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SCHOOL DIETARY HABITS AND THE DENTAL HEALTH STATUS OF PRIMARY SCHOOL LEARNERS IN JOHANNESBURG, SOUTH AFRICA

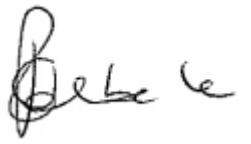
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A research report submitted to the Faculty of Health Sciences, Oral Health Sciences, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Dentistry

Johannesburg, 2023

DECLARATION

I, Octavia Lebele, declare that this research report is my own, unaided work. It is being submitted in partial fulfilment of the requirements for the degree of Master of Dentistry in the Faculty of Health Sciences, Oral Health Sciences, University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other university.



Octavia Lebele

_____day of _____ 20 _____ in _____

DEDICATION

I dedicate this research to my beloved children and husband for being so understanding and supportive throughout my studies. To Aunty Junior who was my pillar of strength on the home front, providing care for my children.

To my mom and siblings for encouraging me to push especially during times when I felt like giving up. More importantly my mom for instilling the importance of education in me and showing me how I can use it as a tool for change.

Lastly to all the women who have faced challenges and pushed against all odds during their studies and in the end became accomplishers of what in the beginning seemed impossible to achieve

ABSTRACT

Childhood caries remain a public health problem largely as a result of dietary and lifestyle behavioural factors. In addition, a partially monitored school health environment can potentially alter children's eating patterns and food choices, as family decision-making can be influenced by caregivers and peers, and the school food environment.

In an attempt to curb malnutrition, the Deptartment of Education runs a National School Nutrition Programme (NSNP), where meals are served to learners who come from disadvantaged backgrounds. Despite this initiative, learners are still exposed to sugar-rich foods contained in their lunchboxes or from school vendors or tuck shops. These unhealthy eating patterns contribute to non-communicable diseases, such as dental caries, obesity, and diabetes, later in life.

Aim: To assess the dietary habits and oral health status of Grade 3 primary school learners aged between 9 and 11 years in a public school that are part of the NSNP and in a non-NSNP schools.

Methodology: This was a cross-sectional study that assessed the school dietary habits, oral health status, and BMI of the learners that were part of the NSNP and those that were non-NSNP. Correlation analysis as well as univariate and multivariate logistic regression was applied to seek an association between oral health status and independent variables such as age, gender, sugar consumption and BMI.

Results: The main findings were that frequent consumption of foods and beverages rich in sugar was associated with dental caries. Learners from the NSNP school were the major contributors to higher mean DMFT/ dmft of 1.91 (2.21); 3 (3.39) respectively compared to those of the learners from the non-NSNP school, which were 0.59 (1.42); 1.4 (2.84) respectively. However, a statistically significant mean difference was only found for dmft with a p-value of 0.018. A significant decrease was observed in the overall Gingival Index (GI) score at both schools with regard to an increase in sugar consumption (p=0.039). About 45.21% of learners from the NSNP

school also presented with a mild GI oral health status compared to 17.64% of learners from the non-NSNP school.

The majority (64.44%) of the learners at both schools were found to be healthy with 35.51% being unhealthy learners. However, the overall mean BMI score was 18.2 (3.59) which falls within the overweight (unhealthy) category. When comparing the association of BMI scores to oral health status at school level, no statistical significance was found.

Conclusion: Based on the findings of this study a conclusion can be made that the learners at both the NSNP school and non-NSNP school consumed a high concentration of sugary foods and drinks, mainly found in their lunchboxes, and frequently purchased food items and beverages. The NSNP provided an environment where underprivileged learners had daily nutritious meals which ensured that schoolchildren do not suffer from malnutrition. However, the school food environment did not promote healthy eating habits. As a result, the caries experienced among the learners was also cause for concern as evidenced by the findings of this study. An increased dmft and GI scores that are associated with increased consumption of sugar rich foods in public primary schools, was apparent in both schools.

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The completion of this report would not have been possible without the grace of God. He made what looked impossible possible, what seemed unachievable achievable, and his favour was present throughout my studies.

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TABLE OF CONTENTS

DECLARATION ..... **ii**

DEDICATION ..... **iii**

ABSTRACT ..... **iv**

ACKNOWLEDGEMENTS ..... **vi**

TABLE OF CONTENTS ..... **vii**

LIST OF ABBREVIATIONS ..... **ix**

LIST OF TABLES ..... **x**

LIST OF FIGURES ..... **xi**

Chapter 1 INTRODUCTION **1**

1.1 Background 1
1.2 Problem Statement 2
1.3 Rationale of the Study 3
1.4 Aim 3
1.5 Objectives 4

Chapter 2 LITERATURE REVIEW **5**

2.1 Effects of Poor Nutrition on Teeth 5
2.2 Nutrition Status and Oral Health 7
2.3 School Nutrition and Oral Health 8
2.4 School Nutrition Programs in South Africa 10
2.5 Impact of NSNP 11
2.6 Consumption Habits at Schools 12
2.7 Summary 13

Chapter 3 METHODOLOGY **14**

3.1 Study Design 14
3.2 Study Population 14
3.3 Sampling Strategy 14
3.4 Study Sample 14
3.5 Inclusion Criteria 15
3.6 Exclusion Criteria 15
3.7 Measurement Tools 15

3.8 Clinical Exam 16
3.9 Clinical Measures 16
3.10 Data Collection 17
3.11 Pilot Study 17
3.12 Statistical Analysis 17
3.13 Ethical Consideration 18

Chapter 4 RESULTS 19

4.1 Demographic Results 19
4.2 Objective 1: Oral Health Status 20
4.3 Objective 2: Sugar Content 23
4.4 Objective 3: Relationship between Sugar Content and Oral Health 26
4.5 Objective 4: Relationship between Sugar Content and BMI 27
4.6 Objective 5: Relationship between BMI and Oral Health Status 28

Chapter 5 DISCUSSION 31

5.1 Summary of Results 31
5.2 Socio-Demographic and Anthropometric Profile 31
5.3 Oral Health Status 32
5.4 Sugar Content of Food Consumed 34
5.5 Relationship between Sugar Content and Oral Health Status 35
5.6 Relationship between Sugar Content and BMI 36
5.7 Relationship between BMI and Oral Health Status 37
5.8 Limitations of the Study 38

Chapter 6 CONCLUSION 39

References 40

Appendix A: Observational Checklist 46

Appendix B: Questionnaire 49

Appendix C: Provisional Study Approval 58

Appendix D: Participation Information Sheet 59

Appendix E: Assent Form for Children 60

LIST OF ABBREVIATIONS

BMI	- Body Mass Index
DBE	- Department of Basic Education
DMFT	- Decayed Missing Filled Teeth (permanent teeth)
dmft	- decayed missing filled teeth (primary / baby teeth)
DOH	- Department of Health
DST	- Department of Science and Technology
ECC	- Early Childhood Caries
FBDG	- Food-Based Dietary Guidelines
GBD	- Global Burden of Disease
GI	- Gingival Index
HHFKA	- Health Hunger-Free Kids Act
IOM	- Institute of Medicine
ISHP	- Integrated School Health Programme
NRF	- National Research Fund
NSLP	- National School Lunch Program
NSNP	- National School Nutrition Program
RTHBC	- Road to Health Birth Chart
SHN	- School Health Nutrition
SIS	- Sugar Intake Score
SSA -	- Sub-Saharan Africa
SSB	- Sugar-sweetened beverage
USA	- United States of America
WFP	- World Food Program
WHO	- World Health Organisation

LIST OF TABLES

Chapter 4: RESULTS

Table 4.1: Demographic characteristics 20

Table 4.2: Household Employment Status 20

Table 4.3: Oral health status 21

Table 4.4: GI by school 22

Table 4.5: Sugar content of food 24

Table 4.6: Sample of lunchbox contents by school 25

Table 4.7: Sample of frequently purchased items by school 25

Table 4.8: Relationship between sugar content and oral health status 26

Table 4.9: Relationship between sugar content and BMI 28

Table 4.10: Relationship between BMI and oral health status.....29

Table 4.11: Variables associated with oral health status.....30

LIST OF FIGURES

Chapter 4: RESULTS

Figure 4.1: Permanent and primary dentition by school 22

Figure 4.2: GI by school 23

Figure 4.3: GI score and consumed sugar content.....27

Chapter 1 INTRODUCTION

Dental caries remain one of the most common conditions among children despite studies having shown some reduction in its prevalence over the past 20 years due to improved education and dental hygiene, as well as sealants and water fluoridation (Wilder et al., 2016). The significant link between sugar intake, poor diet, and dental caries has been shown over the years to be a persistent challenge (Martins et al., 2014). The World Health Organisation (WHO) reported that 60 to 90% of schoolchildren worldwide have experienced dental caries (Petersen et al., 2005). Globally, children who suffer from poor oral health are more likely to have restricted activity days because of pain caused by toothache or dental infection (Shenoy & Sequeira, 2010). Furthermore, over 50 million school hours are lost annually because of oral health problems, which affect children's performance at school (Kwan et al., 2005; Weichselbaum & Buttriss, 2011).

1.1 Background

In South Africa, the prevalence of dental caries among children is high, ranging from 77.1% for four to five year old children and 82.3% for six year-olds in the Western Cape. This is much higher than the national mean ages, which are 50.59% and 60.32% for these particular age groups respectively (Singh, 2011; Thekiso, et al., 2012; Van Wyk & Van Wyk, 2004). The last South African National Children's Oral Health Survey (1999 – 2002) showed dental caries as being more severe in primary teeth than in permanent dentition of children (Van Wyk et al., 2004). Furthermore, over 80% of caries among six year old children is reported as being untreated (Singh, 2011; Van Wyk & Van Wyk, 2004). In response to levels of malnutrition in the country, the South African government introduced the Primary School Nutrition Program (PSNP) under the guidance of the Department of Health and Department of Education (DoE) to promote and advocate for malnutrition control, nutritional education, and dietary guidelines in children from low socioeconomic circumstances. Malnutrition refers to undernutrition and overnutrition, ranging from severe nutrient deficiencies to extreme obesity (Kyere et al., 2020). The program was renamed the

National School Nutrition Program (NSNP) and was transferred to the DoE in 2004 to strengthen implementation and support (Ramugondo, & Mabapa, 2021).

The NSNP provides meals to over nine million learners in over 20 000 public schools as a result of the huge inequality and poverty levels in South Africa (Devereux et al., 2018). The goal of the NSNP is to improve the health and nutritional status of school-going children and to improve learner's school attendance, attentiveness, and performance. Learners are given one meal at the beginning of the school day. This breakfast may comprise of mealie pap, beans, and a nutritious pulse-based sauce with no meat. This is meant to provide energy, protein, and micro-nutrients for children enrolled in the program (Devereux et al., 2018). The selection for the school feeding scheme works in two ways. First, whole schools are selected for funding for this program because most of their learners come from poor families (quintile one to quintile three schools). The quintile system determines the poverty level of the community, with quintile one schools in the poorest communities, and quintile five schools in the most affluent communities. Second, within participating schools, learners are selected by age, grade, or some other criteria for feeding.

