DEPARTMENT OF INTERNAL MEDICINE AND SPECIALTIES

RELATIONSHIP BETWEEN MALNUTRITION AND SALIVARY pH AMONG ADOLESCENTS IN TWO SECONDARY SCHOOLS IN NTUI

Thesis written and presented in partial fulfilment of the requirement for the award of Medicinae Doctor (MD) degree in Oral Medicine by:

AYENI OMOWUMI DORIS

Matricule N°17M204

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Academic Year 2023-2024

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Date of Defense:

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………………………………	
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Academic Year 2023-2024

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DEDICATION

I dedicate this work to:

THE LORD GOD

ALMIGHTY.

ACKNOWLEDGEMENTS

I wish to extend my heartfelt gratitude to:

▪ Prof. SOBNGWI Eugene, my supervisor and the director of this research work. You are an admirable professor and researcher, a constant source of inspiration, and encouragement, and a great role model. It was an honor and privilege for me to share your time and enriching experience. Thank you for your availability and commitment despite your tight schedule. Thank you for always orientating me to the right path.

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KEY

HOD = Head of Department

P= Professor

AP= Associate Professor

SL= Senior Lecturer, **L**= Lecturer

PHYSICIAN'S OATH

Declaration of Geneva adopted by the World Medical Association amended

at the 68th General assembly in Chicago in October 2017

As a member of the medical profession:

l solemnly pledge to dedicate my life to the service of humanity;

The health and well-being of my patient will be my first consideration;

I will respect the autonomy and dignity of my patients;

I will maintain the utmost respect for human life;

I will not permit considerations of age, disease or disability, creed, ethnic

Origin, gender, nationality, political affiliation, race, sexual orientation,

Social standing or any other factor to intervene between my duty and my patient;

I will respect the secrets that are confided in me, even after the patient has died;

I will practice my profession with conscience and dignity and in

Accordance with good medical practice;

I will foster the honour and noble traditions of the medical profession;

I will give to my teachers, colleagues and students the respect and gratitude

Advancement of health care;

I will attend to my own health, well-being, and abilities in order to

Provide care of the highest standard;

I will not use my medical knowledge to violate human rights and civil liberties

even under threat;

I make these promises solemnly and upon my honour.

ABSTRACT

Background: Malnutrition is a major global health problem. Malnutrition refers to deficiencies or excesses in nutrient intake, imbalance of essential nutrients, or impaired nutrient utilization. It is commonly linked with oral diseases. For example, overweight students are 1.5 times more prone to developing dental caries as compared to normal-weight students. Saliva promotes a natural affinity between the resident and host oral microbiota, affecting local pH via its wearing-out properties and thus, promoting oral diseases; but, whether the relationship between malnutrition and oral diseases is mediated by salivary pH is not known.

Objective: To investigate the relationship between malnutrition, salivary pH, and dental caries among school-going adolescents in the semi-urban municipality of Ntui, in the Centre Region of Cameroon.

Methodology: We carried out a school-based cross-sectional analytical study in two secondary schools in Ntui. We included adolescents who agreed to participate and whose parents signed the consent form. Data was collected on socio-demographic characteristics, dietary intake, and oral hygiene status using a self-administered questionnaire. Oral examination was done; and anthropometric, hemoglobin level, and salivary pH were measured. Regression analyses were used to bring forth the relationships between salivary pH, malnutrition, and dental caries. A p-value < 0.05 was considered statistically significant.

Results: We examined a total of 261 adolescents and their mean age was 12.9 ±1.1 years. Overall, 83.2% had a normal weight, 11.5% were overweight, 7.6% were stunted, 3.4% were thin and 1.9% were obese. The prevalence of anemia was 49%. Dental caries was the most prevalent oral disease (49.8%) and the mean salivary pH was 6.9±0.8. A significant relationship was found neither between being overweight (OR:0.59, 95% CI: 0.10-3.61), being obese (OR:0.51, 95% CI: 0.23-1.13), being thin (OR:0.25, 95% CI: 0.05-1.25), being stunted (OR:0.41, 95% CI: 0.15-1.09) and dental caries. A non-significant association was found between anemia (OR:0.79, 95% CI: 0.49-1.29) and dental caries. BMI status (OR 1.40, 95% CI: 0.69-2.89) and being anemic (OR: 0.98, 95% CI: 0.58-1.64) were neither associated with abnormal salivary pH. However, factors significantly associated with salivary pH were starchy foods consumption (p = 0.006), teeth brushing time (p = 0.039), and dental carries (p < 0.001).

Conclusion: In the population studied 16.8% had abnormal BMI for age, 49% had anemia, 49.8% had caries, and 39.9% had acidic salivary pH. However, there was no significant association between the various forms of malnutrition and salivary pH and caries. The relationship between salivary pH and dietary behaviors and hygiene emphasizes the central role of oral hygiene in the prevention of caries.

Keywords: Malnutrition (Body mass index, Height for age, Anemia), salivary pH, Ntui.

RÉSUMÉ

Contexte : La malnutrition est un problème de santé majeur mondial. La malnutrition fait référence à des carences ou à des excès dans l'apport en nutriments, à un déséquilibre des nutriments essentiels ou à une mauvaise utilisation des nutriments. Elle est souvent liée à des maladies bucco-dentaires. Par exemple, les élèves en surpoids sont 1,5 fois plus susceptibles de développer des caries dentaires que ceux de poids normal. La salive favorise une affinité naturelle entre le microbiote oral résident et hôte, affectant le pH local par ses propriétés d'usure et favorisant ainsi les maladies bucco-dentaires ; mais on ne sait pas si la relation entre la malnutrition et les maladies bucco-dentaires est médiée par le pH de la salive.

Objectif : Étudier la relation entre la malnutrition, le pH salivaire et la carie dentaire chez les adolescents scolarisés dans la municipalité semi-urbaine de Ntui, dans la région du Centre du Cameroun.

