups were similar at baseline for BMI, dmft and pufa scores. When the two groups were compared against each other at baseline (Table 18), significant differences between the groups were noted for age, height, weight, Hb and the "p" and "a" components of the pufa index. All these variables were higher in the immediate group except for the "a" component which was more prevalent among children from the delayed group. This highlights one of the problems with using simple random sampling as each child in the study group had an equal chance of being selected in either group leading to a situation where the selected groups were not balanced due to this (Suresh, 2011). This occurred by purely by chance and no attempt was made to adjust this as it would have impacted on the system of recruitment that was used at the trial site (lottery system where numbers 1-100 meant that the child had treatment immediately and numbers greater than 100 meant that child had delayed treatment).

Xiao and colleagues (2011) reported on a simulation exercise where they compared dynamic block randomization and minimization in terms of balance on baseline covariates and statistical efficiency. Simple randomization was included as a reference. They defined minimization as a dynamic randomization technique that sequentially assigns subjects to treatment by attempting to minimize the total imbalance between treatments over multiple baseline covariates. The minimization method achieves marginal balance by looking at all of the selected baseline covariates for the previously assigned subjects and assigning the next subject to a treatment with a probability in favor of minimizing the overall imbalance across the covariates. They found "modest" differences across the three randomization strategies suggesting that simple random sampling is still effective in minimizing bias, achieving balance of potential or known confounders, and thus ensures an efficient and unbiased comparison between groups (Xiao *et al,* 2011l). The differences at baseline between the groups were a chance finding and not the effect of a non-random sampling of group allocation technique.

Monse *et al* (2012), also reported significant baseline differences between the immediate and delayed groups in their study for height, weight, and BMI but these were not found in the Alkarimi *et al* (2012) and van Gemert-Schriks *et al* (2011) randomized clinical trials.

The mean number of teeth extracted under GA in the immediate group and the delayed groups was extremely high among the children in this trial [7.4 (SD 3.53) vs 8.55 (SD 3.94) respectively; p=0.08]. This was significantly higher than in the Monse *et al* trial (2012) where children who had immediate treatment had on average 2.4 (SD 1.4) teeth extracted under GA and in the delayed group where children had an average of 2.0 (SD 0.9) teeth extracted. This provides insights into the rampant nature of the caries problem in this part of the country and is reflected in the national oral health survey results for the country (see Tables A to D) However, the pufa scores for this trial and the Monse *et al* study is similar at +/- 2.4. This points to a fundamental difference in the philosophy of the approach to treatment in children in South Africa versus the Philippines setting. Clearly in the Monse *et al* study (2012), only teeth that had been affected by the consequences of untreated caries and had displayed symptoms that was captured by the pufa index were removed under GA – hence the close correlation between the pufa score and the mean number of teeth extracted. In South Africa, there is evidence from the Western Cape province where the study site was located about the unusually high number of extractions performed under GA. Peerbhay and Barrie (2012) reported on a retrospective descriptive study where they reviewed the records on the Department of Health (DoH) database in the Western Cape Province of South Africa of 16 732 pre-school patients treated under Dental General Anaesthesia over a three year period. They found that of the 58 255 procedures recorded for these preschool patients in the district health clinics in the Western Cape, 99.94% were for extractions and 0.0001 for restorations.

The average rate of Dental General Anaesthesia per 1000 of the population was 1.06. Only 9% (i.e.: 2/22) of dentists at district clinics reported that pre- Dental General Anaesthesia prevention was provided. This approach was evident in this trial where the number of teeth extracted at the GA session was significantly higher than the numbers reported in the Monse *et al* (2012), Alkarimi *et al* (2012) and van Gemert-Schriks *et al.* (2011) trials. In fact, no other treatment was offered under GA besides extractions in this trial.

Peerbhay and Barrie (2012) lamented that the lack of preventive measures could possibly result in a need for retreatment under Dental General Anaesthesia and recommended the introduction of preventive guidelines for use in the Public Service. It is thus clear that this "if in doubt, extract" approach needs to be replaced with a "if in doubt, restore" approach in this area of the country.

One of the key questions that this trial sought to investigate was the mean rate of change (velocity of change) of the anthropometric variables and Hb levels within and between the groups using unadjusted means and transformed means (Z-scores). In the ***immediate*** group from baseline to follow-up (6 months), the mean (unadjusted) rates of increase in height, weight and BMI showed significant improvement (***within group comparison,*** Table 23 &31). This significant improvement was also reflected in the adjusted or transformed z-scores (Tables 34) in the immediate group. Similar significant improvements were noted in the Delayed group at time T_0- T_1 (6 months' time period from baseline to before treatment) and from treatment to follow-up (T_1-T_2) for the whole group (Tables 25, 27) and for ages 2-5 (Tables 26, 28). Age 6 results must be treated with caution because there were only 2 children in the delayed group (Table 28). There was however a significant difference in mean growth rates for height, weight, BMI and Hb levels when children in the delayed group did receive treatment and were followed up 6 months later (Table 31). In simple terms, children's height, weight, BMI and Hb levels improved significantly while waiting for treatment (6months delay) but this improvement was significantly greater when they were assessed 6 months after receiving treatment.

This adds to the weight of evidence that treatment of severe dental caries results in gains in height, weight (this trial), and BMI (Monse *et al,* 2012). van Gemert-Schriks *et al,* 2011who recruited 6-year old children in their trial found a negative correlation between body proportions and the presence of dental caries but no significant influence on dental treatment on the body growth could be established. They conceded that the myriad of factors that affect growth could have influenced their findings and their long follow-up period (up to 3 years) was certainly a major confounder. In fact, the influence of other diseases, diet, daily activities, etc. are all factors that can influence growth in children (van Gemert-Schriks *et al,* 2011). Alkarimi *et al,* 2012 also reported no statistical difference in WAZ, HAZ and BAZ (transformed weight for age, height of age and BMI for age) in their trial among children in Saudi Arabia.