Research found that not all children entitled to the school feeding program receive food. While 90% of eligible children were reported to be receiving free food at schools in rural sites, only 56% of eligible children in urban sites were receiving food. On the other hand, urban children who were receiving food at school got it more regularly than those in rural sites did. While there are a number of studies that have examined the general health effects of these daily meals on children (Dewayani & Sukihananto, 2018; Pine et al., 2016), there is a limited number of studies that have focused on the impact of the meals and learner's dietary preferences on oral health outcomes.

1.2 Problem Statement

Literature has shown that school oral health programs can provide an effective platform for preventing dental caries and promoting oral health because they reach over one billion children worldwide (Kwon et al., 2005). Dramatic changes in lifestyles and the environment have brought about significant alterations in children's eating patterns and food choices. Caregivers and peers now influence what was once mainly determined through family decision-making. In addition, many eating

encounters occur in places outside of the home, such as in schools and surrounding vendors in the community (Crockett & Sims, 1995; Halloran, et al., 2018).

Understanding these changes is pivotal if children are to establish healthy eating patterns, which contribute to the prevention or at least delay of non-communicable diseases, such as dental caries, obesity, and diabetes in later life. According to Crockett and Sims (1995), teachers and the school community play a significant role in shaping the eating behaviours of school-aged children and influencing the nutritional quality of food that learners have access to at school (Crockett & Sims, 1995; Dewayani & Sukihananto, 2018).

A large part of children's waking hours is spent at school. Thus, the environment of the school has a significant impact on learners' overall health and oral health (Anttila et al., 2015). It is in the school environment that children can be reached at influential stages in their lives, where lifelong nutritional patterns are formed (Ismail, 2004).

1.3 Rationale of the Study

The benefits of school nutrition programs on learners include alleviating hunger, as well as reducing micro-nutrient deficiency and anaemia. Further studies have indicated that school nutrition programs also contribute to preventing obesity, improving school enrolment and attendance, increasing cognitive and academic performance, and contributing to gender equity in access to education (Drake et al., 2017). While health outcomes such as malnutrition, stunting, obesity, and diabetes, have been assessed in relation to school nutrition and learner food preferences (Dewayani & Sukihananto, 2018; Pine et al., 2016), little has been documented on the impact of the school food environment on oral health.

1.4 Aim

To assess and compare the dietary habits and oral health status of Grade 3 primary school learners in public schools that are exposed to the NSNP (NSNP schools) and the schools that are not (non-NSNP schools).

1.5 Objectives

To assess and compare:

(1) The oral health status of learners at both the NSNP and non-NSNP schools.
(2) The sugar content of food consumed by learners at both the NSNP and non-NSNP schools.
(3) The relationship between the sugar content of food consumed and the oral health status of learners at both the NSNP and non-NSNP schools.
(4) The relationship between the sugar content of food consumed and the body mass index (BMI) of learners at both the NSNP and non-NSNP schools.
(5) The relationship between the BMI of learners and their oral health status of learners at both the NSNP and non-NSNP schools.

Chapter 2 LITERATURE REVIEW

This chapter discusses the effects of poor nutrition on teeth, specifically school nutrition. Oral health is reviewed to demonstrate the influence of the school nutrition environment. The impact of the National School Nutrition Programme (NSNP) is deliberated in terms of its impact and the content of children's food consumption in school settings.

2.1 Effects of Poor Nutrition on Teeth

Dental caries is the most common global childhood disease and is, for the most part, reversible and preventable (Cooper et al., 2013; Weichselbaum & Buttriss, 2011). According to the 2015 Global Burden of Disease (GBD), early childhood caries is ranked as the 12th most prevalent condition affecting 560 million children globally (Abbass et al., 2019; GBD 2015 Disease and Injury Incidence and Prevalence Collaborators, 2016). This condition is a multi-factorial disease influenced by a cariogenic diet, increased sugar intake, poor oral hygiene habits, lack of access to fluoridated water or fluoridated toothpaste, and limited access to oral health services. Parental education and socioeconomic status are contributing factors affecting diet choice in most households along with the implementation of hygiene practices that reduce caries (Abbass et al., 2019).

It is important to distinguish the differences between anti-cariogenic, cariogenic, and cariostatic foods for a better evaluation of oral health (Inan-Eroğlu et al., 2017). The anti-cariogenic foods can increase the pH of the saliva to an alkaline level and prevent enamel from demineralisation. Dairy products (especially cheese), unrefined plant foods, wholegrain foods, and xylitol artificial sweeteners, are considered as anti-cariogenic foods or food components. Cariogenic foods including sweets, starchy foods and beverages, and products with added sugar, contain fermentable carbohydrates that are fermented by microorganisms in the mouth and result in a decrease in the pH of the saliva to 5.5 or less which promotes the formation of caries. Cariostatic foods do not cause caries since they are not metabolized by microorganisms in the mouth thus salivary pH does not change within 30 minutes.

Protein foods such as egg, meat, fish, and poultry; most vegetables; fats and non-carbohydrate sweeteners are examples of cariostatic foods (Inan-Eroğlu et al., 2017).

Frequent consumption of cariogenic food and drinks by children doubles the risk of dental caries and enamel erosion (Sohn et al., 2006). Bacteria on the tooth surface ferment sugars and other carbohydrates and these bacteria are found in dental plaque (Sohn et al., 2006). The bacteria produce localised acid, which causes demineralisation of the tooth surface thereby resulting in tooth decay (EFSA, 2010).

Other frequently consumed foods, which increase the risk of developing caries, are retentive carbohydrates. A good example would be toffees, chocolates, jelly beans, dried fruit, and desserts such as cakes and biscuits. All of these food items are also referred to as ‘sugar confectionery’ (Sworn, 2009). Studies show that these types of carbohydrates contain a high concentration of sugars in the form of sucrose, glucose, fructose, or various other kinds of corn syrups (Sworn, 2009).

Enamel erosion can also result from poor nutritional habits. The difference in enamel erosion and dental decay is the loss of hard tissue because of dietary acids in the former, while the latter is due to acid produced by bacteria. Extrinsic acids such as citric acid, phosphoric acid, ascorbic acid, malic acid, tartaric acid, vinegar containing food, and carbonic acid commonly found in fruit juices and carbonated drinks cause the erosion (Moynihan & Petersen, 2004). Demineralisation of the enamel would then occur due to chemical etching resulting in tooth destruction (Bassiouny, 2014; Sanders, 2004).

Inadequate intake of micro-nutrients such as vitamins, folate, calcium, phosphorus, and magnesium, may result in micro-nutrient deficiencies, which compromise the structure of children’s teeth and thus result in dental caries (Shetty et al., 2011). Calcium is a mineral that enhances enamel mineralisation and supports the tooth and bone structure and function, while phosphorus plays a role in the formation of teeth. Vitamin D helps the body absorb calcium from food and supplements. Folate and iron support mucosal or connective tissue formation and immune function. Low levels of folate are associated with periodontal disease (Kecskemethy, 2018).

2.2 Nutrition Status and Oral Health

Quantifying or measuring feeding patterns and diet composition can be very challenging, as such there are different measuring tools used to measure general nutritional status. The body mass index (BMI) is a measurement of a person's weight-to-height ratio. It is calculated by dividing the weight (kg) by the height squared (m^2) (Nuttall, 2015). This is in accordance with the World Health Organisation (WHO) standards. The BMI is primarily used to measure the nutritional status of both adults and children, however, in teenagers and children aged between two and 10 years, interpretation is based on age and sex. This is done in percentiles and the classification categories are underweight (less than fifth percentile), healthy weight (fifth percentile to less than 85th percentile), overweight (85th percentile to less than 95th percentile) and obese (equal or greater than the 95th percentile) (Nuttall, 2015; Ortega et al., 2017).

Several studies on overweight, obese, and high BMI children and associations with dental caries have been published. Most studies reported inconclusive results with the exception for one study by Angelopoulou et al. (2019), which suggested that high BMI could have a higher risk of dental caries. The systematic review done by Alshehri et al. (2020), found a combination of positive, negative, and no association between BMI and dental caries.

Some researchers have found that caries can be associated with obesity and others have found links with undernutrition. However, few studies found that caries were associated with both high and low BMI in the same population (Hayden et al., 2013; Hooley et al., 2012). As obesity and dental caries are multi-factorial diseases, obesity itself cannot be taken as the only predictor of caries in children (Kantovitz et al., 2006). A diet rich in refined carbohydrates as well as poor oral hygiene was found to be strongly associated with both caries and obesity, however a high sugar diet had a stronger impact on obesity in children and adolescents (Hayden et al., 2013).

In addition, children living in low to middle-income countries where there is a nutritional transition, are most likely to be obese if they experienced stunting at younger ages due to impaired fat oxidation and storage of fat (Hoffman et al., 2000).

The nutritional transition involves higher access to foods high in carbohydrates and fats leading to an increased prevalence of caries.

2.3 School Nutrition and Oral Health

Prior to the COVID-19 pandemic, school feeding was the largest and most widespread social safety net in the world, benefiting 388 million children globally. According to the World Food Program (WFP), data from 163 countries show that 99% of these countries, including developed and developing countries, delivered school feeding programs (WFP, 2020). Studies show that 90 percent of those meals were complemented by a package of interventions to improve health. Globally, one in every two schoolchildren, or 388 million children, received a school meal, although there were wide disparities between countries and even wider disparities resulted due to the pandemic (WFP, 2020).

On average nearly 312 million meals are served in schools every day in England and Wales, with 45% of children and young people in schools using the school meals service. In England, 16.8% of primary school children and 14.5% of secondary school children were entitled to free school meals in 2004. Additionally 19.4% and 16.8% of primary and secondary school pupils in Wales received school meals respectively (Crawley, 2005). Thus, the majority of the primary school children in the UK are able to receive a free healthy school lunch (as well as a free healthy breakfast) in a bid to improve health and education. More recently, data has shown that the uptake of school meals has now risen to 80% (Crawley, 2005). The feeding scheme offered a free piece of fruit to all children aged between four and six years in Local Education Authority (LEA) maintained schools in England and Wales (Crawley, 2005). The same study found that children carrying packed lunches alone were eating double the recommended lunchtime intake of saturated fat and sugar and up to half their daily recommended salt intake (Crawley, 2005).

Dental decay is one of the most common childhood conditions in the UK, with the development of the condition being directly related to how often a child consumes sugary foods and drinks, and to the total amount of sugars consumed (Crawley, 2005). On average among seven to 10 year-olds 1.1 teeth had dental decay compared with 2.7 teeth in 11 to 14 year-olds (Crawley, 2005).

In the United States of America (USA), the National School Lunch Program (NSLP) provides a substantial portion of daily energy intake to over 30 million children daily (Raynor et al., 2021). In 2009, the Institute of Medicine (IOM) recommended new meal standards to improve the nutritional quality of school-provided meals. In 2012, the Healthy Hunger-Free Kids Act (White House, 2010) enacted these changes by establishing calorie, sodium, and saturated fat limits; setting fruit, vegetable, and whole grains requirements; and eliminating high-fat milk (Raynor et al., 2021). These changes seem to have improved the overall nutritional quality of school-provided meals, yet further evidence is needed to quantify their impact on the actual nutrient composition of selected and consumed school meals and the influenced of the meals on the oral health of learners.

According to the 2019 global survey, of the 39 African countries with school feeding schemes, 59% had just one school meal program, 18% had two programs, 13% had three programs and 10% had four programs in operation. In these countries, over 60 million children of all ages received food through school meal programs (Wineman et al., 2022). The two countries with the greatest absolute numbers were Egypt (11.5 million), Nigeria (9.8 million); the rate at which Nigeria's national school meal program was scaled up is particularly noteworthy, as it was newly launched in 2016 (Wineman et al., 2022).