Méthodologie : Nous avons réalisé une étude transversale analytique dans deux établissements scolaires à Ntui. Nous avons inclus les adolescents qui ont accepté de participer et dont les parents ont signé le formulaire de consentement. Des données ont été recueillies sur les caractéristiques sociodémographiques, l'apport alimentaire et l'état de l'hygiène bucco-dentaire à l'aide d'un questionnaire auto-administré. Un examen bucco-dentaire a été effectué ; les données anthropométriques, le taux d'hémoglobine et le pH salivaire ont été mesurés. Des analyses de régression ont été utilisées pour mettre en évidence les relations entre le pH salivaire, la malnutrition et les caries dentaires. Une valeur $p < 0,05$ a été considérée comme statistiquement significative.

Résultats : Nous avons examiné un total de 261 adolescents d'un âge moyen de 12,9 $\pm$1,1 ans. Dans l'ensemble,Quatre-vingt trois pourcent d'entre eux avaient un poids normal, onze pourcent étaient en surpoids, huit pourcent souffraient d'un retard de croissance, 3,4 % étaient minces et deux pourcent étaient obèses. La prévalence de l'anémie était de 49%. La carie dentaire était la maladie bucco-dentaire la plus répandue (49,8 %) et le pH moyen de la salive était de 6,9$\pm$0,8. Aucune relation significative n'a été trouvée entre le surpoids (OR:0.59, 95% CI : 0.10-3.61), l'obésité (OR:0.51, 95% CI : 0.23-1.13), la maigreur (OR:0.25, 95% CI : 0.05-1.25), le retard de croissance (OR:0.41, 95% CI : 0.15-1.09) et les caries dentaires. Une association non significative a été trouvée entre l'anémie (OR:0.79, 95% CI : 0.49-1.29) et les caries dentaires. L'IMC (OR 1,40, 95% CI : 0,69-2,89) et être anémique (OR : 0,98, 95% CI : 0,58-1,64) n'ont pas été associés à un pH salivaire anormal. Cependant, les facteurs significativement associés au pH salivaire étaient la consommation de féculents ($p = 0,006$), le temps de brossage des dents ($p = 0,039$) et les carries dentaires ($p < 0,001$).

Conclusion : Dans la population étudiée, 16,8 % avaient un IMC anormal pour l'âge, 49 % une anémie, 49,8 % des caries, 39.9 % un pH salivaire acide. Cependant, il n'y avait pas d'association significative entre les

différentes formes de malnutrition et le pH salivaire et les caries. La relation entre le pH salivaire, les comportements alimentaires et l'hygiène souligne le rôle central de l'hygiène bucco-dentaire dans la prévention des caries.

Mots-clés : Malnutrition (indice de masse corporelle, taille pour l'âge, anémie), pH salivaire, Ntui.

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LIST OF ABBREVIATIONS

BMI- Body Mass Index

CI- Calculus Index

CAO- "Carie Absent Obturé"

CBC - Complete Blood Count

DC- Dental caries

DE- Dental Erosion

DQQ-Diet Quality Questionnaire

DMFT- "Decayed, Missing, and Filled Teeth"

EX-CUSS- "Centre Universitaire des Sciences de la Santé"

HFA- Height For Age

IDA-Iron Deficiency Anemia

LMICs- Lower Middle-Income Countries

LT-"Lycée de Ntui"

LTN- "Lycée technique de Ntui"

NS- Nutritional Status

OHIS- Oral Hygiene Index score

PEM- Protein-energy malnutrition

pH- Proportion of Hydrogen

PI- Plaque Index

RBC- Red Blood Cells

SUN-APP - Scaling Up Healthy Nutrition in Adolescents and Pregnant women

WHO- World Health Organization

INTRODUCTION

Malnutrition has an impact on oral health and poor oral health, in turn, can lead to malnutrition [1]. There is a global rise in the prevalence of oral diseases in adolescents and it represents a major public health problem [1, 2]. The World Health Organization (WHO) identifies oral diseases as a pandemic affecting 60–90% of school-going children with the most prevalent being dental caries [3, 4]. In Cameroon, it represents one of the most prevalent chronic diseases in children and adolescents; with more than 6 in 10 school-going pupils affected [2, 3]. Oral diseases impact the oral health-related quality of life of adolescents [5–9] with the largest impact felt on the performance of daily activities such as social contact, school work, and most commonly eating and smiling [5–7, 10–12]. There are many factors associated with the increasing prevalence of oral diseases amongst which malnutrition [4, 10, 13–15].

The "triple burden of malnutrition" refers to the co-occurrence of undernutrition (stunting and wasting/thinness), micro-nutrient deficiencies (most commonly iron deficiency anemia), and overnutrition (overweight and obesity) [4–6]. Malnutrition in all its forms is documented to increase the risk of oral diseases[1, 7]. Over the years, there has been an increasing prevalence of malnutrition in adolescents worldwide making it a major global health problem [8–11]. This is depicted by the increasing prevalence of obesity and overweight despite the persistent prevalence of undernutrition and micronutrient deficiency in children and adolescents in sub-Saharan Africa [12]. Cameroon's Global Nutrition Report 2015 to 2020 shows that the prevalence of malnutrition among children aged 5-19 years is increasing; overweight increased from 17.4 to 20% in girls and obesity from 1 to 2% in boys [12, 13]. Studies reveal that the prevalence of oral diseases is increasing with the increasing prevalence of malnutrition [1, 8, 14]. Undernutrition and anemia in children and adolescents result in severe caries [7, 15–17]. This is due to alterations in the pH, flow rate, and buffering capacity of saliva [11, 18, 19]. More and more scientific research is drawing attention to the changes in the microflora of the oral cavity during malnutrition which are closely related to the morphological and functional alterations of saliva [1, 2, 18, 20–22]. Also, Adeniyi et al in 2016 in Nigeria documented underweight children had a higher prevalence of dental caries with an increased odds of 1.87 [2, 23]. Also, overweight pupils are 1.5 times more likely to develop dental caries than non-overweight pupils in a study carried out in Cameroon. Boukeng et al in 2023 in Cameroon, revealed 33.1%, 53.2%, and 60.3%, of adolescents, had gingivitis, periodontal disease, and dental caries respectively [2].