The sample population characteristics differed significantly in the four trials (this trial, Monse *et al,* 2012; van Gemert-Schriks *et al,* 2011; Alkarimi *et al,* 2012) which have examined the effects of dental treatment on anthropometric measures. Although all four trials showed expected improvements in weight, height and BMI in a positive direction, the huge number have factors that affect growth in children must have had some influence in the outcomes achieved in each trial. The Department of Education and Early Childhood Development in the State of Victoria, Australia (2012) listed genetics, ethnicity, birthweight, pre-maturity, nutrition, hormones and the environment as some of the factors that can affect growth. This provides evidence of the difficulties in isolating only a few factors to demonstrate an exclusive cause-and-effect relationship between dental caries treatment and improvement in anthropometric and clinical measures. Further evidence of this is presented in the mixed regression model analysis that sought to determine whether the factors under investigation (weight, height, BMI, Hb level) had improvements due to the intervention alone or other confounding factors (Table 40). The regression model showed that height and weight gain were linked to the intervention (dental treatment of severe caries under GA) but no definitive links could be established for Hb levels and BMI.

When the Immediate and delayed groups were compared, there were significant height and weight gains in the treatment (immediate) group compared to the no treatment (Delayed Group) but no statistically significant improvements for Hb (p= 0.25) and BMI scores (p= 0.16) (Tables 29, 39). This differed from the Monse *et al,* trial (2012) which reported significant weight gains only. Hb levels were not reported in this trial. The time to follow-up (4 months in the Monse et al trial versus 6 months in this trial), larger sample size (85 versus 126 in this trail) and the nutritional status at treatment (underweight versus children recruited from the general population in this trial) are all factors that could have accounted for less than significant height gain in the Monse *et al* trial. Indeed, the poor nutritional intake associated with underweight has been shown to also be associated with a high prevalence (49.2%) of stunting (low height for weight) in this Filipino population (Papier *et al,* 2014). No direct comparisons in the unadjusted means between this trial and the Alkaimi *et al* (2012) and van Gemert-Schriks *et al* trial (2011) can be made because the population characteristics differed significantly. The children in this trial ranged in age from 2-6 years old whilst both the Alkaimi et al (2012) and van Gemert-Schriks *et al* trials (2011) recruited children from age 6 years onwards.

Dental sepsis and inflammation which are common clinical symptoms of severe untreated dental caries is postulated to affect growth through chronic inflammation via a metabolic pathway where cytokines affect erythropoiesis levels and thus lead to lowered haemoglobin (Hb) levels which can lead to anaemia which is a chronic disease arising from depressed erythrocyte production. Clinically this can be seen as lowered blood Hb levels which is postulated to return to normal or increase with treatment of the disease (caries) (Beltrame *et al*, 2016; Bansal *et al*, 2016; Means Jr, 2003; Means and Krantz, 1992).

This association between severe untreated dental caries and low Hb and/or mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration, and packed cell volume (PCV) has been reported in a few recent studies (Beltrame *et al*, 2016; Bansal *et al*, 2016; Schroth *et al*, 2013). Lowered Hb levels are also an important risk marker for the development of anaemia (Ganna, 2014; Thomson *et al*, 2016). Bansal and colleagues (2016) in India, examined 60 children aged 2-6 years (30 with severe early childhood caries (S-ECC) and 30 controls with caries status <2 (less than 2 decayed, extracted of filled teeth). Each child received a clinical examination for dental caries status using deft index and haemoglobin (Hb) levels were taken. On comparison of the percentage of children with iron deficiency anaemia in the S-ECC and control groups, it was found that children with S-ECC were more likely to have iron deficiency anaemia (OR (10.77; 95% CI 2.0, 104.9; p = 0.001). In addition to this, S-ECC children were significantly more likely to have low Hb, (p< 0.001) which implied that S-ECC may be a risk marker for the development of anaemia. Similarly, Schroth *et al* (2013) recruited 266 children (mean age was 40.8 ± 14.1 months): 144 with S-ECC and 122 caries-free children in a case –control study that sought to compare ferritin (iron) and haemoglobin (Hb) levels between pre-schoolers with S-ECC and caries-free controls. They concluded that Children with S-ECC had a significantly greater odds of lower haemoglobin and ferritin levels than the caries-free control group which put them at a significantly higher risk for developing iron deficiency anaemia when compared to cavity-free (and by implication, inflammation-free) children. These were however cross-sectional case-control studies which were point in time studies and the groups compared were different at baseline.

Indeed in this trial, if one analyses the within group improvements in the treatment (immediate group), mean Hb levels were found to have significantly increased from baseline to after treatment at 6 months follow-up (8.07 vs 11.52; p= 0.00). This was also evident in the Delayed group (Table 25) providing evidence of an "effect" or association between having dental treatment (this reduced the presence of inflammation as caused by severe decayed teeth) and raised Hb levels (Tables 23 & 25). This trial also found a significant negative correlation between mean change in height and mean change in Hb (p=0.049, Table 22) and a positive correlation between mean Hb change and mean weight gain (p= 0.003) and mean Hb change and mean BMI change (p=0.000). Put simply, Hb levels were found to increase with weight (growth) and BMI and could be linked to reduced inflammation (carious teeth were removed, hence inflammation reduced) providing grounds to support the theory linking Hb levels with dental treatment/rehabilitation (Acs *et al,* 1992; Acs *et al,* 1999; Alkarimi *et al,* 2014; Boyd *et al,* 1998; Duijster *et al,* 2013; Hannaway, 1970; Monse *et al,* 2012; Tang *et al,* 2013). However, when multilevel regression modeling was undertaken to assess whether the antroprometeric changes (height, weight, BMI) and changes in Hb were due to the intervention or other factors, the results suggest that the intervention (dental treatment under GA) resulted in significant improvements in height and weight but this was not noted for BMI and Hb levels (Table 40). It means that other factors such as nutrition, growth, etc could also be a factor in the improved Hb levels. One of the limitations of this trial was that the food intake (nutrition) was not monitored. So whilst the children who had severe untreated caries may have consumed smaller amounts of food, the quality thereof could have been promoted growth and assisted in raising Hb levels. The regression model however provided conclusive evidence that the intervention (dental treatment under GA) was significantly assiociated with height and weight gains but not BMI or Hb levels. Since the BMI formula uses both height and weight (these are the co-variates of BMI), it is expected that if both height and weight are significant, then BMI would not be so. It also explains why Monse *et al,* 2012 in their multilevel regression model analysis found that treatment was associated with significant weight and BMI gain but not height gain.