School Health Nutrition (SHN) grew substantially in the Education Sector Plans in sub-Saharan Africa (SSA) between 2000 and 2015, with school enrolment also rising from 83% in 2000 to 91% in 2015 (Kyere et al., 2020). To address micro-nutrient malnutrition, about two-thirds of the programs served fortified foods, and one-quarter included micro-nutrient supplements. Even as rates of overweight/obese African school children are rising among, just 10% of school meal programs identified its prevention as an objective (Wineman et al., 2022). The same sentiments can be shared for the increase in the prevalence of dental caries among African schoolchildren with very few prevention measures being incorporated in the existing school nutrition programs.

2.4 School Nutrition Programs in South Africa

International organisations such as the WHO, World Bank, and the WFP share the same sentiment, that hunger affects the physical and cognitive development of a child (Sanousi, 2019). Similarly, the Department of Health in South Africa noted that hunger, poverty, and poor education are interdependent social issues (Faber et al., 2013).

South African Government schools are addressing the food security issue through the NSNP, which targets schools in the poorest areas of the country (quintile 1 to 3 schools) (Faber et al., 2013). NSNP forms part of the integrated food security strategy, which seeks to contribute towards the sustained provision of quality nutrition to learners, provision of skills to establish food production initiatives in schools as well as promoting healthy lifestyles in school communities threatened by poverty and hunger (DoE, 2008; Faber et al., 2017).

The NSNP consists of three objectives, first to reduce short term hunger by providing nutritious meals daily to learners at school, second, through nutrition education to improve nutritional knowledge, healthy eating, and promote healthy lifestyles among school communities. Third, by promoting sustainable food production initiatives to provide insight and transfer skills to schools and communities with the ultimate goal of improving household food security (DoE, 2008; Faber et al., 2013).

A qualitative case study was done in Cape Town, to explore the perceptions of school principals, teacher coordinators, food handlers, members of the School Governing Body, and a staff member from the Department of Basic Education (DBE) of the Western Cape on the impact of the NSNP in schools. According to the perceptions of the interviewed participants, the NSNP in Cape Town improved food security by reducing short-term hunger but not necessarily fulfilling nutritional needs. Food quality, quantity, and targeting system (the quintile system) was found to exclude some poor learners from receiving NSNP meals (Sanousi, 2019).

In the Western Cape school feeding scheme, learners are served two meals a day from Monday to Friday, while in other provinces one meal is usually served per day at school. The meals served by the Western Cape school feeding scheme included cooked maize and mabele (sorghum) porridge for breakfast. These cereals provide

nutritional diet such as carbohydrates, energy as well as micro-nutrients (vitamin E and zinc). At lunch time, they are served pilchard and lentil stew, cooked rice, and butternut, or sugar bean stew with cooked samp, and a whole fruit, or soya mince curry, cooked carrots, and cabbage throughout the week. All these food products provide rich protein and starch (fibre, minerals, and vitamins) (DoE, 2010; Sanousi, 2019).

The sugar content of all the above-mentioned meals are within the South African food based dietary guidelines (FBDG) and the WHO recommended guidelines (Sanousi, 2019). However, the level of sugar consumption by the learners on a daily basis may well be above the accepted level as stated in above mentioned guidelines, considering that the learners may consume added sugars from sugar sweetened beverages (SSB's) and other 'sugar confectionery' foods that they buy from vendors in and outside the school premises (Sanousi, 2019).

2.5 Impact of NSNP

The Department of Science and Technology (DST) and the National Research Fund (NRF) carried out a national workshop on the school feeding programme in order to assess the achievement and limitations of the NSNP. The findings from this workshop indicated that in as much as school-feeding schemes reduced food insecurity; it also created problems of stigma and social exclusion of poor children and orphans who received school meals (Devereux et al., 2018). Receiving meals from the feeding scheme program was associated with poverty among peers and many learners opted to buy food from school and local vendors, or carry a lunch box (Devereux et al., 2018).

Another study showed that school feeding achieved limited impact on anthropometric indicators such as stunting because it was accessed too late in a child's physical development. Nutritional deficits that occur in the first 1,000 days of life leave negligible potential for 'catch-up', thus leaving little or no room to reverse the damage of early nutritional deficits (Bundy et al., 2009). Nutritional deficits, which develop during early stages in life, can lead to vitamin D deficiency, which, in turn, leads to hypo calcification of teeth. Hypo calcified teeth are at a higher risk for development of caries compared to teeth that are normally calcified (Bener et al., 2013).

A study undertaken with the aim of determining an association between dental caries, BMI, and sugar intake in children, aged between two and five years, attending primary school in Brazil, found BMI was independent of the presence of caries and no significant association was found (Martins et al., 2014). Results of the study showed that 33% of the learners fell into the BMI stratification of at risk of being overweight; however, their decayed, missing, filled teeth (dmft) score for primary teeth was 0.80 (Martins et al., 2014). Therefore, information gaps exist on the effect of food environment on the oral health status, and influence on the BMI of school learners in South Africa.

2.6 Consumption Habits at Schools

Studies have shown that many learners in South Africa frequently eat a range of unhealthy snacks, particularly at schools in low-income settings (Steyn et al., 2015). A randomised clinical trial (RCT) was done on sixteen schools in low-income settings, from two school districts in the Western Cape. The aim of the study was to evaluate the dietary outcome of the Health Kick Intervention regarding the variety of food groups in their diet intake over a period of three years (Steyn et al., 2015). The intervention was introduced to eight primary schools while another eight schools of similar settings had served as controls as they had no program.

The studies found that most of the learner's meals were found to consist of little variety in terms of the different food groups such as cereals, meats, poultry & fish, dairy, fruits and vegetables and fats & oils. The majority of children consumed less than four food groups per day (Steyn et al., 2015). The popular snacks consumed by the children were high in fat and sugar content. Crisps, fried foods, sweets, and carbonated beverages were frequently consumed in schools (Steyn et al., 2015). These items were mostly purchased at school tuck shops, vending machines, or from vendors around the school premises (De Villers & Faber, 2015).

Moreover, the South African National Health and Nutrition Examination Survey (2013) found that more than half (51%) of children aged between 10 and 14 years took tuck money instead of a lunch box to school. Second, of the children who took money to school, nearly half of them spent money on snacks on a daily basis (De Villers & Faber, 2015). It may well be that some children prefer healthy eating habits;

however, they may not have access to nutritious foods within and outside of their school environment (De Villers & Faber, 2015). Hence, school nutritional programs can facilitate healthy eating practices at educational settings thereby promoting the growth, development, and overall health of the learners (Anttila et al., 2015).

2.7 Summary

The above literature review outlined the effects of poor nutrition on teeth, which revealed how diet plays a major role in the formation of dental caries. Effects of school nutrition and oral health was then discussed in order to demonstrate that the school nutrition environment influences the association between sugar consumption and caries development among school going children (Heilmann & Ziller, 2021). The final three sections elaborated on the school nutrition program in South Africa, and its impact on food consumption by South African children in school settings.

Chapter 3 METHODOLOGY

3.1 Study Design

This was a cross-sectional analytical study that assessed the school dietary habits and oral health status among Grade 3 learners at schools that were part of the National School Nutrition Program (NSNP) (exposed group), and at schools that were not participating (unexposed group).

3.2 Study Population

The study population included Grade 3 primary school learners aged between nine and 11 years in public schools that were located in the Johannesburg Metro District. The focus was on one of the five Johannesburg Metro sub-districts, named Johannesburg Central. According to the Gauteng Department of Education, this sub-district had 134 public primary schools with a total study population of 13 928 Grade 3 learners. Johannesburg was chosen as the study site as no similar study had been reported in the district.

3.3 Sampling Strategy

A multistage cluster sampling technique was used. In the first stage, a list of quintile 1 to quintile 3 primary schools in Johannesburg Central sub-district was obtained from the Department of Education (DoE). From the list, schools were stratified into two groups according to their participation in the NSNP. In the second stage, one school was randomly selected from each group to ensure equal representation of schools that were part of the NSNP and those that were not participating. The third stage involved inviting all Grade 3 learners in the two randomly selected schools to participate in the study.

3.4 Study Sample

For a population size of 13 928 at an expected frequency of dental caries at 50%, with a design effect of 1, a sample size of 235 learners was required. (Epi Info, version 7.2.01).

3.5 Inclusion Criteria

Participants included were only Grade 3 learners aged between nine and 11 years from the two randomly selected public primary schools within the sub-district. Only those children whose parents had given informed consent were invited to participate in the study. Since caries develop over approximately two to three years (Martins et al., 2014), the children had to have been exposed to the program over a period of at least two years.

3.6 Exclusion Criteria

- Learners who had underlying systemic medical conditions such as diabetes and epilepsy.
- Learners with no given consent by their parents; and
- Learners outside of the age range of between nine and 11 years.

3.7 Measurement Tools

The measurement tools for this study included an observational checklist, a questionnaire, and an oral health examination.

An observational checklist (Appendix A) with three sections was used to assess the school food environment. An interviewer-administered questionnaire was used to collect non-clinical data by the principal investigator and three other clinicians. The questionnaire was adapted from the Stats-SA National School Survey and Household income and Red Cap school food environment survey (Labadarios et al., 2011).

The questionnaire (Appendix B) covered demographic information about the Grade 3 learners in Part 1. In Part 2, learners in NSNP intervention schools were asked about the meals they are served at school, how often the meals were served, what the contents of the meals were and if they fetch their served meal. Both the NSNP exposed and unexposed groups' learners were asked about their purchasing habits, where they purchased their food and what they usually purchase; or if they carry a lunch box, what the content of the lunch box was, and how often they purchase those items in a day or week, etcetera.

A sugar intake score (SIS) based on items consumed on the day was calculated for both the groups (Steyn, et al., 2015). Essentially estimates of sugar consumption were made based on the following: -

- For daily meals served at school, information on the actual sugar content was obtained from a South African calorie counter online website/application (www.fatsecret.co.za) which is also a nutrition database.
- For lunch box content, sugar content was obtained by comparing these to similar items sold in store with packaging that contains information on amount of sugar in product. For example, for a child having a chicken and mayonnaise sandwich, a similar product sold in a store was accessed and the sugar content reading was recorded. Similarly, for fruit, sugar content was accessed from package inserts.
- For snacks such as chocolates and chips, the investigator obtained a sample of the product and took the information about sugar content from the packaging.

3.8 Clinical Exam

In Part 3 of the questionnaire, five calibrated oral health examiners carried out oral examinations. Inter/intra-examiner calibration was done. Clinical data for dental caries was collected using the decayed, missing, filled teeth (dmft/DMFT) index, where the lower case acronym referred to primary teeth and the upper case acronym referred to permanent teeth. Assessments were done using mouth mirrors and blunt probes under artificial light in a mobile dental unit as recommended by the World Health Organization (WHO, 2013).