Studies documented so far have revealed the association between malnutrition and oral diseases but, whether this relationship is mediated by salivary pH is not known. We therefore aim to evaluate the relationship between malnutrition and salivary pH and determine its relevance to the prevalence and severity of dental caries.

CHAPTER I: STUDY FRAMEWORK

I.1 JUSTIFICATION

In Cameroon, the secondary school enrolment rate of children aged 10-19 years was 45.02% in 2022 [24]. This period presents an opportunity window in the life course for effective health promotion to reduce the burden of diseases [9, 25, 26]. Furthermore, the demographic load of adolescents represents a key target for the implementation of nutritional and oral health prevention and promotional activities [27]. Many adolescents still suffer from oral diseases especially dental caries in Cameroon despite several implementations of oral health promotion and preventive measures to promote good oral hygiene. This burden also imputes a considerable loss in the country's income due to its impact on productivity [2]. Studies have established a relationship between malnutrition and the burden of dental caries in adolescents but, no study has explored the relationship between malnutrition and salivary pH in the burden of dental caries in Cameroon. Thus, a need arises to evaluate such data with the dwellers of the semi-urban municipality of Ntui, where a high proportion of adolescents suffer from oral diseases and malnutrition. Interventions aimed at improving nutritional deficiencies and restoring salivary pH balance could contribute to overall health improvement and prevent oral complications. Many studies link malnutrition to dental caries in adolescents but, whether this relationship is mediated by salivary pH is not known.

I.2 RESEARCH QUESTION

Is there a relationship between malnutrition and salivary pH in adolescents?

I.3 RESEARCH HYPOTHESIS

Adolescents with malnutrition have altered salivary pH compared to those without malnutrition.

I.4 RESEARCH OBJECTIVES
I.4.1 GENERAL OBJECTIVE

To investigate the relationship between malnutrition and salivary pH among school-going adolescents in Ntui Municipality, Centre Region of Cameroon.

1.4.2 SPECIFIC OBJECTIVES

In a population of school-going adolescents dwelling in the semi-urban municipality of Ntui, our specific objectives were :

1. To determine the prevalence of malnutrition.
2. To assess the oral health status.
3. To investigate the putative relationship between salivary pH and malnutrition.

I.5 DEFINITION OF OPERATIONAL TERMS

Malnutrition; According to WHO 2023, malnutrition refers to deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients. The term malnutrition covers 2 broad groups of conditions. One is 'undernutrition'—which includes stunting (low height for age), wasting (low weight for height), underweight (low weight for age), and micronutrient deficiencies or insufficiencies (a lack of important vitamins and minerals). The other is overweight, obesity, and diet-related noncommunicable diseases (such as heart disease, stroke, diabetes, and cancer) [28, 29].

In this study, the triple burden of malnutrition is considered as;
- **Overnutrition (overweight/obesity).**
- **Macro-nutrient undernutrition which can manifest as low weight for height (thinness/wasting) or low height for age (stunting).**
- **Micro-nutrient undernutrition (for iron deficiency anemia which is the most common).**

Dental Caries: Dental caries is a multifactorial disease characterized by the localized destruction of susceptible dental hard tissues by acidic by-products from bacterial fermentation of dietary carbohydrates [2].

Anemia; According to WHO 2023, anemia is a condition in which the number of red blood cells or the hemoglobin concentration within them is lower than normal. Various forms of anemia exist of which Iron deficiency Anemia is the most common.

In this study, we classified Anemia using the WHO Classification of Anemia according to age and severity. Hemoglobin values for; non-Anemic was ≥ 12, Mild Anemia 11-11.9, Moderate Anemia 8-10.9

Saliva; a slightly alkaline(basic) secretion of water, mucin, protein, salts, and often a starch-splitting enzyme (such as ptyalin) that is secreted into the mouth by salivary glands, lubricates ingested food, and often begins the breakdown of starches.

Salivary pH; Salivary pH refers to the measurement of acidity or alkalinity(basic) of your saliva. It's expressed on a scale from 1 to 14, with 7 being neutral. Below 7 is acidic, and above 7 is basic.