The other theory includes the indirect effects of untreated caries and different body responses to chronic dental infection. Three mechanisms were suggested. The first concerns immune responses. Infected dental pulp may affect immunity and erythropoiesis (Hahn *et al,* 200; Plitnick *et al,* 1998; Means Jr, 2003, Means and Krantz,

1992) which may result in anemia (Means Jr, 2003) and influence bone remodeling (Machado *et al,* 2015; Stephensen, 1999), sleep patterns, (Kelly *et al,* 2003; Takahashi *et al,* 1968) and food intake (Plata-Salamán, 1996). None of this could be assessed in this trial and no link between sleep, appetite and Hb levels could be ascertained from the data collected.

Although both Alkarimi *et al* (2012) and Monse *et al* (2012) reported that they recorded Hb levels in their trials, no analyses of the data were presented. This trial found no difference in the mean Hb levels between the treatment (immediate) and no treatment (delayed) groups at 6 months follow-up (p= 0.25). This implies that the intervention (treatment of severe dental caries with pulpal involvement) had no significant effect on improved Hb levels compared to a group of children with severe dental caries that had no treatment at 6 months follow-up. This finding from a randomized clinical trial puts into question the postulated theory that links severe untreated dental caries to chronic inflammation via a metabolic pathway where cytokines affect erythropoiesis levels and thus lead to lowered haemoglobin (Hb) levels which returns to normal levels or improves after dental treatment. This trial has a huge sample size and the effect observed is unlikely to be a chance finding as this was a powered trial with an adequate sample size. This lack of treatment effect on Hb levels is significant and indicates the importance of adequate sample sizes to demonstrate differences (if any) that can be attributed to the treatment effect rather than chance (Brainard *et al,* 2016). Details of sample size calculation and power was reported in the Alkarimi *et al* (2012), the van Gemert-Schriks *et al* trail (20110 and in this trial but not in the Monse *et al* trial (2012).

OHRQoL and Dental treatment in children

Oral health-related quality of life (OHRQOL) is the perceived impact of one's own oral health on daily life (Kragt *et al,* 2016). There is an increased interest in understanding the effects of severe tooth decay on the physical, anthropometric, psychosocial, functional, and oral health related quality of life (OHRQoL) among children (Alkarimi *et al.,* 2014*;* Benzian *et al.,* 2011; Hooley *et al,* 2012, Jankaukiene & Narbutaite, 2010; Kragt *et al.,* 2016). Dental caries can have a substantial impact on children's quality of life (QoL); not only causing pain and difficulties eating, but also affecting school attendance and disrupting sleep patterns, and consequently resulting in adverse growth development and educational performance (Finucane 2012; Guarnizo-Herreño 2012;

Naidoo et al, 2001). Jankauskiene and Narbutaite (2010) concluded in their systematic review that assessed changes in OHRQoL among children following dental treatment under GA that there was an immediate improvement of children's oral health and physical, emotional and social quality of life and it had a positive impact on the family. However, of the 11 studies used in this review, 10 (91%) were one group pre-test-post-test types of studies with no controls. The systematic review in chapter 2 of this thesis goes into great detail as to why it is improper and bias to use single arm clinical trials to answer clinical questions. Thus, this current trial adds significantly to the paucity of randomised clinical trials that have investigated the OHRQoL outcomes among children who have severe tooth decay and consequentially receive treatment either immediately or at a later period.

The instruments used in this trial is an earlier version of Scale of Oral Health Outcomes for 5-year-old children (SOHO-5) (Tsakos *et al,* 2012) which was developed by the University of Glasgow and the University College, London and recently validated by in Scotland by Tsakos *et al* (2012). This questionnaire has been used by Duijster *et al,* 2013 in her study that examined associations between oral health-related impacts and the rate of weight gain after extraction of pulpally involved teeth in underweight preschool Filipino children. She found that there was a significant association between oral health-related impacts and rate of weight gain after extraction of pulpally involved teeth. More importantly, she reported that children who were free of impacts on sleeping related to having severely decayed teeth extracted gained significantly more weight compared to children who reported sleeping problems after dental treatment. The limitation of this finding is that it was a single arm study with no control.

The results of this current trial as regards OHRQOL from both the child and/or parent/caregiver perspective is in agreement with a number of single arm pre-test-post-test types of studies that have up until now, provided the bulk of the evidence related to improvements in OHRQoL outcomes after dental treatment of severe tooth decay under general anaesthesia (GA). An early study by Low *et al,* (1999) who examined effect of severe caries on the quality of life among 77 children (age 35-66 months, mean = 44 months) with severe caries in the primary dentition found that there was a significant change in complaint of pain, eating preferences, quantity of food eaten, and sleep habits before and after treatment of dental caries.

This was one of the earliest studies that focused on OHRQoL outcomes rather than clinical variables. Acs *et al*.(2001) also assessed the perceived outcomes and parental satisfaction following dental rehabilitation of children under general anesthesia among 228 parents. A descending hierarchy of improved treatment outcomes was noted, with improvement in pain the predominant outcome, followed by improved abilities to eat and sleep, reported by 86, 69, and 41% of parents, respectively, 72% perceived an improvement in their child's health. Children with medically or developmentally compromising conditions were significantly more likely to have improved abilities to eat and sleep, and had a significantly improved overall health status.