3.9 Clinical Measures

A simplified gingival index was used to measure the severity of gingivitis of the learners and was classified according to the Loe (1967) criteria on a scale ranging from 0.1 to 3.0 (0.1–1.0: mild gingivitis, 1.1–2.0: moderate gingivitis, and 2.1–3.0: severe gingivitis). The clinical exam was done by running the side of a blunt probe along the following six teeth surfaces: upper right first molar (tooth 16), upper right lateral incisor (tooth 12), upper left first premolar (tooth 24), the lower right first

premolar (tooth 44), the lower left lateral incisor (tooth 32) and first molar (tooth 36) (Rodan et al., 2015). Missing teeth were not substituted. This exam is done to assess the amount of plaque accumulation and inflammation on the above-mentioned teeth.

Anthropometric measures of height and weight were recorded using a digital weight and height scale. From the information collected, a BMI measure was calculated based on the formula, BMI = Weight (kg)/Height (m2) (Martins et al., 2014). The weight and height were transferred into z-scores by age and sex of the learner according to the South African Road to Health birth chart (RTHBC). The z-scores were stratified into BMI categories of underweight, normal weight, overweight and obese according to the percentile weight and height related to the sex and age in the South African RTHC that monitors children's growth and development patterns (Tarwa & De Villiers, 2007). Thus, for the purposes of this study, learners who had a normal weight BMI score were classified as healthy, where as those who were classified as unhealthy were underweight, overweight, or obese.

3.10 Data Collection

The principal investigator and four other dental clinicians collected data. All of the investigators were trained and calibrated until the kappa score reached a minimum of 80% agreement (Bonita et al., 2006).

3.11 Pilot Study

The questionnaire was piloted at two schools, one that was part of the NSNP and another school that was not participating. These schools were not involved in the actual research. The piloting was to ensure that the learners were able to understand the questions asked and that the questions were valid. Furthermore, piloting of the study assisted with addressing aspects of reliability (Bonita et al., 2006). All identified gaps from the pilot were recorded and adjusted accordingly.

3.12 Statistical Analysis

Data was captured onto Excel. Verification of the data was done by entering the data twice prior to importing to STATA for data analysis. Each learner was given a study

identity number that was written on the questionnaire and clinical examination sheet. The following analyses were done using STATA Windows Version 17:

- The oral health status was analysed using summary statistics expressed in measures of frequency, means, and standard deviation. T-test analysis was used to compare the means, and Chi-squares were used to compare proportions within and between the two primary schools, one being part of the NSNP and the other a non NSNP school (Bonita et al., 2006).
- The sugar content of food consumed was analysed using summary statistics expressed in measures of frequency and proportions.
- The BMI status was analysed using summary statistics expressed in measures of frequency and proportions.
- Pearson correlation test was used to assess the degree of association relationships between the sugar content of food consumed and oral health status at both the schools.
- Univariate and Multivariate Linear Regression models were used to assess the effects of all variables on the oral health status.

All the statistics were set at a 95% confidence interval with a p-value of 0,05. Furthermore, a pictorial view of continuous variables was done using the scatter plot.

3.13 Ethical Consideration

An approval from the Human Research Ethics Committee at Wits Health Sciences Faculty (Appendix C) as well as approval from the Head of school was obtained in order to proceed with the study.

Approval from the DoE and principals of the schools was obtained to gain entry into the schools.

Prior to administering the questionnaire and screening the learners, an informed consent from their parents or guardian was requested in order to enable the learners to participate in the study (Appendix D).

Lastly, the learners were also required to provide a written assent before being examined (Appendix E).

Chapter 4 RESULTS

This study had 115 participants, comprising of Grade 3 learners from two public primary schools in Johannesburg Central sub-district. Of the 115 participants, eight (n=8) participants had missing data and as a result, only 107 (n=107) participants were included in the analysed data. Of the 107 participants included, the mean age was 8.69 (SD=0.79) years, and 68.2% (n = 73) of the learners were from a primary school that participated in the NSNP (NSNP School), and 31.8% (n = 34) of the learners were from the school that was not participating in the NSNP (Non-NSNP School).

4.1 Demographic Results

Table 4.1 summarises the demographic characteristics of the learners. The participants consisted of 54.2% girls and 45.8% boys. Of the 107 participants from both schools, the mean body mass index (BMI) was 18.2 (SD=3.59). Categorising the BMI into healthy (healthy being considered as a BMI score between 13,7 - 17,4 and a BMI score below or above this range was categorised as unhealthy); 64.44% of the learners were healthy while 35.51% of learners were unhealthy. Of the unhealthy group, n=18 (47.4%) were obese, 19 (50.0%) were overweight and one was underweight. There were more healthy learners in the NSNP School (73.97%), while the non-NSNP School had more unhealthy learners (55.8%). Of the 107 participants from both schools, 73 learners were from the NSNP School and 34 learners were from the non-NSNP school. Categorising the BMI into healthy (BMI score between 13.7 and 17.4) and unhealthy (BMI score below or above this range) 64.44% of the learners were healthy while 35.51% of learners were unhealthy. Of the unhealthy group, 18 (47.4%) were obese, 19 (50.0%) were overweight, and one was underweight. There were more healthy learners in the NSNP school (73.97%), while the non-NSNP school had more unhealthy learners 55.8%.

Table 4.1: Demographic characteristics

Variables	Total Learners	Descriptive statistics Mean(SD)	NSNP school n(%)	Non-NSNP school n(%)
Study population	107	-	73(68.2)	34(31.8)
Female	58	54.2%	39(53.42)	19(55.88)
Male	49	45.8%	34(46.58)	15(44.12)
Age	107	8.89(0.79)	8.67(0.88)	8.74(0.57)
BMI*	107	18.2(3.59)	17.51(3.1)	19.64(4.14)
Healthy BMI	69	64.44%	54(73.97)	15(44.12)
Unhealthy BMI	38	35.51%	19(26.03)	19(55.8)

*****The BMI variable is made up of two categories; healthy and unhealthy. The healthy category was made up of children whose BMI readings were between 13.7-17.4. All those who had readings below or above this range were grouped into the "unhealthy" category.

Table 4.2 indicates the response from learners pertaining to the employment status of family members within each household. This information was used to ascertain the socio-economic status of the families of children of both NSNP School and Non-NSNP School. The figures represent the percentage of household members who were formally employed, self-employed or unemployed in each school.

Table 4.2: Household Employment Status

Response from learners at NSNP school (n=73)			Response from learners at Non-NSNP school (n=34)		
Formally Employed	Self - Employed	Unemployed	Formally Employed	Self - Employed	Unemployed
5%	5%	90%	96%	3%	0%

4.2 Objective 1: Oral Health Status

The first objective aimed to assess the oral health status of learners at both the NSNP and non-NSNP schools.

The decayed, missing, filled teeth (DMFT), in upper case, is the sum of decayed, missing due to caries, and filled permanent teeth. While dmft, in lower case, is the sum of decayed, missing and filled primary teeth. A new index called the 'Significant

Caries Index' (SCI) was proposed in 2000, in order to bring attention to those individuals with the highest caries scores in the study population. It is the mean DMFT/dmft of the one third of the study group with the highest caries score.

The oral health results of the learners are shown in Table 4.3. The learners in the NSNP school had higher DMFT/dmft scores of 1.9 (SD=2.23); 3.0 (SD=3.39) compared to the DMFT/dmft score of 0.59 (SD=1.42); 1.4 (SD=2.84) of the learners from the non-NSNP school. However, only the dmft was found to be statistically significant with a p-value = 0.018.

Table 4.3: Oral health status

Variable	Total number of learners	NSNP school Mean(SD) (n=73)	Non-NSNP school Mean(SD) (n=34)	Comparison p value
DMFT	107	1.9(2.23)	0.59(1.42)	0.0022
DMFT SCI	37	4.2(2.27)	1.7(2.02)	-
dmft	107	3.(3.39)	1.4(2.84)	0.018
dmft SCI	37	6.9(2.87)	3.8(3.74)	-

The findings of this study indicated that the dmft score for the learners at the NSNP school was double that of the learners at the non-NSNP school. Based on this finding, the unmet treatment need of primary teeth was calculated by dividing the percentage of untreated caries by the caries prevalence (Van Wyk & Van Wyk, 2004). Using this formula, the unmet treatment of the learners at the NSNP School in this study, was 99,8% (i.e. 224/225), meaning these learners had evidence of carious activity on their primary teeth which needed some form of dental treatment, compared with 86% of learners at the non-NSNP school (i.e. 43/50). The unmet treatment need of learners at both schools was very high.

Figure 4.1 provides a pictorial comparative view of the oral health of the learners. The learners in the NSNP school appear to have higher DMFT scores, dmft scores, DMFT SCI index, and dmft SCI index.

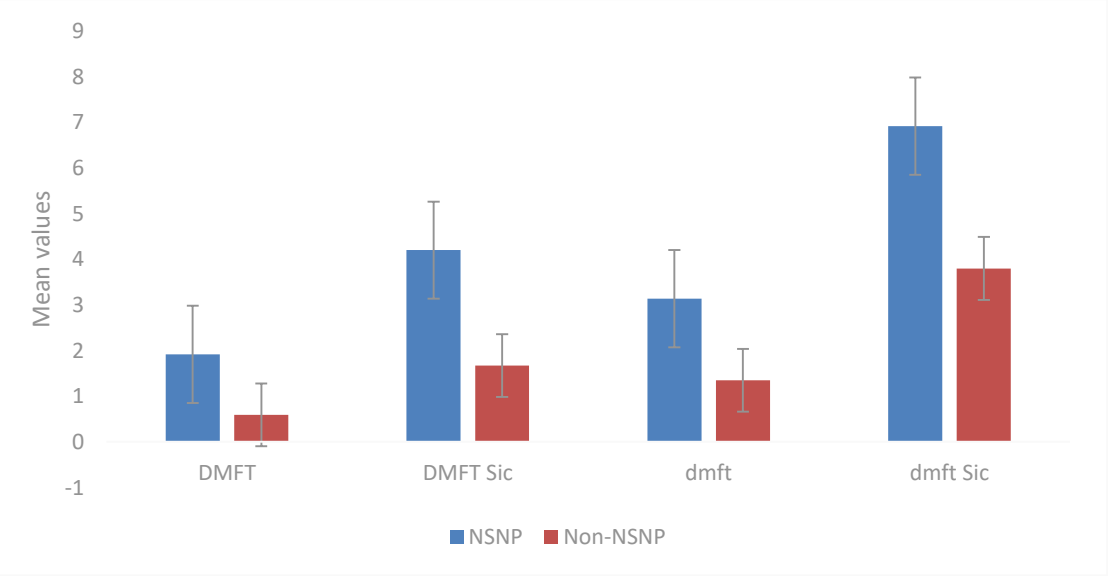


Figure 4.1: Permanent and primary dentition by school

Table 4.4 indicates a comparative view of the gingival index (GI) of learners at both schools. The learners in the NSNP school had higher mild, moderate, and severe GI scores of 33 (45.21%); 12 (16.43%); 5 (6.85%) respectively compared to the GI scores of 6 (17.64%); 0; 1 (2.94%) respectively of the learners from the non-NSNP school. However, only the mild and moderate GI scores were found to be statistically significant with a p-value < 0.0001. Please note that due to the COVID-19 pandemic learners were divided into groups and came to school in those groups on alternate days. Thus two of the NSNP school learners were not at school on the day the GI assessment was done, but were present on other days that data was collected.