CHAPTER II: LITERATURE REVIEW

II.1 MALNUTRITION

DEFINITION

Malnutrition refers to deficiencies or excesses in nutrient intake, imbalance of essential nutrients, or impaired nutrient utilization. The triple burden of malnutrition refers to the simultaneous occurrence of three types of nutritional problems within the same population. It is the coexistence of undernutrition (stunting and wasting), micronutrient deficiencies (often termed hidden hunger), and overnutrition (overweight and obesity) [28, 29].
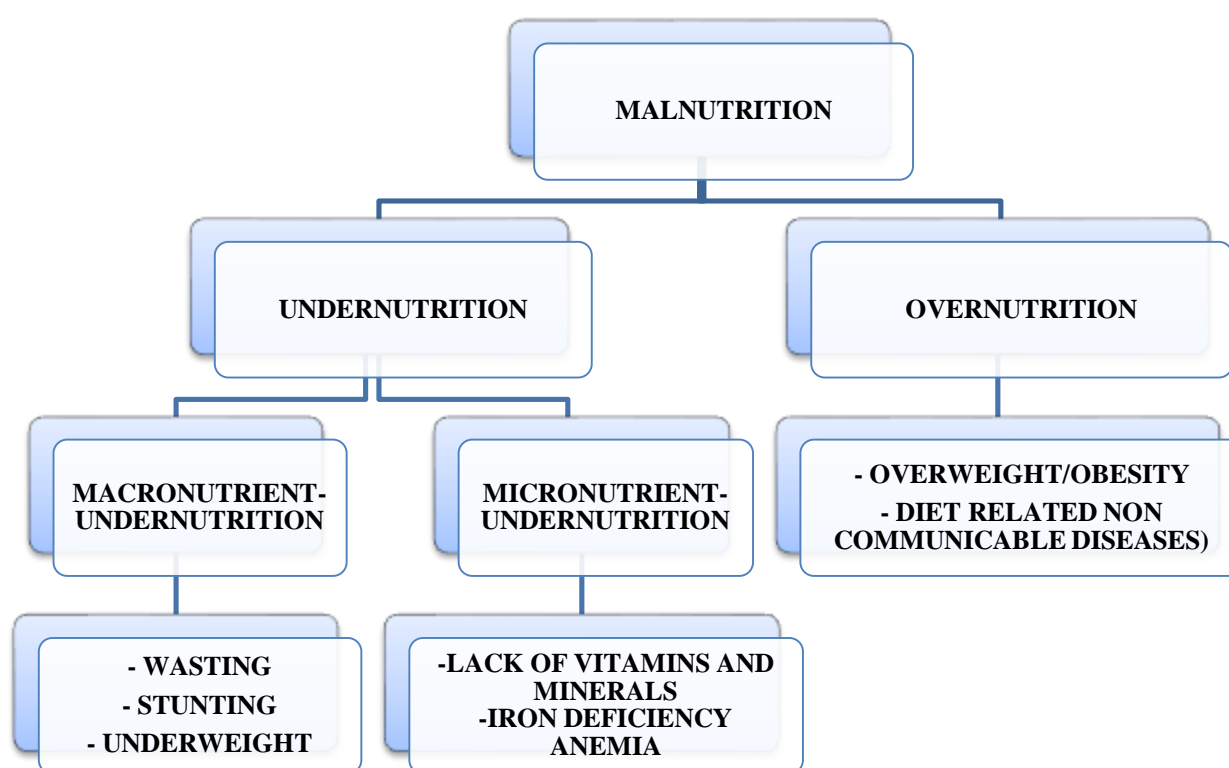
Figure 1: Classification of Malnutrition

II.1.1 TYPES OF MALNUTRITION

The term malnutrition addresses 3 broad groups of conditions: under-nutrition (macro-nutrient under-nutrition and micro-nutrient under-nutrition) and over-nutrition (See fig 1).

II.1.1.1 UNDERNUTRITION

II.1.1.1.1 MACRO-NUTRIENT UNDERNUTRITION

A. **Wasting (low weight-for-height);** It usually indicates recent and severe weight loss because a person has not had enough food to eat and/or has had an infectious disease, such as diarrhea, which has caused them to lose weight. A young child who is moderately or severely wasted has an increased risk of death, but treatment is possible [28].

B. **Stunting (low height-for-age);** It is the result of chronic or recurrent under-nutrition, usually associated with poor socioeconomic conditions, poor maternal health and nutrition, frequent illness, and/or inappropriate infant and young child feeding and care in early life. Stunting holds children back from reaching their physical and cognitive potential.

C. **Underweight (low weight-for-age);** Children with low weight-for-age are known as underweight. An underweight child may be stunted, wasted, or both.

II.1.1.1.2 MICRO-NUTRIENT UNDERNUTRITION

This includes micro-nutrient deficiencies (a lack of important vitamins and minerals) or micro-nutrient excess such as inadequacies in the intake of vitamins and minerals. Micro-nutrients enable the body to produce enzymes, hormones, and other substances that are essential for proper growth and development. Iodine, vitamin A, and iron are the most important in global public health terms; their deficiency represents a major threat to the health and development of populations worldwide, particularly children and pregnant women in low-income countries [28]. For this type of malnutrition, we are studying Anemia for iron deficiency.

A. ANEMIA

Anemia is a condition in which the number of red blood cells or the hemoglobin concentration within them is lower than normal. Hemoglobin is the protein contained in red blood cells that is responsible for the delivery of oxygen to the tissues. To ensure adequate tissue oxygenation, a sufficient hemoglobin level must be maintained. The amount of hemoglobin in whole blood is expressed in grams per deciliter (g/dl). The normal Hemoglobin level for males is 14 to 18 g/dl; that for females is 12 to 16 g/dl. Anemia occurs when the body produces few red blood cells (RBCs), destroys too many RBCs, or loses too many RBCs (which contain hemoglobin, a protein that carries oxygen throughout the body). Blood is a vital liquid whereby the heart pumps blood through veins and arteries and all over the body. The different types of anemia are linked to various diseases and conditions. Anemia can affect people of all ages, races, and ethnicity. Some types of anemia are very common, and some are very rare. Some are very mild, and others are severe or even life-threatening if not treated aggressively. Nevertheless, anemia can usually be managed and even prevented. The causes of anemia can be acquired or inherited. "Acquired," means one isn't born with reduced hemoglobin levels but rather develops later. "Inherited," means one is born with anemia usually due to genetic defects from heredity or mutations in utero. Sometimes the cause of anemia could be unknown as well [31].

a. Symptoms of Anemia

- **Fatigue;** feeling too tired to manage your activities is the most noticeable anemia symptom.
- **Shortness of breath (dyspnea):** This is the feeling you can't catch your breath or take a deep breath.
- **Dizziness:** This is feeling lightheaded or unsteady on your feet.
- **Pounding or "whooshing" sound in your ear (pulsatile tinnitus):** This is a swooshing sound in one of your ears that may come and go.
- **Pale or yellow skin:** Your skin color may be paler than usual**.**
- **Chest pain:** This may feel like something is pressing on or squeezing your chest.
- **Fast or irregular heartbeat**
- **Increased thirst, Sweating, Weak /rapid pulse, rapid breathing, Lower leg cramps.**

b. **Diagnosis of Anemia**

- **Complete blood count (CBC)**: This is used to check on all blood cells with a focus on your Hemoglobin level and RBCs. They count and evaluate your RBC's size and shape. It could equally be used to check on vitamin B12 or B9 levels.