White *et al*. 2003 investigated parental satisfaction of 45 children who underwent dental treatment under GA. The authors assessed their perception of the impact of the procedure on the physical and social quality of life. Their findings indicated that dental treatment under GA for preschool children has a high degree of satisfaction among parents and is perceived to have a positive social impact on their children. In 2004, Anderson *et al*. (2004) also concluded that dental treatment under GA results in an immediate improvement in oral health and aspects of the quality of life for both children and their families. Many other early single arm studies (Thomas *et al*, 2002; Baens-Ferrer *et al*, 2005, Versloot *et al*, 2006; Amin *et al*, 2006; Malden *et al*, 2008; Klaassen *et al*, 2008) also reported significant improvements in OHRQoL outcomes from either the child's or parents perspective. The interesting observation in ALL of these studies that have assessed improvements in OHRQoL outcomes, was the significant ***effect size*** of the intervention. Unlike the variations in effect sizes when anthropometric measures were investigated (Alkarimi *et al* 2012,Monse *et al*, 2012 van Gemert-Schriks *et al*, 2011) OHRQol outcomes were significant and effect sizes were huge. For example, in this trial, children who had no treatment were 33.75 times more likely than to report tooth pain present in their mouths in the last month when compared to children who had treatment. Similarly, children who had no treatment were 16.67 times more likely to have cried because of pain in the previous month compared to those children who had treatment (Table 43). Routine daily activities such as playing, eating, and sleeping were 9.1, 1.86, and 3.57 times more likely to be affected by the presence of tooth pain respectively in the past one month among children who had no treatment when compared to those who had dental treatment.

Worryingly, the current trial has also shown that when children have to wait for treatment (Delayed Group, Table 42), the impact on the child regarding tooth pain in the past month or tooth pain currently, tooth pain affecting sleeping and tooth pain keeping them awake at night was significantly higher at 6 months when compared to baseline. Other activities such as eating and playing were not significantly worse when compared to baseline but were still unacceptably high. Tooth pain that woke up parents/caregivers at night was significantly higher at 6 months from baseline implying that the Qol of even the parent/caregiver worsened during this waiting period. However when treatment was offered and the children were followed 6 months later, there were significant reductions in ALL impact scores in the Child oral health questionnaire. These reductions in impacts were similar to those reported by children in the immediate group who were followed for 6 months after treatment (Table 41). This significant shift in the impact scores were also present when OHROoL impacts where assessed from the parent/caregiver perspective (Tables 44,45,46). The negative impacts on OHRQoL scores remained high or worsened during the wait for dental treatment in the Delayed group but the significant improvement 6 months after treatment were comparable with the OHRQoL scores seen in the immediate group 6 months after treatment. These significant impacts on OHRQoL measures on children who had no dental treatment provide evidence of the need to provide urgent care (with as little waiting period as possible) to young children who suffer from severe tooth decay. It was clear from these OHRQoL instruments that there was a significant negative impact on the Qol of both the child and the parent/caregiver again highlighting again highlighting the need for urgent action regarding the long waiting periods children and their parents/caregivers have to endure to access dental care.

More recently, El Batawi and colleagues in Saudi Arabia (2014) investigated the perceived clinical outcome and parents' satisfaction after dental rehabilitation under general anesthesia over a follow-up period of 2 years among 352 pediatric patients before and after treatment of early childhood caries with full dental rehabilitation under general anesthesia. The questionnaires they used focused on oral symptoms, functional limitations, and emotional and social well-being before and after dental treatment. These authors also reported a dramatic disappearance of symptoms from the parents' perspective. There was also a high satisfaction rate (99.14%) also among parents of the children included in the study.

Similar results were reported by Aggarwal *et al,* 2016 in India, Yawary *et al*, 2016 in Australia, Abanto *et al,*2016, Brazil and de Souza *et al,* 2016 in the UK, Xaio *et al*, 2011 in China and Wong *et al,* 2016 also in China. Knapp and colleagues (2016) reported on a systematic review that sought to assess change in OHRQoL in children following treatment under GA for the management of dental caries. Twenty studies were included, which demonstrated significant heterogeneity in the instruments used, the study setting, and study quality. Details of these studies and the instruments used is shown in Table X . However ALL studies reported improved OHRQoL. The authors of the review again highlighted the need for further high-quality studies employing validated, child-reported measures of OHRQoL to provide high quality evidence on the effects of dental treatment on OHRQoL. This current trial has used the most rigorous study design (RCT) and validated child and parent/caregiver instruments to assess changes in OHRQoL following dental treatment and would be an important contribution to the literature on this topic.

Table 47: Summary of Studies that have examined OHRQoL in children **

****Knapp *et al*, 2016**

Study	Instrument	Summary of change in OHRQoL following treatment
Low *et al*. (1999)[21]	Designed own questionnaire	Reported change in presence of symptoms as follows: presence of pain reduced from 48% to 3%, problems eating reduced from 43% to 3%, 59% of children began to eat more following treatment, 84% children reported improved sleeping. Number of children with behavioural issues reduced from 4 to 2. Significant changes in all but the 'behavioural issues' category, indicating overall improvement in OHRQoL
Thomas & Primosch (2002)[29]	Designed own questionnaire	Overall improvement in OHRQoL reported in 90% of children. Reported reduction in percentage reporting symptoms as follows: complaints about teeth 56% (pre-test) to 2% (post-test), chewing problems 60% to 8%, eating less 52% to 4%, sleeping problems 30% to 4%, behavioural problems 32% to 0%. No statistical significance test carried out
Anderson *et al*. (2004)[25]	Modified P-CPQ and FIS	The study found reduction in numbers reporting 'all the time/often' for all questions post-test compared to pre-test, indicating improvement in all aspects of OHRQoL examined. All changes were statistically significant
Klaassen *et al*. (2008)[15]	P-CPQ and FIS	Statistically significant overall change in mean score from 0.73 pre-test to 0.44 post-test indicating improved OHRQoL. The change in the majority of individual subscales was a statistically significant decrease, except for 'emotional well-being' where the decrease was not significant, and 'social well-being' where there was actually a non-significant increase in score. Pre-test not found to affect results
Malden *et al*. (2008)[19]	P-CPQ and FIS	Mean overall P-CPQ scores reduced from 25.9 to 11.8, mean FIS score reduced from 10.1 to 4.0, with decreases in all P-CPQ subscales, indicating improved OHRQoL. All results statistically significant