Table 4.4: GI by school

Variable	NSNP school n (%)	Non-NSNP school n (%)	Comparison p-value
Healthy	21 (28.77)	27 (71.41)	< 0.0001
Mild GI	33 (45.21)	6 (17.64)	<0.0001
Moderate GI	12 (16.43)	0	<0.0001
Severe GI	5 (6.85)	1 (2.94)	0.1944

Figure 4.2 provides a pictorial comparative view of the oral health status of soft tissues of the learners. The learners in the NSNP school appear to have higher GI scores for mild GI, moderate GI, and severe GI.

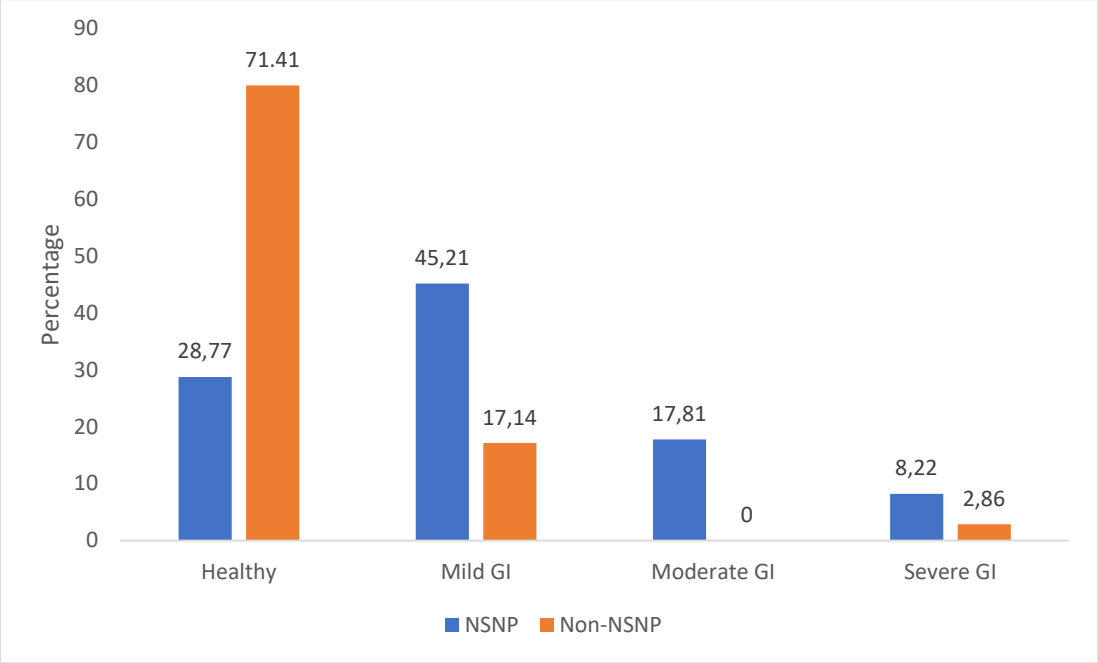


Figure 4.2: GI by school

The non-NSNP school had the most learners who had healthy gingiva, compared to the NSNP school; 71.41% of the learners had healthy GI in the non-NSNP school compared to 28.77% in the NSNP school. The NSNP school had the majority of the learners with mild GI (45.21%) followed by moderate GI (17.81%) and severe GI (8.22%). A GI score of healthy, mild, and moderate for learners at both schools was found to be statistically significant with a p-value less than 0.0001 while the severe GI score was found to be statistically insignificant.

4.3 Objective 2: Sugar Content

The second objective aimed to assess the sugar content of food consumed at both the NSNP and non-NSNP schools.

Table 4.5 shows results for the sugar content learners were exposed to in meals, either served as part of NSNP, brought from home, or bought from vendors. The total amount of sugar consumed by all the learners per day from the meals served at the NSNP school was 477.78 grams. The mean sugar consumption per day/per learner

served was 11.65 grams (SD=9.6) and 17.14 grams (SD=16.86) compared with meals brought or frequently purchased at the same school.

Table 4.5: Sugar content of food

Variable	Descriptive statistic	NSNP school	Non-NSNP school	Total
Total sugar content of meals served by school (g)/ per day*	Total (95%CI)	477.78 (353.52 - 602.04)	-	477.78 (353.5 - 602.04)
	Mean (SD)	11.65 (9.6)	-	11.65 (9.6)
Total sugar content of food consumed (g)/ per day**	Total (95%CI)	819.13 (647.05 - 1135.21)	1218.47 (863.71 - 1573.24)	2037.6 (1657.07 - 2562.13)
	Mean (SD)	17.14 (16.86)	35.84 (29.91)	52.98 (46.77)
	Comparison p-value			0.0001

* First row shows the learner's mean sugar consumption of meals served only at the NSNP School.
** Second row shows a comparison of the total mean sugar consumed from lunchboxes and frequently purchased items by learners from both schools.

The amount of sugar consumed by all learners per day from both schools from their lunchboxes and frequently purchased items was 2 037.6 grams. A greater proportion of the above-mentioned sugar consumption was by the learners from the non-NSNP school, who consumed a total of 1 218.47 grams of sugar compared to 819.13 grams of sugar by the NSNP school learners. The mean sugar consumed was 35.84 grams (SD=29.91) per learner/ day from the non-NSNP school compared to the NSNP school learners who had an average of 17.14 grams (SD=16.86) per learner/per day, which is approximately double the amount of sugar consumed from lunchboxes and frequently purchased items at school by learners from the non-NSNP school. There was a statistically significant relationship found in the sugar consumption of learners at both schools, with a p-value of 0.0001. Tables 4.6 and 4.7 gives an indication of the difference in lunchbox content and frequently purchased items by learners at both schools.

Table 4.6: Sample of lunchbox contents by school

Lunchbox Content Non-NSNP School	Lunchbox Content NSNP School
2 slices white bread, fried chips, tomato sauce, 1 pack mini tennis biscuits, cucumbers and salt, caramel popcorn, water	2 slices brown bread, peanut butter, rama, 2 scones
2 slices white bread with nutella, salt & vinegar potato chips, 2 vanilla biscuits, water	2 slices brown bread, peanut butter
Yogurt, chips, 4 Oreos. Oros juice, 2 slices white bread with peanut butter and jam	baked cakes, apple, oros juice, chips, lollipop
2 slices toasted white bread, 3 oreos. doughnut, mango juice, water	2 slices white bread with polony, water, popcorn
2 beef burgers, Oros juice	2 slices brown bread with cheese, oros
4 vanilla oreos, 2 hotdogs, 2 apple juices	2 vetkoeks, polony
pie, apple juice	2 slices white bread, apple juice
beef burger, chocolate cake, water	noodles, oros, orange, naartjie, banana

Table 4.7: Sample of frequently purchased items by school

Frequently Purchased Items Non-NSNP School	Frequently Purchased Items NSNP School
popcorn	pie, hotdog
peanuts & raisins	Sweets or chocolates
fruit	Pie, hotdog, packet of chips, popcorn or snack
kota/bunny chow	Sweets or chocolates
peanuts	Packets of chips, popcorn or snack
1 packet of potato chips	Sweets or chocolates, packet of chips, popcorn or snack
1 cup fried chips	Packets of chips, popcorn or snack
1 can sprite zero	Pie, hotdog, packet of chips, popcorn or snack
1 biscuit	Packets of chips, popcorn or snack

4.4 Objective 3: Relationship between Sugar Content and Oral Health

The third objective aimed to assess the relationship between the sugar content of food consumed and the oral health status of learners at both the NSNP and non-NSNP schools.

Table 4.8 illustrates the correlation between the sugar content values of food consumed by learners and their oral health status at the schools using Pearson's correlation analysis. The sugar content of meals served increased with an increase in DMFT, while the dmft and GI showed a decrease with an increase in sugar content served among the NSNP school learners. Among the non-NSNP school learners, the sugar content consumed increased with an increase in dmft while both the GI and DMFT showed a negative relationship. None of the relationships in either school was significantly correlated.

Table 4.8: Relationship between sugar content and oral health status

Variable	Total sugar content of meals served (g)/per day		Total sugar content of food consumed (g)/per day	
	Correlation coefficient	p-value	Correlation coefficient	p-value
NSNP school				
DMFT	0.0373	0.8144	0.0958	0.4907
dmft	-0.2098	0.1823	-0.1466	0.2901
GI	-0.0686	0.6698	-0.1409	0.3142
Non-NSNP school				
DMFT	-	-	-0.0706	0.6823
dmft	-	-	0.1723	0.3149
GI	-	-	-0.0188	0.9133

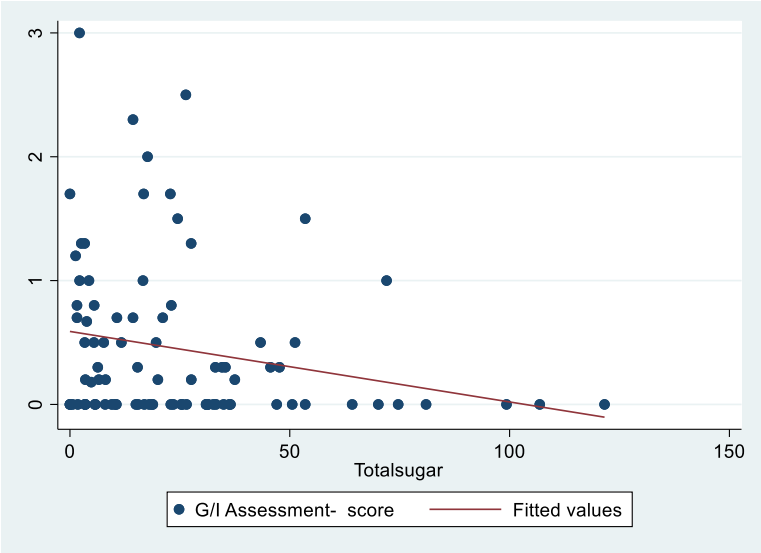


Figure 4.3: GI score and consumed sugar content

When stratified at school level, a decrease was observed in the GI score at both schools with an increase with sugar consumed as shown in Figure 4.3. However, no statistical significance was found at either school.

4.5 Objective 4: Relationship between Sugar Content and BMI

The fourth objective aimed to assess the relationship between the sugar content of food consumed and the BMI of learners at both the NSNP and non-NSNP schools.

Table 4.9 indicates that the unhealthy learners in the NSNP school consumed a higher sugar content of 20.85 grams (SD=17.89) compared to the sugar content of the meals served of 12.98 grams (SD=9.5) but this was not significantly different (p-value= 0.3638). The unhealthy non-NSNP school learners had mean total sugar content of food consumed of 36.8 grams (SD=32.29), which was higher than the mean total sugar of the unhealthy learners in the NSNP school of 20.85 grams (17.89) but this was also not statistically significant (p-value= 0.8362).

Table 4.9: Relationship between sugar content and BMI

Group of School	Variables	Total sugar content of meals served (g)/ per day	Total sugar content of food consumed (g)/ per day
NSNP school Mean (SD)	Healthy BMI	11.28(9.7)	15.9(16.6)
	Unhealthy BMI	12.98(9.5)	20.85(17.89)
	P-value	0.644	0.3638
Non-NSNP school Mean (SD)	Healthy BMI	-	34.62(27.65)
	Unhealthy BMI	-	36.8(32.29)
	P-value	-	0.8362

4.6 Objective 5: Relationship between BMI and Oral Health Status

The fifth objective aimed to assess the relationship between the BMI and the Oral Health Status of learners in both the NSNP and non-NSNP schools.