- **Peripheral blood smear**: This is used to examine RBCs under a microscope. A blood smear looks at the shape of your blood cells. Abnormally shaped red blood cells can be a sign of sickle cell anemia.

- **Hemoglobin test:** This is used to evaluate the level of hemoglobin in your blood (high or low) and determine how severe the condition is.

Table I: WHO Classification of Anemia according to age and severity [32]

Population	Non- Anemia*	Mild Anemia*	Moderate Anemia*	Severe Anemia*
6-59 months of age	≥ 11	10-10.9	7-9.9	< 7
5-11 years of age	≥ 11.5	11-11.4	8-10.9	< 8
12-14 years of age	≥ 12	11-11.9	8-10.9	< 8
Non-pregnant women (≥ 15 years)	≥ 12	11-11.9	8-10.9	< 8
Pregnant women	≥ 11	10-10.9	7-9.9	< 7
Men (≥ 15 years)	≥ 13	11-12.9	8-10.9	< 8

c. **Treatment of Anemia**

Anemia most often is easily treated. Its treatment depends on its type, cause, and severity. The main aim of the treatment is to [32]:

- Raise RBC count or hemoglobin level to improve the blood's ability to carry oxygen.
- Treat the underlying condition causing the anemia.
- Prevent complications of anemia, such as heart or nerve damage
- Relieve symptoms and improve your quality of life.

d. Preventing or Controlling Anemia

Some actions enable us to have more energy and improve the quality of life. Actions like;

- Following a healthy diet ensures that enough nutrients needed by the body is supplied. These nutrients include iron, vitamin B12, folate, and vitamin C. These nutrients are found in a variety of foods.

- Focus on nutrient-dense foods and beverages which are vegetables, fruits, whole grains, fat-free or low-fat dairy products, seafood, lean meats and poultry, eggs, beans and peas, and nuts and seeds.

- Equally, limit intake of salt, solid fats, added sugars, and refined grains. Maintain a healthy weight by balancing the calories from foods and beverages with the calories you use through physical activity.

- Follow food safety guidelines when preparing and eating foods to reduce the risk of foodborne illnesses.

- Make following a healthy diet a family goal because Infants, young children, teens, and adolescents grow rapidly. A healthy diet supports growth and development and can help prevent anemia.

- Anemia is common in older adults because of chronic (ongoing) diseases, lack of iron, and poor diet.

- Avoid Substances that can cause or trigger anemia such as contact with chemicals or toxins in the environment [31].

II.1.1.2 OVERNUTRITION

This includes Overweight, obesity, and diet-related noncommunicable diseases (such as heart disease, stroke, diabetes, and some cancers).

II.1.1.2.1 Overweight and Obesity

Over 390 million children and adolescents aged 5–19 years were overweight in 2022. The prevalence of overweight (including obesity) among children and adolescents aged 5–19 has risen dramatically from just 8% in 1990 to 20% in 2022. The rise has occurred similarly among both boys and girls: in 2022 19% of girls and 21% of boys were overweight [28].

While just 2% of children and adolescents aged 5–19 were obese in 1990 (31 million young people), by 2022, 8% of children and adolescents were living with obesity (160 million young people). According to WHO 2024, Overweight is a condition of excessive fat deposits and Obesity is a chronic complex disease defined by excessive fat deposits that can impair health. Obesity can lead to an increased risk of type 2 diabetes and heart disease, it can affect bone health and reproduction, and it increases the risk of certain cancers. Obesity influences the quality of living, such as sleeping or moving. The diagnosis of overweight and obesity is made by measuring people's weight and height and by calculating the body mass index (BMI): weight (kg)/height² (m²). The body mass index is a surrogate marker of fatness and additional measurements, such as the waist circumference, can help the diagnosis of obesity. The BMI categories for defining obesity vary by age and gender in infants, children, and adolescents. With our focus on adolescents, Overweight and obesity are defined for children aged between 5–19 years as:

- Overweight is BMI-for-age greater than 1 standard deviation above the WHO Growth Reference median; and
- Obesity is greater than 2 standard deviations above the WHO Growth Reference median.

II.1.1.2.2 Diet-Related Non-Communicable Diseases

Diet-related noncommunicable diseases (NCDs) include cardiovascular diseases (such as heart attacks and stroke, and often linked with high blood pressure), certain cancers, and diabetes. Unhealthy diets and poor nutrition are among the top risk factors for these diseases globally.

II.2 MALNUTRITION AND DENTAL CARIES

Malnutrition affects oral health and poor oral health in turn, may lead to malnutrition. This interdependent relationship sees good nutritional health, thus promoting good oral health and vice versa. Malnutrition may alter homeostasis, which can lead to disease progression of the oral cavity, reduce the resistance to the microbial biofilm, and reduce the capacity of tissue healing. It may even affect the development of the oral cavity leading to dental caries [1].

Protein-energy malnutrition occurs when there is a deficiency of protein, energy foods, or both, which are relative to a body's needs. Studies have suggested that enamel hypoplasia, salivary gland hypo-function, and saliva compositional changes may be the mechanisms through which

malnutrition is associated with caries, while an altered eruption timing may create a challenge in the analysis of the age-specific caries rates [1].