Table 47: Summary of Studies that have examined OHRQoL in children **

****Knapp *et al*, 2016**

Study	Instrument	Summary of change in OHRQoL following treatment
Jabarifar *et al*. (2009)[22]	P-CPQ and FIS	Mean scores for P-CPQ decreased from 43.3 to 39.2 and FIS decreased from 8.0 to 3.7, indicating improved OHRQoL. Results were all statistically significant. Effect sizes were large for all subscales except 'emotional well-being' which had a moderate effect size
Klaassen *et al*. (2009)[13]	ECOHIS	Mean total ECOHIS reduced from 12.9 to 7.4, which was statistically significant and indicated improved OHRQoL. Pre-test was found to have no effect
Gaynor & Thomson (2011)[16]	P-CPQ and FIS	Decrease in mean overall P-CPQ score from 22.8 to 8.8 and mean overall FIS score from 8.7 to 4.4, indicating improved OHRQoL, which was statistically significant. Significant decreases were seen in all P-CPQ and FIS subscale scores also. Effect sizes were large for P-CPQ and moderate for FIS
Lee *et al*. (2011)[24]	ECOHIS	27.6% reduction in overall ECOHIS score which was statistically significant with large effect size, indicating improved OHRQoL overall. For the individual subscales, statistically significant reduction in scores was found with moderate effect sizes for all subscales except two. 'Family function' had a non-significant decrease, and 'child self-image and social interaction' had a non-significant increase
Almaz *et al*. (2014)[27]	ECOHIS	54.7% reduction in total score, 48.4% in CIS and 67.4% in FIS. The decrease in scores was seen in all subscales, and all changes were statistically significant. Effect sizes were large for all subscales except 'child psychology' and 'child self-image and social interaction' (small effect size) and 'family function' (moderate effect size)

Table 47: Summary of Studies that have examined OHRQoL in children **

****Knapp *et al*, 2016**

Study	Instrument	Summary of change in OHRQoL following treatment
Baghdadi (2014)[7]	Short form P-CPQ and FIS	Statistically significant decreases in overall and all individual subscale scores in P-CPQ and FIS following treatment, with mostly large effect sizes. The 'social well-being' and 'parental emotions' subscales showed moderate effect sizes
Cantekin *et al*. (2014)[28]	ECOHIS	Overall score decreased by 44%, CIS by 34%, FIS by 65%, indicating improved OHRQoL. Statistically significant decrease in mean scores was seen in all subscales, except the 'child self-image and social interaction subscale which showed a significant increase in score
El Batawi *et al*. (2014)[30]	Modified P-CPQ and FIS	Reduction in the percentage of individuals reporting all outcomes, indicating improved OHRQoL. No statistical test carried out
Jankauskiene *et al*. (2014)[20]	ECOHIS	Overall and all individual subscale scores decreased after treatment and all changes were statistically significant. Large effect sizes for all but the 'child self-image and social interaction' subscale where the effect size was small
Pakdaman *et al*. (2014)[26]	ECOHIS	Mean scores for the both the child and parent subscales decreased at both the first (4 week) and second (3 months) follow-up, and these changes were statistically significant compared to baseline. The change between 4 weeks and 3 months, however, was not statistically significant
Thomson *et al*.	ECOHIS	Mean ECOHIS-child score decreased from 7.7 to 2.6 with large effect size and mean ECOHIS-family score decreased from 3.8 to 1.8 with moderate effect

Table 47: Summary of Studies that have examined OHRQoL in children **

****Knapp *et al*, 2016**

Study	Instrument	Summary of change in OHRQoL following treatment
(2014)[14]		size, indicating improved OHRQoL. Both changes were statistically significant
Xiao *et al*. (2014)[17]	ECOHIS	Mean scores for ECOHIS overall, and all subdomains, showed statistically significant decreases
Baghdadi (2015)[5]	P-CPQ and FIS	Mean scores for the P-CPQ and FIS showed a statistically significant decrease, with large effect size, indicating improved OHRQoL
Yawary *et al*. (2015)[23]	ECOHIS, CPQ and FIS	ECOHIS, CPQ, and FIS overall and subscale mean scores all showed a statistically significant decrease at 2 weeks and 3 months, indicating improved OHRQoL. The decrease in mean scores between 2 weeks and 3 months, however, was not statistically significant. Effect sizes were large for to moderate for all subscales, and large overall
de Souza *et al*. (2016)[18]	P-CPQ and FIS	Statistically significant reduction in overall scores and all individual subscales with medium to large effect sizes, indicating improved OHRQoL. No significant difference was found between treatment groups (exodontia only *versus* comprehensive care)

Several studies have shown that past caries experience is an excellent/valid predictor for future caries in children (Wang *et al,* 2016; Chaffee *et al,* 2016 Chaffee *et al,* 2015, Mejàre *et al,* 2014). In addition, children with tooth decay have poorer OHRQoL than those who have no caries or those who have received treatment (Knapp *et al,* 2016). In an innovative study, Kragt *et al,* 2016 have taken this further when they reported on Early Caries as a predictor of low Oral Health-Related Quality of Life at a later age in children. They argued that while Oral diseases influence children's OHRQOL directly, OHRQOL outcomes might also be related to oral health experiences from the past. Thus, they investigated the relation between dental caries at the age of 6 with OHRQOL assessed at the age of 10 in a population-based prospective cohort study. Caries experience was assessed with the decayed, missing, and filled teeth index (dmft) at a median age of 6.09 years (90% range: 5.73-6.80). OHRQOL was assessed with a short form of the Child Oral Health Impact Profile at the children's age of 9.79 years (9.49-10.44). In total, 2,833 children participated in this study, of whom 472 (16.6%) had mild caries (dmft 1-3) and 228 (8.0%) had severe caries (dmft >3). They found that the higher the dmft score at the age of 6, the lower the OHRQOL at the age of 10 ($p < 0.001$). Additionally, children with severe caries at the age of 6 had significantly higher odds of being in the lowest OHRQOL quartile at the age of 10 (OR = 1.69; 95% CI: 1.17-2.45). This study highlighted the importance of oral health during childhood, because those who get a compromised start to oral health were much more likely to follow a trajectory which leads to poor oral health and OHRQol later. They concluded that OHRQOL was not only related to current oral health experiences but also to oral health experiences from the past. The implications of these findings are quite clear: the evidence of early caries and subsequent poorer OHRQoL has implications for the health system as this cycle of disease will continue into adulthood in many of these children with the concomitant negative impact on OHRQol.