Table 4.10 shows the relationship between the BMI categories of learners and their oral health status using independent t-test. The tabulated results suggested that regardless of the school, the healthy learners had a higher mean value GI score compared to the unhealthy learners. Moreover, the unhealthy learners had a higher mean DMFT and dmft score compared to the healthy learners. When stratified at school level, unhealthy learners in both schools had higher DMFT scores of 2.47 (SD=2.95) among learners from the NSNP school and 0.74 (SD=1.79) among learners from the non-NSNP school. Similarly, the dmft score was higher among the unhealthy learners compared to the healthy learners in both schools, 3.26 (SD=2.78) in the NSNP school and 1.53 (SD=3.56) in the non-NSNP school. Furthermore, healthy learners from the NSNP school had a higher mean GI of 0.77 (SD=0.79) while the unhealthy learners from the non-NSNP school had a higher GI of 0.16 (SD=0.58). However, none of the mean differences were statistically significant.

Table 4.10: Relationship between BMI and oral health status

Variable	BMI: Healthy Mean (SD)	BMI: Unhealthy Mean (SD)	P-value
DMFT			
NSNP school	1.71(1.9)	**2.47(2.95)**	0.198
Non-NSNP school	0.4(0.74)	0.74(1.79)	0.4997
dmft			
NSNP school	**3.05(3.58)**	**3.26(2.78)**	0.8183
Non-NSNP school	1.13(1.64)	1.53(3.56)	0.696
GI score			
NSNP school	**0.77(0.79)**	**0.59(0.71)**	0.4032
Non-NSNP school	0.09(0.15)	0.16(0.58)	0.677

Table 4.11 shows how the variables such as age, gender, sugar consumption, and BMI interact with oral health. From the obtained results, there was no significant interaction between DMFT, dmft, age, gender, and BMI. In terms of GI, an increase in sugar consumed was significantly associated with decreased GI scores of -0.01(-0.011 to -0.0002) p=0.041, and -0.001(-0.01 to -0.0003) p=0.039, for univariate and multiple regressions respectively.

Table 4.11: Variables associated with oral health status

Variable	Univariate regression		Multiple regression	
	Coefficient (95%CI)	**p-value**	**Coefficient (95%CI)**	**p-value**
DMFT				
Age	-0.03(-0.53 to 0.48)	0.916	-0.216(-0.83 to 0.39)	0.485
Sugar consumed	-0.01(-0.02 to 0.01)	0.447	-0.01(-0.03 to 0.01)	0.514
Male	Reference (0)		Reference	
Female	0.22(-0.57 to 1.01)	0.581	0.114(-0.79 to 1.02)	0.804
Healthy BMI	Reference		Reference	
Unhealthy BMI	0.18(-0.66 to 1.01)	0.677	0.17(-0.79 to 1.14)	0.72
dmft				
Age	-0.63(-1.42 to 0.15)	0.113	-0.59(-1.56 to 0.37)	0.224
Sugar consumed	-0.01(-0.04 to 0.01)	0.291	-0.02(-0.05 to 0.01)	0.294
Male	Reference		Reference	
Female	-0.67(-1.91 to 0.58)	0.292	-0.69(-2.12 to 0.74)	0.342
Healthy BMI	Reference		Reference	
Unhealthy BMI	-0.25(-1.58 to 1.08)	0.712	-0.61(-2.14 to 0.91)	0.424
GI				
Age	0.11(-0.07 to 0.28)	0.231	0.13(-0.06 to 0.32)	0.172
Sugar consumed	-0.01(-0.011 to -0.0002	***0.041**	-0.001(-0.01 to -0.0003	***0.039**
Male	Reference		Reference	
Female	0.037(-0.24 to 0.32)	0.79	0.03(-0.25 to 0.31)	0.821
Healthy BMI	Reference		Reference	
Unhealthy BMI	-0.244(-0.54 to 0.05)	0.099	-0.13(-0.43 to 0.16)	0.365

Chapter 5 DISCUSSION

A low response rate was expected due to the timing of the study (June 2021 to October 2021) which occurred during the COVID-19 pandemic amid the second wave of infections in Gauteng, South Africa. The Department of Education (DOE) was reluctant to provide approval for this research project and only gave approval at the end of the second wave (almost three months had lapsed from the time of the application for permission to do this study to the time of approval). This was due to the tight infection control protocols adopted in line with World Health Organisation (WHO) recommendations on standard precautions for infection control. Despite approval, there was still reluctance and fear by both parents and learners to participate in any additional activities in school due to the risk of exposure.

5.1 Summary of Results

The findings of this study address the gap in understanding the impact of the school food environment and learner food preferences on oral health. A sample size of 235 learners was required to participate for a 95% confidence interval in the study. However only (n=115) participated in the study, hence a response rate of 49%. Due to missing information in data collected from eight participants, only data from 107 participants was ultimately used for this study.

5.2 Socio-Demographic and Anthropometric Profile

In this study, the mean age of participants was 8.69; there were 54.2% females and 45.8% males. When stratified at school level the mean body mass index (BMI) scores of learners at both schools classified them as being overweight, with readings of 17,51 (SD=3,1) and 19,64 (SD=4,14) at the NSNP and non-NSNP schools respectively, with a major contributor being learners from the non-NSNP school. In addition, some learners were found to be at risk of becoming obese (Wiles et al., 2011). For many children, particularly those in low-income settings, the food served in schools represented their only regular meal of the day, making school meal programs relevant to achieving the second Sustainable Development Goal (SDG) of ending hunger (Wineman et al., 2022). Over the years, South Africa has also

undergone a nutrition transition in favour of processed foods, with limited consumption of fruit and vegetables and high levels of sugar intake (Wineman et al., 2022). As a result, the prevalence of overweight and obese children has been on the rise in rural areas (Jinabhai et al., 2003).

According to the school nutrition policy from the DoE, schools that participate in the NSNP, have learners from poor families (quintile one to quintile three schools). Table 4.2 gives an indication of the socio-economic status of family members in households of learners from both schools. Only 5% family members out of (n= 73) learners in the NSNP school were formally employed, which implies that the majority of families have no stable income. Additionally literature indicates that there is a direct relationship between household income and BMI in children. Findings showed an increased likelihood of children being overweight or obese being associated with per-capita household income (Asim, & Muhammad, 2020).

It is well documented that individuals with high household income can afford healthier food and have higher purchasing power (Liu et al., 2016). Similarly, leisure pursuit and sedentary lifestyle including transport are common in high-income families (Asim, & Muhammad, 2020). This is the case for overweight learners from the non-NSNP school; however, the overweight learners from the NSNP school come from families experiencing food insecurity (FI) ,who often rely on low-cost, processed, calorie dense foods (Eagleton et al., 2021), such as fast foods rich in fats and refined sugars. Their intake of cheap and refined sugars from vendors outside the school premises is most likely all they can afford.

5.3 Oral Health Status

Learners from the NSNP school had higher caries prevalence in primary teeth than permanent teeth. These learners presented with a higher mean dmft reading of 3 (SD=3.39) compared to a reading of 1.4 (SD=2.84) of the learners from the non-NSNP school. This was statistically significant with a p-value of 0.018. Possible reasons for the high prevalence of caries in primary teeth of learners from the NSNP school could be a result of combination of factors. Diet quality, feeding patterns at home and at school during early childhood, and oral hygiene practice could have influenced the presence of dental caries and its severity (Anderson et al., 2022).

Literature has also shown that oral hygiene levels are predictors of caries frequency and intensity (Cleaton-Jones et al., 2000; Van Loveren & Duggal, 2001; Walker, 1995). Good oral hygiene practices and preventative measures such as fluoridation and dental sealants can alter the oral environment and enhance saliva flow, neutralising the contribution of a high carbohydrate diet. However, in the absence of oral hygiene practices, as seen among many low-income populations, the diet rich in carbohydrates remains a key factor in caries development (Van Loveren & Duggal, 2001). Additionally, lack of access to oral health care and low levels of oral health literacy among caregivers are also contributing factors (Anderson et al., 2022).

These findings correlate with the rising index of unmet treatment needs among children of this age group and younger in South Africa. As calculated in the results section, the unmet treatment need of primary teeth at the NSNP and non-NSNP schools was found to be very high at 99.6% and 86% respectively. These findings were similar to those found in a study done by Molete (2019) in Tshwane that looked at the dental status of children receiving school oral health services. Furthermore, the most current regional data appears to be showing a similar pattern, over 80% of caries among six year old children is reported as being untreated (Mohamed & Barnes, 2018; Singh, 2011; Van Wyk & Van Wyk, 2004).

A gingival index (GI) score of healthy, mild, and moderate for learners at both schools was found to be statistically significant with p-value less than 0.0001 while the severe GI score was found to be statistically insignificant. The findings of this study showed that there was an increased number of mild and moderate GI cases at the NSNP school compared to the non-NSNP school. At both schools, few learners had severe GI cases. Possible reason for these findings at the NSNP school could be the result of lack of access to oral heath cleaning aids, where parents or guardians of learners may not be able to afford to buy their children toothbrushes or toothpaste; even providing a meal at home can pose as a challenge (Wineman et al., 2022). This, combined with poor hygiene practices, led to the learners developing mild to moderate gingivitis. Studies have shown that high plaque volume combined with gingivitis is associated with high sucrose intake as compared to low sucrose diets (Jakubovics et al., 2021).

5.4 Sugar Content of Food Consumed

An overall amount of 2 109.6 grams of sugar was consumed by learners on a daily basis, with the mean sugar consumed per learner being 24.53 grams. The American Heart Association (AHA) recommends that children two to eighteen years should limit their added sugar consumption to less than six teaspoons (25 grams) per day (Vos et al., 2016). This indicates that the sugar consumption by learners remains fairly high even though it's slightly lower than the AHA recommendation. When the results were stratified at school level, the learners at the non-NSNP school were found to consume more food items and beverages with high sugar content from their lunchboxes compared to the learners from the NSNP school who frequently purchased food items high in sugar content outside the school premises. The findings of the study also showed that there were plenty of challenges identified in terms of promoting a healthy school food environment at both schools. Literature has also shown that there is little control from the school health environment when it comes to the food choices made by parents who pack the lunchboxes of the learners and the learners themselves who purchase from school vendors (De Villers & Faber, 2015).

The study additionally found that the difference in the mean sugar consumption of meals served compared to the sugar consumption of lunchboxes by learners at the NSNP School was very small (5.49 grams per day). Implications may be that, as much as the school purchasing environment of the learners at the NSNP school was not well regulated, it is possible that the content of the lunchboxes, could have also been a major contributing factor in the caloric and cariogenic diet intake. However, further studies are required to determine such an association. A comparison of lunchbox content and frequently purchased items by learners from both schools is indicated in Tables 4.6 and 4.7.

However, when comparing the sugar consumption of lunchboxes and frequently purchased items between the learners from these two schools, the mean sugar consumed was 35.84 grams (SD=29.91) per learner/per day from the non-NSNP school, compared to the NSNP school learners who had an average of 17.14 grams (SD=16.86) per learner/per day. That is about double the amount of sugar consumed by learners at the non-NSNP school from lunchboxes and frequently purchased items

at school. There was a statistically significant relation found in the sugar consumption of learners at both schools, with a p-value of 0.0001.