II.2.1 DENTAL CARIES

Dental caries is the most prevalent oral disease worldwide, with the majority of caries lesions being concentrated in a few, often disadvantaged social groups[33]. It is a disease of the calcified tissues of the teeth characterized by demineralization of the inorganic component and dissolution of the organic component of the tooth under the action of bacteria on fermentable sugars. Dental caries is a preventable disease and once it occurs, its manifestations persist throughout life even if the lesion is treated.

II.2.1.1 STAGES OF DENTAL CARIES

We have 5 stages of dental caries (DC) characterized by their symptoms

- **White spot (stage 1 or the initial stage);** It is the appearance of a chalky-white or yellow spot area on surfaces of the teeth due to demineralization. This stage is reversible if proper treatment with fluoride and sealants is done with improved oral hygiene by the patient. At this stage, Dental caries are called incipient caries

- **Enamel decay (stage 2);** is the moderate stage which is viewed by enamel breakage with the surface still intact. If decay persists, the surface layers break and the cavity is seen. These scratches can be mitigated by more exhaustive preventive management, whereas others might call for tooth-preserving fillings [34].

- **Dentinal Decay (stage 3)**; The decay progresses from the enamel to the dentine. Pain may be felt at this level due to the presence of nerve endings. Tooth restoration is still possible at this level.

- **Pulpal involvement (stage 4)**; The pulp gets infected due to the action of bacteria. Appreciable pain is felt at this stage which is also known as pulpitis. A treatment called Root canal treatment (RCT) is done.

- **Abscess formation (stage 5)**; infection reaches the root tip of the tooth together with the bone surrounding the tooth thereby causing severe pain. A swollen may be seen on the cheek of the affected jaw. Prescriptions of antibiotics and analgesics are necessary at this

stage. The teeth may be treated depending on the level of damage. If the damage is beyond repair then an extraction of the tooth will be the only option.

II.2.1.2 FACTORS INFLUENCING DENTAL CARIES

Multiple factors that include the interaction of bacteria, diet, and host response trigger dental caries development. These factors interact and cause caries initiation. Dental caries is the localized damage of a vulnerable surface of the tooth through the action of acid that comes from sugar breakdown from the diet people eat over a long period [35].

a. **Streptococcus mutans;** a cariogenic bacterium that is accompanied by changes in dietary regimes and lifestyles is the main cause of caries, and is occasioned by the intake of refined sugars (WHO, 2015). The occurrence of caries in children is influenced by sex, age, economic status, ethnicity, and food intake, which include the pattern of sugar intake as well as oral health behaviors [35].

b. **Dental Caries and cariogenic foods;** Dental caries can be well-defined as sugar-modified microbial disease. A diet that is rich in sucrose favors the development of oral microbes and changes the alignment of the bacterial habitat in a caries-enhancing way. The high intake of cariogenic foods has been known to cause dental caries for many decades, however, reviews indicate that with fluoride contact daily, the association between the consumption of cariogenic foods and caries prevalence is not consistent [36]. Recurrent ingestion of cariogenic products increases the likelihood of dental caries (WHO, 2015). Sugared beverages continue to create the main source of harmful sugar in kids' food [37].

c. **Fluoride levels and dental caries;** Fluoride is the foundation of dental caries avoidance and there is an assortment of sources that add to the nutritional ingestion of fluoride. Food sources that are rich in fluoride include: vegetables such as carrots, potatoes, and beans; fruits such as grapes, mangoes, oranges, tomatoes, and pears; fluids such as milk, black tea, water, and seafood [38]

d. **Food intake and Dental caries**; dental caries result in dental loss that decreases the capability to eat a diverse diet. Dental caries is linked with eating a diet deficient in vegetables of different kinds and fruits. This denies the growing child enough nutrients that are necessary for growth and development thus resulting in prolonged negative effects on physical growth, cognitive development, and overall academic performance [39]. Failing

to eat a diversified diet has been established as a causal factor in under-nutrition which generally leads to wasting, stunting, and being underweight [33].

e. **Dental caries and nutritional status***;* The intake of caffeinated drinks and highly processed foods as well as physical inactivity has been implicated in the increasing number of overweight individuals around the globe[40]. Studies show that children who are overweight are linked to prolonged exposure to carbohydrates [35]

f. **Oral hygiene behaviors and dental caries;** Oral cleanness is one of the important mechanisms of preventing dental decay. Increased brushing of teeth implies lesser occurrence of dental caries.
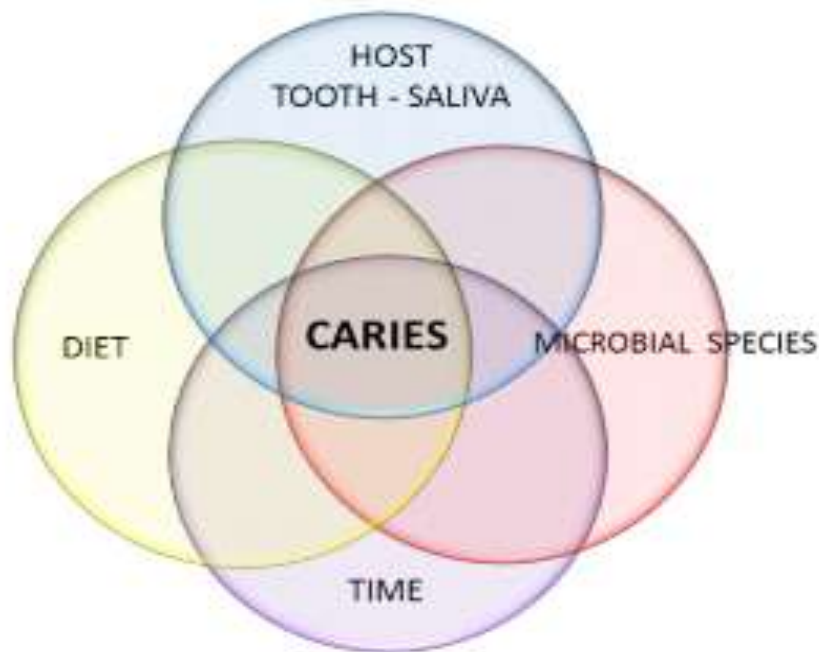
Figure 2: Keyes diagram modified by Newbrum showing four circles that represent the factors involved in the carious process [56].