6.2 Limitations of this study

Although this trial is one of the largest studies that has examined the question of whether immediate tooth extraction under general anaesthesia in preschool children with severe dental caries is followed by improved Anthropometric outcomes (height, weight, BMI) and oral health related quality of life (OHRQoL) outcomes compared to delayed or no treatment, there are a few limitations that must be noted. The simple random method of group allocation resulted in the groups not being balanced at baseline for important variables such as height, weight and Hb levels. Additionally, the numbers included in the trial for the 6 year olds (delayed group sample size for 6 year olds was n=2) was far too small to undertake any meaningful analysis. The subjective nature of the OHRQoL questions could have led to some recall bias especially as regards the parental questionnaire which, in retrospect, was too long.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

In this chapter, the key findings are highlighted, and their implications are discussed as they relate to the recommendations made, and suggestions for further research are outlined.

This randomised controlled trial found that children with severe tooth decay who received treatment under general anaesthesia had significantly better height and weight gains than those children who has no treatment. Although gains were also noted in the BMI and Hb levels, these gains were not statically significant and their improvements could not be explained by the intervention alone (dental treatment under general anaesthesia).

OHRQoL outcomes showed significant improvement from both the child and parental/caregiver perspective when comparing children who received treatment against those who did not have treatment. Children who had to wait for treatment had similar negative impacts on OHRQoL at 6 months follow-up compared to baseline. However, once they received treatment (delayed group), similar significant improvements for OHRQoL as reported in the immediate group was also found in the delayed group.

This RCT has conclusively shown that children who have to wait for treatment suffer significant anthropometric and OHRQoL impacts that affect both the child and the parent/caregiver. Whilst it is known that there are limited resources for dental treatment under GA, there has to be some concrete action taken to reduce the long waiting times for dental treatment among children who have severe tooth decay. Furthermore, the lack of preventive programs for children at crèches has translated into a caries epidemic in the Western Cape Province especially among the poorer Coloured Communities where extractions comprise more than 99% of the type of care received. There is clear evidence presented in this trial that children do not have access to other forms of treatment besides tooth extraction. It is also recommended that WHO recommended fluoride tooth brushing programs, oral health education for mothers at early childhood developmental centres be introduced as a matter of urgency in this part of the country.

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APPENDICES

APPENDIX 1: ETHICAL CLEARANCE

Office of the Deputy Dean
Postgraduate Studies and Research

Faculty of Dentistry & WHO Collaborating Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE

Private Bag X1, Tygerberg 7505

Cape Town

Date: 13th February 2009

Dear Dr V Yengopal,

STUDY PROJECT: The effect of dental treatment on weight gain in children in South Africa

PROJECT REGISTRATION NUMBER: 01/1/24

ETHICS: Approved

At a meeting of the Senate Research Committee held on Friday 4th February 2009 the above project was approved. This project is therefore now registered and you can proceed with the work. Please quote the above-mentioned project title and registration number in all further correspondence. Please carefully read the Standards and Guidance for Researchers below before carrying out your study.

Patients participating in a research project at the Tygerberg and Mitchells Plain Oral Health Centres will not be treated free of charge as the Provincial Administration of the Western Cape does not support research financially.

Due to the heavy workload auxiliary staff of the Oral Health Centres cannot offer assistance with research projects.

Yours sincerely

Professor Sudeshni Naidoo

APPENDIX 1A

Volunteers Consent Form

Dr. Jeff Yengopal has explained to me the nature of the research and what I and my child would be asked to do as volunteers. They have given me my own copy of the volunteer information sheet, which I have read.

I consent for my child to take part in this study and I understand that I am free to withdraw my child at any time without giving a reason.

I confirm that I understand what the study involves, and my child's role within it.

Signed: ..... Date:…….

Name: .....

Witnessed: ..... Date:…….

Name: .....

I confirm I have explained the purpose and nature of the study.

Signed: ..... Date:…….

Name: .....

Volunteers Information Sheet – APPENDIX 1B

We are investigating whether or not children's ability to achieve normal weight is related to their dental health.

In order to do this, we would like you, and your child's help.

Joining the study will not make any difference to a usual dental treatment. However,

1) Your child's height will be measured as well as your child's weight, and we will test if your child is TB positive and test the blood Haemoglobin levels.

2) We will ask you some questions concerning toothache of your child and how it impacts your family life. We will as well ask questions to your child concerning toothache .

3) You will be asked to attend for a check-up visit 6 months from now.

All of the data we use will be anonymised and we will let your district health worker know if we think your child is not putting on weight as he/she should.

All data will be held in the STRICTEST CONFIDENCE.

We hope you will be happy to join the study.

APPENDIX 1C

CLASSIFICATION OF OCCUPATIONS

Two systems for classifying Socioeconomic Status.