The contents of the lunchboxes of the non-NSNP school were mostly sugar sweetened beverages, snacks, sugar rich and fatty foods, as well as sweets compared to the learners from the NSNP school, who mostly brought two to four slices of bread with polony, and sugar rich foods (see Tables 4.5 and 4.6). This is reflective of the possible low levels of nutritional literacy for the caregivers of the learners in terms of healthier food items that the learners could carry in their lunchboxes or purchase at school. Research has indicated that caregivers' nutritional knowledge and opinions affect the type of food they provide to children in their care; however, factors that typically influence the food selection of caregivers include age, marital status, level of education, and employment status (Hansen et al., 2022).

5.5 Relationship between Sugar Content and Oral Health Status

The results indicated an inverse relationship between sugar content of food consumed and the GI score of the learners at both schools. When stratified at school level, a decrease was observed in the GI score at both schools with an increase of sugar consumed shown (Figure 4.3). However, no statistical significance was found.

Some literature has shown an association between gingivitis and the daily consumption of sugars in primary school children. Hence, the findings of an inverse relationship of sugar consumption and gingivitis in this study is contrary to the findings by Jaghasi et al. (2012); which looked at the association between dietary patterns and oral health in primary school children from Damascus. Jaghasi et al. (2012) found that severe gingivitis was more frequent in children who reported to consume sugars more than seven times a day (40%) versus 22% who consumed sugar three or less times per day, (P=0.003). A study by Jakubovics et al. (2021) documents that high plaque volume has associated gingivitis with high sucrose intake as compared to low sucrose diets. The metabolism of dietary sucrose leads to an inflammatory response and tissue destruction. The outcome of these interactions leads to the development of dental disease, such as gingivitis or periodontitis, (Jakubovics et al., 2021).

As a limitation, perhaps the sample size of this study influenced the findings of an inverse relationship of sugar consumption and gingivitis and as such further studies need to be done on a larger sample size to establish a cause and effect relationship between the sugar consumption and gingival health status of primary school learners.

5.6 Relationship between Sugar Content and BMI

In this study, table 4.9 indicated that sugar was found to have a positive correlation BMI scores at the NSNP school, which meant that as sugar increased, BMI increased. This is supported by literature that has shown that a significant proportion of children and adolescents who had high consumption of added sugars increased the probability for most youth being overweight or obese irrespective of other dietary or macro-nutrient intakes (Magriplis, et al., 2021).

Although evidence has shown that feeding programs at schools have assisted in combating malnutrition in South Africa (Steyn et al., 2022), it has not been able to prevent learners from becoming overweight or obese. Another salient finding from the 2019 global survey of the school feeding program was the limited attention given to overweight/obese children in school meal programs in Africa, with just 10% identifying obesity prevention as an objective (Wineman et al., 2022).

Literature has stated several reasons for the current school environment in South Africa not being able to prevent learners from becoming overweight and obese. First, the NSNP did not provide sufficient fruit and vegetables to learners in school meals. Second, unhealthy food items were being sold to learners at the tuckshops and outside vendors. Three, the contents of lunchboxes had one or two sugar sweetened food or beverages, which learners consumed on a daily basis (Faber et al., 2013). These findings were in line with previous studies in similar settings, which were found to be contributory factors to learners being unhealthy. These studies also suggested that additional barriers included the inability of vendors to store perishable fruits and vegetables for long periods of time and also the children’s preference for unhealthy food (Faber et al., 2013).

5.7 Relationship between BMI and Oral Health Status

In this study, the DMFT and dmft of unhealthy learners at the NSNP school was found to be high but no significant relationship was found at school level between BMI and oral health status. These findings differed to the findings of a study done by Markovic et al. (2015), where the study looked at the association between being overweight and oral health in Serbian schoolchildren. In spite of poor oral hygiene, overweight children and adolescents (12 to 18 years) were found to have significantly more healthy primary and permanent teeth than those of normal weight. The study by Markovic et al. (2015) also found a positive correlation of significantly higher GI ($p<0.001$). Children and adolescents of normal weight had a significantly higher average number of decayed, filled permanent teeth and missed primary teeth ($p<0.01$), as well as a higher DMFt/dmft index ($P<0.001$) compared to the ‘at risk of being overweight’ and ‘overweight’ participants (Markovic et al., 2015).

Univariate and multivariate linear regression models were used to assess other variables associated with oral health of the learners in both schools. The variables looked at were age, sugar consumption, gender, and BMI. In order to establish an association between oral health status and a specific variable, the other variables were adjusted for. The only significance found in the results was a unit increase in sugar content consumed reduced the GI score by 0.0001. The aforementioned result, was found to be statistically significant ($p=0.041$). No other significance was found with the association of other above-mentioned variables with DMFT or dmft.

Some studies indicated that after adjusting for age, sugar content, gender and BMI , a positive association was found between DMFT and being overweight as was the case in the study by Markovic et al. (2015) on Serbian school children; however, there was no statistical significance. A positive association was also found between GI and age in the study. However, a negative correlation between body weight and dental caries was found in the third National Health and Nutrition Examination Survey (NHANES III) undertaken in the USA (Sohn et al., 2006). In addition, Willerhausen et al. (2007) demonstrated a significant positive association between the frequency of caries and body weight.

5.8 Limitations of the Study

This was an observational study and learners who brought lunchboxes to the NSNP school were not controlled. This limited us from being able to provide the impact of school nutritional feeding programs on dental health of learners. However, the information gathered provided insight into the level of sugar consumed at school settings.

Second, the sample size was small particularly among the learners in the non-NSNP school and hence the data from the two schools had to be combined in order to have a meaningful analysis.

Chapter 6 CONCLUSION

School meal programs address objectives related to health and nutrition by reducing hunger and improving children's micro-nutrient status with diverse menus and food fortification; particularly in low income settings. Based on the findings of this study a conclusion could be made that the learners at both the NSNP and non-NSNP schools consumed a high concentration of sugary foods and drinks mainly found in their lunchboxes and frequently purchased food items and beverages.

Literature has shown that fruit tuck shops on their own did not change children's snacking behaviour, but when combined with applicable school policies on the types of foods children were allowed to bring to school, had a greater impact. The NSNP acts as a safety net for disadvantaged school-going children, ensuring that they have access to a balanced nutritious meal daily. However ,it is necessary that the programs also endeavour to create a healthy school food environment, which would enable the learners to make healthy choices.

It is recommended that the Department of Health and the DoE work together and look into effective strategies that could assist all schools to have better control of what learners consume during school hours. These strategies could include having a school cafeteria with served meals, a well-managed tuck-shop, and consistently monitored vendors outside the school premises, as well as providing better stalls for outside vendors thus enabling the storage of healthier foods. In addition, health promotion programs which educate the tuckshop manager, outside vendors, school staff, and learners on the importance of creating a healthy school environment by providing healthy nutritious meals for learners and the importance of assisting learners to make healthier food choices, should be promoted. This would contribute to a healthier school environment for the learners and prevent or reduce non-communicable diseases such as dental caries, diabetes, and obesity in young children.

Further studies are needed, with bigger sample sizes, to establish associations among the food choices and oral health status of learners to assist in effective oral health promotion in schools and in turn provide a school food environment conducive to learners' health.

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Appendix A: Observational Checklist

Section 1 – School Details

1.	**Name of School**	
2.	**Is the school part of the NSNP**	
3.	**No of Grade 3 learners**	
4.	**No of Grade 3 learners on NSNP**	
5.	**Observer ID**	
6.	**Contact ID & number**	
7.	**Date**	
8.	**Comments**	

Section 2 – School Surroundings

Section 2.1 Food / Beverage Availability
How many food / beverage stores are in total within 50m of the school boundary? _____ Type and number: Fixed store _____ Spaza shop _____ Informal vendor_____ Fast food_____ Are SS food and drinks (junk food) on sale? _____ Are SS Food & Beverage alternatives (healthier food) on sale? _____ Are there advertised brands at the food / beverage stores? Y N If yes, what type of food/ beverage is being advertised? _____

Section 3 – School Grounds

Section 3.1 – Food / Drink Availability

Are there functioning water fountains and / tap water dispensers in the school building?

☐ Yes ☐ No

How many tuck shop / snack shops at the school? _____

Are there advertised brands at the food / beverage stores? Y N

If yes, what type of food/ beverage is being advertised? _____

Tuck shop / snack shop 1.

Please indicate the items that are sold by the tuck shop from the list provided: Y/N

☐ Sweets	☐ Bottled water
☐ Chocolates	☐ Flavoured bottled water
☐ Simba chips	☐ Flavoured ice tea
☐ Regular can or bottled fizzy drinks	☐ Energy drinks (can or bottled)
☐ Diet can or bottled fizzy drinks	☐ Cooked meals (protein, veges, starch)
☐ 100% Fruit juice	☐ White bread sandwiches
☐ Diluted juice (Oros)	☐ Brown bread sandwiches
☐ Fresh fruits or salads	☐ Hamburgers
☐ Pastries (pies, vetkoek, doughnuts, sausage roll)	☐ Ice sucker / lollies
☐ Kota / Bunny chow	☐ Bunny licks
☐ Slap chips / chip roll	☐ Ice Cream
☐ Other _____	☐ Other _____

Vending Machines

Are there vending machines at the school? ☐ Yes ☐ No

If yes, complete the following section:

Please indicate the items that are sold by the tuck shop from the list provided: Y/N

☐ Sweets	☐ Bottled water
☐ Chocolates	☐ Flavoured bottled water

☐ Simba chips	☐ Flavoured ice tea
☐ Regular can or bottled fizzy drinks	☐ Energy drinks (can or bottled)
☐ Diet can or bottled fizzy drinks	☐ Cooked meals (protein, veges, starch)
☐ 100% Fruit juice	☐ White bread sandwiches
☐ Diluted juice (Oros)	☐ Brown bread sandwiches
☐ Fresh fruits or salads	☐ Hamburgers
☐ Pastries (pies, vetkoek, doughnuts, sausage roll)	☐ Ice sucker / lollies
☐ Kota / Bunny chow	☐ Bunny licks
☐ Slap chips / chip roll	☐ Ice Cream
☐ Other _____	☐ Other _____

Appendix B: Questionnaire

Part 1: Demographic Information (Interview participant)

☐ Boy ☐ Girl

Weight: _____ Height: _____ BMI: (WxH) _____

1. How old are you? _____

2. How many people do you live with at home? _____

3. How many of these people work? _____

4. What type of work does each person do? **Eg. Mom is a nurse Dad is a fireman**
_____
_____
_____
_____

5. Which items do you have at home?

		Tick what they have			Tick what they have
a.	Daily newspapers		i.	Stove	
b.	Weekly magazines		j.	Internet access	
c.	Radio		k.	Video / DVD player	
d.	TV set		l.	Refrigerator	
e.	Computer / laptop		m.	Car	
f.	Tap water (cold)		n.	Electricity	
g.	Tap water (hot)		o.	Flushing toilet	
h.	House made of bricks		p.	Cellphone	

8. Do you eat breakfast before school starts? ☐ Yes ☐ No

9. Do you carry a lunchbox to school? ☐ Yes ☐ No

10. Do you carry money to school? ☐ Yes ☐ No

Part 2: Questionnaire (Interview participant)

If the learner's answer's to Part 1 (Question 9 & 10) is yes, you do not need to complete Part 2.1 and can carry on with Part 2.2. If learner has answered no or nor responded, please carry on with Part 2.1.