Figure 3: Molar teeth with dental caries

(NB: This picture was taken by Ayeni in "Lycée de Ntui" during recruitment).

II.3 SALIVA

Salivary glands are a part of the digestive system [41]. 99% of saliva is water and the other 1% is composed of organic and inorganic molecules. While the quantity of saliva is important, so is its quality [19]. Salivation plays a vital role in digestion, as digestion of food begins in the mouth [42]. It plays an important role in remineralization, providing calcium, phosphate, and fluoride to dental tissue [43]. Salivary flow is an important factor since it favors the cleaning of bacterial substrates, protects the oral surfaces, and helps control the development of caries. A reduced salivary flow can produce a cascade of events where the biofilm accumulates and matures, resulting in the acidification of the micro-environment and the selection of acidogenic bacteria. Perhaps the best clinical indicator of saliva's protective properties would be salivary flow rate, as other salivary parameters (pH and buffer capacity) depend on it [43, 44]**.**

Saliva has several functions which include:

- **Protection**: Saliva flushes away pathogens like bacteria, with the help of proteins that have antimicrobial activity like lysozyme, lactoferrin, peroxidase,

- **Buffer**: It acts here by increasing pH with the help of bicarbonate, phosphate, and other ions. Biologically active proteins and growth factors are found in saliva and work to regenerate tissue and promote wound healing.

- **Maintenance of tooth integrity by protecting teeth** from caries under 4 aspects; [19]

  - Diluting and eliminating sugars and other substances
  - Buffer capacity
  - Balancing demineralization/ remineralization
  - Antimicrobial activity

- **Tissue repair**: Saliva harbors enzymes like lysozymes, which act as nature's disinfectants by breaking down bacteria and cellular debris that could hinder healing. Also, saliva's lubricating properties create a moist environment, promoting optimal conditions for cell activity and protecting the wound from further irritation.

- **Digestion:** Digestion begins in the mouth whereby saliva contains the enzyme amylase which breaks down starches into maltose and dextrin. This function in itself also reduces the number of sugars available to microorganisms and helps inhibit their growth.

- **Taste**: It assists with the sensation of taste by solubilizing food so that the taste receptors can interact with the molecules that cause receptor activation.

II.3.1 COMPOSITION OF SALIVA [45]

II.3.1.1 Inorganic constituents of saliva

Although the primary secretion is a plasma ultrafiltrate (that is, isotonic), energy-dependent reabsorption of $Na+$ and $Cl-$ in the ductal system results in a hypotonic final secretion. Bicarbonate allows buffering, while calcium and phosphate allow for the maintenance of tooth mineral integrity. Early work defined the effects of flow on electrolyte composition. Interestingly, the pH and ionic composition may also influence the activity of organic components in the saliva.

II.3.1.2 Organic constituents of saliva

Saliva contains a wide variety of proteins that are unique to this fluid and which have biological functions of particular importance to oral health. Many of these proteins contain high levels (35–40%) of proline and are, therefore, designated proline-rich proteins (PRPs). PRPs, which comprise almost 70% of the total protein content of human parotid saliva, are further divided into three groups based on charge and degree of glycosylation: acidic, basic, and glycosylated basic PRPs. Since amylase comprises most of the remainder of the total protein content of parotid saliva, the other proteins (such as lysozyme, lactoferrin, peroxidase, and secretory IgA) that have received more attention in attempted linkages between saliva and oral health are, in fact, relatively minor components.

II.3.2 SALIVARY pH

Salivary pH varies depending on several factors, including diet, oral hygiene, and overall health. Under normal conditions, the pH of saliva typically ranges from 6.2 to 7.6, which is slightly acidic to slightly basic. In the oral cavity, the pH is maintained near neutrality (6.7-7.3) by saliva. The saliva contributes to the maintenance of the pH by two mechanisms [46]. Caries formation is influenced by the pH level in the mouth. Conversely, higher pH levels exceeding 7.3 can favor the formation of dental calculi (tartar) [45–47]. When the pH drops below a critical level, typically around 5.5, the tooth enamel begins to demineralize, leading to the development of caries. At this pH, the acidic environment favors the dissolution of hydroxyapatite, the mineral component of tooth enamel.

II.4 SALIVARY pH AND ORAL HEALTH

Salivary pH is an important indicator of oral health. The oral cavity has a delicate balance between acidic and basic conditions, primarily regulated by saliva. The oral cavity maintains a delicate balance between acidic and basic conditions, primarily regulated by salivary pH.

The level of pH in saliva plays a tremendous role in oral health and hygiene. The levels fluctuate depending on the type of food and drinks consumed throughout the day, but consistently low or high levels can severely impact the teeth and gums. Knowing the meaning behind pH levels,

controlling them, and recognizing the various foods and beverages that positively influence the oral cavity can promote not only oral health but complete systemic health.

II.5 SALIVARY pH AND MALNUTRITION

Malnutrition is a complex and multifactorial condition that arises from inadequate nutrient intake or poor absorption, leading to detrimental effects on an individual's health. It encompasses both macro-nutrient deficiencies (undernutrition and overnutrition) and micro-nutrient deficiency (Anemia), which poses a significant global health challenge with wide-ranging consequences for individual health and well-being. Malnutrition is increasingly recognized for its potential impact on oral health. Saliva, a multifaceted and crucial bodily fluid, plays a central role in maintaining oral health through its diverse functions, including lubrication, digestion, and defense against harmful microorganisms. Recent research has highlighted a potential correlation between malnutrition and changes in salivary pH [15, 46, 48].