1. The simple one designed by Beasley et al (1999, 2000) and a more detailed one.

Socioeconomic details:

Mothers education	None	Primary	Secondary	Adult Education	
Mothers Occupation	Housewife	Farmer	Trader	Maid	Mother dead
Father's Occupation	Unemployed	Manual	Skilled	Salaried	Father dead
Style of House	Shack	Cement	Other		
Sanitation	Pit toilet	Flush Toilet	other		
Home ownership	Own house	Renting rooms			
Number of beds	0	1-2	3-4	5-6	7
Possessions	Bicycle	Radio	Sewing machine		
Water Supply	Tap	Well	Stream	Pool	

The Beasley scoring system is:

Score Given	**0**	**1**
Style of House	Shack	Brick walls
Style of House	Other	Concrete floor and tin roof
Style of Toilet	Other	Toilet
Bed	No	Yes
Radio	No	Yes
Bicycle	No	Yes
Sewing machine	No	Yes

Score from 0 to 7

2. South African System

Code	Occupations - Criteria
1	Working for government organisation
2	Working for non-government or private organizations such as employee at bank or company, owner of business, independent jobs (e.g. lawyer, dentist, hair-dresser)
3	Labour, Argricultural worker
4	Non-worker such as student, housewife, looking for job
9	Do not have guardian

Source: Dental Health Division (2004)

APPENDIX 1D

Subject Information

Name of subject:_____
Sex_____
__

Age:____/____/ _____ Civil status _____

Present Address: _____

Educational attainment: _____

Occupation:

Regular ❑ Casual ❑ Monthly Income R_____

Source of income _____ Monthly income R_____

(If separate income)

Do you receive a social welfare grant: Yes ❑ No ❑ Pension R_____

Self-employed ❑ employed ❑

Parent's Income (for minors) : R _____

Living Conditions

Type of house: Appearance: Very Good ❑ Good ❑ Poor ❑

Shack ❑ Brick ❑ Wooden ❑

Roof: Tin ❑ Asbestos ❑ Other ❑

Other observations: _____

(describe)

Owned by _____Rental Rands_____/month

Mortgage Yes ❑ No ❑

Residential lot: Owned ❑ Squatter ❑ Rented ❑ Rands_____/month

Relocation Site ❑ Urban Poor Association ❑ Family property ❑

Water supply: Public Faucet ❑ Commercial (per gal) ❑ Water district or Assn R _____/month

Rain ❑ Deep Well ❑ Spring ❑ Pump ❑

Electric supply: Owned ❑ Flying connection ❑

Electricity R_____/month (check the latest bill)

Gas/Kerosene R_____/month

Home appliances: TV (color/bw) ❑ Ref. ❑ Karaoke ❑ Component ❑ Electric fan ❑ Cell phone ❑

Others: _____

Details of Income

Farmer: Farm owner ❑ Tenant ❑ Co-op member ❑

Other _____

Homestead (not titled) ❑

Vegetable garden ❑ Size _____ha

Fisherman: Paddle or sailing boat ❑ Motorized Boat ❑ employed ❑

Livestock (#): Cow_____Sheep _____Pig_____Chicken_____Ducks_____

Other source of income: Stores ❑

Others (specify):_____

Surveyed by:_____ Date:_____

APPENDIX 2

UNIVERSITY of the WESTERN CAPE

Weight Gain Study

ORAL EXAMINATION AND TREATMENT NEEDS

Child number: | | | | |

Child Name: _____

Address: _____

_____

_____

Date of birth: _____/_____/_____

day month year

Date of Exam: _____/_____/_____

day month year

1. Dental Caries and Treatment Need

	S	O	B	L	M	D	T/N	ABS		S	O	B	L	M	D	T/N	ABS
17									37								
16									36								
15/55									35/75								
14/54									34/74								
13/53									33/73								
12/52									32/72								
11/51									31/71								

21/61									41/81								
22/62									42/82								
23/63									43/83								
24/64									44/84								
25/65									45/85								
26									46								
27									47								

2.2.1.6.1

2.2.1.6.2	PERMANENT	2.2.1.6.3	PRIMARY	2.2.1.6.4	TREATMENT
2.2.1.6.5	**0=sound**	2.2.1.6.6	**A**	2.2.1.6.7	**0=none**
2.2.1.6.8	**1=decayed**	**2.2.1.6.9**	**B**	2.2.1.6.10	**P=preventive**
2.2.1.6.11	**2=filled with decay**	**2.2.1.6.12**	**C**	2.2.1.6.13	**F=fissure sealant**
2.2.1.6.14	**3=filled no decay**	**2.2.1.6.15**	**D**	2.2.1.6.16	**1=one surface filling**
2.2.1.6.17	**4=missing due to caries**	**2.2.1.6.18**	**E**	2=two surface filling	
2.2.1.6.19	**5=missing for other reasons**	**2.2.1.6.20**		5=pulp care	
2.2.1.6.21	**6=sealant**	**2.2.1.6.22**	**F**	6=extraction	
2.2.1.6.23	**T=trauma**	**2.2.1.6.24**	**T**	2.2.1.6.25	**7=need for other care**
2.2.1.6.26	**8=unerupted tooth**	2.2.1.6.27		9=not recorded	
9=excluded tooth		2.2.1.6.28		2.2.1.6.29	

2.2.1.6.30

Pufa/ PUFA index

Scoring

presence of a visible pulp,(p)

ulceration of the oral mucosa due to root fragments, (u)

55	**54**	**53**	**52**	**51**	**61**	**62**	**63**	**64**	**65**
85	**84**	**83**	**82**	**81**	**71**	**72**	**73**	**74**	**85**

a fistula (f)

abscess (a)

0	Sound
1	Pulp exposure
2	Fistula at tooth apex
3	Soft tissue ulcer from tooth-fragment
4	Abscess

Data Collection: Hospital Form

1. **Name of child:**

Date of treatment:

2. Height & Weight assessment:

Height : _____m_____cm

Weight :_____kg_____gm

3. Blood Sampling

Hemogloblin: _____

4. Skin Sensitivity Test PPD

Result: _____

5. Treatment carried out:

Extraction of: (Please mark on table below:-

55	**54**	**53**	**52**	**51**	**61**	**62**	**63**	**64**	**65**
85	**84**	**83**	**82**	**81**	**71**	**72**	**73**	**74**	**85**

17	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
47	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**

APPENDIX 3

CHILD ORAL HEALTH QUESTIONNAIRE:

Questionnaire 1

Child | | | | | **number:**

Child Name: _____

Address: _____

_____

_____

Date of birth: _____/_____/_____

day month year

Date of interview: _____/_____/_____

day month year

We want to know more about your teeth or mouth.