Part 2.1: (Interview participants – NSNP learners)

School Feeding Scheme Programme

Do they serve a cooked meal/s at school? ☐ Yes ☐ No

How many times a day are meals served at school?? ☐ Once ☐ Twice

Do you fetch the cooked meal/s when its served? ☐ Yes ☐ No

If yes, what was served today?

_____

_____

(This section will be calculated by researcher based on above answers)

Estimated sugar intake of meal served at school: (Based on the sum of sugar content in each food item)

Item 1: _____ Calories (cal): _____ Sugar (g): _____

Item 2: _____ Calories (cal): _____ Sugar (g): _____

Item 3: _____ Calories (cal): _____ Sugar (g): _____

Item 4: _____ Calories (cal): _____ Sugar (g): _____

Item 5: _____ Calories (cal): _____ Sugar (g): _____

Item 6: _____ Calories (call): _____ Sugar (g): _____

Total calories and sugar intake of learner:

Calories (cal):_____ **Sugar (g):**_____

Part 2.2: (Interview participants – both NSNP and non-NSNP school learners)

Tuck Shop / Vending Machine or Other School Vendors Purchasing Habits

Where do you buy food and drinks at school?

		Tick one or more:
1.	School Tuck Shop	
2.	Vending machine	
3.	Other school vendor	

How many times in a day do you buy from the tuckshop / vending machine or other school vendor?

		Tick one
a	Every day (Break time)	
b	Twice a day (Break time and afterschool)	
c	Once a week	
d	Twice a week	
e	More than twice a week	

How much money do you usually have to spend at the tuck shop? _____

Who gives you money to buy at the tuck shop?

		Tick one / more:
a	My parents / guardians give me	
b	I use my own money (savings)	
c	I borrow money from a friend	
d	Other: _____	

Do you bring packed lunch or food from home to eat during the school breaks?

☐ Yes ☐ No

If yes, what is inside your lunch box?

_____
_____
_____
_____

Who prepares your lunch box at home?

		Tick one
a	A family member/ guardian	
b	The nanny / person who works at home	
c	I make my own lunch	

d	Other:_____	

What do you usually buy at the tuck shop? You can tick more than one.

		First Break	Second Break
a	Something to drink		
b	Something to eat eg pie, hotdog		
c	Sweets or chocolates		
d	Packet of chips, popcorn or snack		
e	Fruit		
f	Other: _____		

Why do you buy the above chosen items?

		Tick one or more:
a	The person looking after me at home told me I can buy these items	
b	My friends buy these items	
c	The item is my favourite thing to eat	
d	I think this item will keep my body healthy	
e	I don't like what I brought in my lunchbox	
f	I am not allowed to eat or drink this item at home	
g	Other reason:_____	

When you buy something to drink what do you usually buy?

		First Break	Second Break
a	Regular can or bottled fizzy drinks e.g. Coke		
b	Diet can or bottled fizzy drink e.g. Sprite Zero		
c	100% Fruit Juice		
d	Diluted Juice e.g. Oros		
e	Bottled water		
f	Flavoured water		
g	Flavoured ice tea		
h	Energy drinks e.g. Energade		
i	Other: _____		

If you buy sweets or chocolates, what do you buy most often?

		First Break	Second Break
a	Loose sweets: Fizzers, Suckers, Liquorice		
b	Packet of sweets: Jelly beans, Jelly babies, toffees		

		First Break	Second Break
c	Energy bar: Jungle oats		
d	Cereal bar: Coco Pops		
e	Chocolate bar: Bar one		
f	Chocolate – Mini bar		
g	Other: _____		
h	I do not buy any sweets or chocolates		

If you buy something to eat, what do you buy most often?

		First Break	Second Break
a	Small packet of corn chips (Frinax, nicknaks)		
b	Normal size packet of corn chips (Fritos, Doritos)		
c	Potato Chips (Simba, Lays, Willards)		
d	Pastries: Pie, Samoosa, doughnut, vetkoek, koek suster		
e	Muffin: Chocolate, blueberry		
f	Biscuits / Homemade crunchies		
g	Dried fruit		
h	Popcorn		
i	Peanuts		
j	Peanuts & Raisins		
k	Jelly & Custard		
l	Pretzels		
m	Fruits		
n	Yoghurt		
o	Toasted Sandwich		
p	Hot dog		
q	Hot chips/ French fries / slap chips		
r	Beef burger		
s	Pizza		
t	Assorted filled salad rolls		
u	Kota / Bunny chow		
v	salads		
w	Cooked meal with starch, veges and meat		
x	Other: _____		

(This section will be calculated by researchers based on above answers)

Estimated sugar intake of purchased food items at school / lunch box content: **(Based on the sum of sugar content in each food item)**

Item 1:_____ Calories (cal):_____ Sugar (g):_____

Item 2:_____ Calories (cal):_____ Sugar (g):_____

Item 3:_____ Calories (cal):_____ Sugar (g):_____

Item 4:_____ Calories (cal):_____ Sugar (g):_____

Item 5:_____ Calories (cal):_____ Sugar (g):_____

Item 6:_____ Calories (cal):_____ Sugar (g):_____

Total calories and sugar intake of learner:

Calories (cal):_____ Sugar (g):_____

Part 3 – Oral Health Survey Form (Examine Participant)

Dental Status

Permanent Teeth (DMFT)

18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38

Primary teeth (dmft)

55	54	53	52	51	61	62	63	64	65
85	84	83	82	81	71	72	73	74	75

0 = Sound

1= decayed

2= filled & decayed

3= filled, no decay

4= missing due to caries

5= missing for any other reason

6= sealant, varnish

7= bridge abutment/ special crown

8= unerupted tooth

9= excluded tooth

Gingival Index Assessment:

Surface	16	12	24
d/ facial			
Facial			
m/facial			
palatal			
Total			
	44	**32**	**36**
d/facial			
facial			
m/facial			
lingual			
Total			

Gingival index for individual teeth=

$$\frac{\text{Total of gingival index of each tooth}}{\text{No. of teeth present}}$$

Note: max score=3

Interpretation:

Score	Condition
0.1-1.0	Mild Gingivitis
1.1-2.0	Moderate gingivitis
2.1-3.0	Severe gingivitis

1. Do you have a toothbrush and toothpaste at home?

Yes	No

If you don't have, why?

_____

2. How often does your parent help you brush your teeth after meals?

		Tick one:
a	No brushing	
b	At least 1	
c	Twice a day	
d	Three times a day	
e	I don't know	

3. When, during the day, do you brush your teeth?

		Tick one:
a	Morning	
b	Before meals	
c	After meals	
d	Before bedtime	

4. How often do you brush your teeth?

		Tick one:
a	At least 1	
b	Twice a day	

c	Three times a day	
d.	I don’t know	
e	No brushing	

5. If no brushing, reasons for inability to maintain oral hygiene

“I don’t know how to brush” ☐

“I forget” ☐

Other ☐

Appendix C: Provisional Study Approval

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

23 January 2021

To Whom It May Concern

SUBJECT: **CONFIRMATION OF PROVISIONAL STUDY APPROVAL**
(This letter is not a clearance certificate – not yet cleared)
Protocol Ref No: M201120
Protocol Title: School dietary habits and the oral health status of primary school learners in Johannesburg, South Africa
Principal Investigator: Dr Octavia Lebele
Department: Oral Health

This letter serves to confirm that the Human Research Ethic s Committee (Medical) has provisionally approved the above mentioned study. In order for a clearance certificate to be issued, the researcher is required to submit written approval to conduct the study in your district/institution.

The researcher has been informed that this letter is not a clearance certificate and that the study cannot commence without your approval and receipt of a clearance certificate from the HREC (Medical).

Should you have any queries, you may contact me at tel: 011 717 1234/2700/2656 or by email Rhulani.Mkansi@wits.ac.za or HREC-Medical.ResearchOffice@wits.ac.za

Yours Faithfully,

.....

Mr Rhulani Mkansi
Administrative Officer
Human Research Ethics Committee (Medical)

23 JAN 2021

Research Office Secretariat: Faculty of Health Sciences, Phillip Tobias Building, 3rd Floor, Office 304, Corner York Road and 29 Princess of Wales Terrace, Parktown, 2193 Private Bag 3, Wits 2050 | T+27 (0)11-717-1234/2656/2700/1152 | Rhulani.Mkansi@wits.ac.za | Office & HREC-Medical.ResearchOffice@wits.ac.za | Website: www.wits.ac.za/research/about-wits-research/ethics-and-research-integrity/

Appendix D: Participation Information Sheet

Participation Information Sheet for Parent / Guardian

Dear Parent / Guardian

RE: **Consent for your child to participate in study**

I am a registrar of the Discipline of Community Dentistry at the University of Witwatersrand, Johannesburg. I am studying toward my MDent and my research topic is entitled "**School dietary habits and the oral health status of primary school learners in Johannesburg, South Africa.**"

I will be conducting my study in four randomly selected public primary schools and data will be collected as follows: All grade three learners at each respective school will be interviewed. After the interview all of the Grade 3 learner's mouths will be examined, and their height and weight will also be measured.

Since your child is a grade 3 learner in one of the selected schools, I humbly request permission to interview and examine your child's mouth, as well as measure their height and weight. I will explain what the study is about and how we will conduct the study to each participant after receiving permission from their parent or guardian. The examination will be a 10-minute pain free procedure using a dental mirror. Should the child feel any discomfort or would like me to stop what I am doing; they are welcome to let me know.

Please note that all COVID-19 protocols will be adhered to and we will ensure that all children are wearing masks and that a sanitizer is available for them to use. All researchers will be wearing the necessary PPE gear before interviewing and examining all the participants.
Should you agree that your child may participate, I request that you sign the consent letter below. I will also request assent from the learners themselves.

The information obtained from each participating child will be collected on an anonymous, strictly confidential and voluntary basis. You may withdraw the participation of your child at any stage of the study. There will not be any negative or undesirable consequences should you choose to do so.

Should you have any queries regarding my research, please feel free to contact me on 082 551 8376 or Octavia.Lebele@wits.ac.za.

Yours Sincerely,

Octavia Lebele

Wits Community Dentistry Registrar

Appendix E: Assent Form for Children

Assent form for children

Title of Study: School dietary habits and the oral health status of primary school learners in Johannesburg, South Africa

Good day, my name is Octavia Lebele, a Masters student conducting research on School feeding programmes and its impact on the oral health of primary school learners in Johannesburg, Gauteng. In this study i want to learn how the oral health status of learners is influenced by the food consumed and food choices they make at school and the effectiveness of the school feeding programmes. I will also look at how i can help in finding ways of improving the school food environment and the oral health of the learners.

- Your parents have given us permission to have a look into your mouth today with a mirror but you have a choice on whether you would like to participate or not. I want to let you know that it does not hurt. I need you to sit on a chair and open your mouth so that I can look at your gums and teeth.
- A mouth mirror as shown on the picture below will be used and I will only take 10 minutes. Should you feel any discomfort or would like me to stop what I am doing; you are welcome to let me know.





- Thank you for your time and co-operation.