Do your teeth hurt you now? ☐Yes, ☐No ☐Not sure.

Is it difficult for you to bite or chew? ☐Yes, ☐No ☐Not sure.

During the last four weeks, have you had toothache? ☐Yes, ☐No ☐Do not remember.

1. Now, could you choose from the words below what best describes your last toothache?
   - ☐ Mild
   - ☐ Discomforting
   - ☐ Distressing
   - ☐ Horrible
   - ☐ Excruciating

Questionnaire 2

Pain Questions

Name or Number _____ ☐☐☐☐

1. Age ☐☐

2. Did you experience toothache in the past month? Yes ☐ No ☐

3. Do you have toothache now? Yes ☐ No ☐

4. Did you cry because of pain? Yes ☐ No ☐

(For those who have experienced toothache in the past month)

Because of pain, you cannot:

a. play ☐
b. eat ☐
c. sleep ☐
d. others (what else can you not do due to pain?) ☐

_____

_____

5. Do you get up at night because of pain? Yes ☐ No ☐

6. Did you wake up your parents or others because of pain? Yes ☐ No ☐

APPENDIX 4

CHILD ORAL HEALTH QUESTIONNAIRE:
Parental report

Thank you for your help with this survey. By answering these questions you will help us to find out more about children in your area.

Your answers will be looked at by the survey study team and by no one else. The information will be coded and will be used for research purposes only.

Child number: | | | | |

Date of interview: _____/_____/_____

Day Month Year

These questions should be answered by the mother, father or guardian of the child.

Is your house built with brick wall?	☐Yes	☐No
Has your house built concrete floors?	☐Yes	☐No
Has your house a tin roof?	☐Yes	☐No
Has your house a toilet?	☐Yes	☐No
Do you or your husband have a bicycle?	☐Yes	☐No
Do you or your husband a radio?	☐Yes	☐No
Interviewer note if child had shoes on at interview.	☐Yes	☐No

Socio-economic score: Possession (1) or lack (0):

Ownership of selected assets:

Do you have television?	☐Yes	☐No
Do you have a refrigerator?	☐Yes	☐No
Do you have air conditioner?	☐Yes	☐No
Do you have any motor vehicle?	☐Yes	☐No

Do you have electricity and piped water in your house? □Yes □No

The next questions refer only to the head of the family. <u>Consider as head of the family the person who has the higher income.</u>

This part of our questionnaire should be answered by the mother, father or guardian of the child, and refers only to children who are taking part in our research.

SECTION 1: Child's oral health and wellbeing

How much is your child's overall wellbeing been affected by the condition of his/her teeth or mouth?

□	□	□	□	□
Not at all	Very little	Some	A lot	Very much

SECTION 2: The following questions ask about <u>symptoms</u> and <u>discomfort</u> that children may experience due to <u>the condition of their teeth and mouth</u>

Has your child got toothache now?

□ Yes 2. □No 3. □Do not know

2. Has your child had difficulty drinking or eating hot or cold foods?

□	□	□	□	□	□
Never	Once or twice	Sometimes	Often	Everyday or almost everyday	Don't know

Has your child had trouble or difficulty to bite or chew food?

□	□	□	□	□	□
Never	Once or twice	Sometimes	Often	Everyday or almost everyday	Don't know

SECTION 3: The following questions ask about the effects that <u>the condition of children's teeth and mouth</u> may have on their <u>feelings</u> and <u>everyday activities</u>

Has the condition of your child's teeth and mouth upset them?

☐	☐	☐	☐	☐	☐
Never	Once or twice	Sometimes	Often	Every day or almost everyday	Don't know

Has the condition of your child's teeth and mouth made them irritable or frustrated?

☐	☐	☐	☐	☐	☐
Never	Once or twice	Sometimes	Often	Every day or almost everyday	Don't know

Has the condition of your child's teeth and mouth led to them not want to talk to other children?

☐	☐	☐	☐	☐	☐
Never	Once or twice	Sometimes	Often	Every day or almost everyday	Don't know

Has your child had trouble sleeping because of toothache?

☐	☐	☐	☐	☐	☐
Never	Once or twice	Sometimes	Often	Every day or almost everyday	Don't know

Has the condition of your child's teeth and mouth caused them to avoid smiling or laughing when around other children?

☐	☐	☐	☐	☐	☐
Never	Once or twice	Sometimes	Often	Every day or almost everyday	Don't know

SECTION 4: The following questions ask about effects that a child's oral condition may have on PARENTS AND OTHER FAMILY MEMBERS

Have you or other family members been upset because of your child's oral condition?

□	□	□	□	□	□
Never	Once or twice	Sometimes	Often	Every day or almost everyday	Don't know

Have you or other family members had sleep disrupted upset because of your child's oral condition?

□	□	□	□	□	□
Never	Once or twice	Sometimes	Often	Every day or almost everyday	Don't know

In the past 4 weeks how many nights did you have your sleep disturbed due to your child's toothache? _____ Nights.

SECTION 5: Child's sex and age

a. Your child is:

□ MALE
□ FEMALE

b. Your child's age is: _____YEARS and **_____**MONTHS

Mother's Occupation: Housewife Farmer Trader Maid Salaried Other_____

Father's Occupation: Unemployed Manual Skilled Salaried Father dead Other_____

Questionnaire completed by:

□ MOTHER
□ FATHER
□ OTHER _____

Date completed: _____ / _____ / _____
DAY MONTH YEAR

THANK YOU FOR YOUR PARTICIPATION

Thanks for agreeing to help us with our study!

Just one more thing. To test how good this questionnaire is at giving us the information we need, we would like a group of children to complete it again.

Would you be willing to help us by completing another copy of the questionnaire soon? We would mail it to you in the next 2 weeks.

YES □

THANK YOU FOR HELPING US