Both undernutrition and overnutrition can influence saliva production and composition, potentially impacting its buffering capacity and, consequently, pH. Undernutrition, particularly protein-energy malnutrition, and micronutrient deficiencies can lead to reduced salivary flow rate and altered electrolyte concentrations. Studies have shown that decreased levels of essential minerals like calcium, phosphate, and bicarbonate in the saliva of malnourished individuals, impair its buffering capacity and contribute to acidic shifts in pH. So, malnourished children exhibit significantly lower salivary pH levels compared to their well-nourished counterparts [49]. Conversely, overnutrition, particularly diets high in refined carbohydrates and sugars, can stimulate salivary amylase activity, potentially altering pH towards basic conditions (higher salivary pH) [48].

II.6 REVIEW OF PUBLICATIONS

II.5.1 WORLD

Table II: Summary of some published works in the world

Title and place of study	Authors and year of study	Sample and setting	Results
Salivary pH A diagnostic biomarker United States of America (USA)	Baliga, Sharmila; Muglikar, Sangeeta; Kale, Rahul 2013	The study population consisted of 300 patients. They were divided into three groups of 100 patients each: Group A had clinically healthy gingiva, Group B had generalized chronic gingivitis and Group C had generalized chronic periodontitis. The randomized unstimulated saliva from each patient was collected and pH was tested. Data was analyzed statistically using the analysis of variance technique.	The salivary pH was more alkaline for patients with generalized chronic gingivitis as compared with the control group (P = 0.001) whereas patients with generalized chronic periodontitis had more acidic pH as compared with the control group (P = 0.001).
Higher body mass index associated with severe early childhood caries Canada	Katherine Davidson1, Robert J. Schroth et al… 2016	Children with Severe Early Childhood Caries (S-ECC) were recruited on the day of their slated dental surgery under general anesthesia. Age-matched, caries-free controls were recruited from the community. All	Two hundred thirty-five children were included (141 with S-ECC and 94 caries-free). The mean age was 43.3 ± 12.8 months and 50.2 % were male. Overall, 34.4 % of participants were overweight or obese.

		children were participating in a larger study on nutrition and S-ECC. Analysis was restricted to children ≥ 24 months of age. Parents completed a questionnaire and heights and weights were recorded. BMI scores and age and gender-adjusted BMI z-scores and percentiles were calculated. A p-value ≤ 0.05 was significant.	Significantly more children with S-ECC were classified as overweight or obese when compared to caries-free children (p =0. 038) and had significantly higher mean BMI z-scores than caries-free children (0.78 ± 1.26 vs. 0.22 ± 1.36, p =0. 002). Those with S-ECC also had significantly higher BMI percentiles (69.0 % ± 29.2 vs. 56.8 % ± 31.7, p = 0.003). Multiple linear regression analyses revealed that BMI z-scores were significantly and independently associated with S-ECC and annual household income as were BMI percentiles.
Nutritional Education and the State of Oral Health in Adolescents Poland	Małgorzata Jaraszek, Wojciech Hanke and Andrzej Marcinkiewicz 2022	The study consisted of two stages (at the beginning and end of education) and two parts: a questionnaire and a dental examination. The study group initially included 55 male students from the secondary technical school of gastronomy and 54 in	After three years, in the engineering and information technology group, compared to gastronomy one, a statistically significant increase in caries prevalence and the number of students eating between meals was observed.

		electro-engineering and information technology school. In the second stage of the study, it was 42 and 51, respectively.	
Malnutrition, enamel defects, and early childhood caries in preschool children in a sub-urban Nigeria population Nigeria	Morenike Oluwatoyin Folayan, Maha El Tantawi, Ayodeji Babatunde Oginni, et al… 2020	Study participants for the primary study were recruited through a household survey, which facilitated access to preschool children, ensured appropriate distribution of socioeconomic status, and better-represented children in the study area [33, 34]. The local government area was selected for the study to enable comparison with historical data that had been collected from the same population, using the same procedure, five years earlier [27]. A three-level, multi-stage cluster-sampling technique was used to identify eligible participants	Descriptive statistics were provided for ECC presence (yes/no), malnutrition status (stunting, wasting, underweight, and overweight), and enamel defects (hypoplasia, hypomineralized second primary molar, fluorosis, and amelogenesis imperfecta). Multivariable Poisson regression models were used to assess the relationship between exposures (malnutrition status and enamel defects), confounders (socio-economic status, frequency of sugar consumption in-between-meals and oral hygiene), and the outcome variable (presence of ECC measured by prevalence ratio). We used robust variance estimation due to the sparse data on some

		variables. The models were adjusted and assessed for the age group combined. Statistical analyses were conducted using Stata/SE 14.0 for Windows. The significance level was set at $p \leq 0.05$.
Malnutrition and its oral outcome – a review	Aparna Sheetal et al…	Malnutrition appears to have multiple effects on the oral tissues and the subsequent oral disease development. It affects the development of the oral cavity and the progression of oral diseases through altered tissue homeostasis, reduced resistance to microbial biofilms, and reduced tissue repair capacity [3]. Deficiencies of vitamin D and vitamin A and Protein Energy Malnutrition (PEM) have been associated with enamel hypoplasia. PEM and vitamin A deficiency are also associated with salivary gland atrophy, which subsequently reduces the defense of the oral	Various studies which have been conducted, dictate that malnutrition and protein energy malnutrition affect dentition. The resultant defects include the effects on tooth eruption patterns, enamel hypoplasia, dental caries prevalence, and periodontal ligament. They also have other effects on the oral cavity, like inflammation of the lining of the oral cavity and the tongue and oral ulcers. A detailed case analysis of malnutrition, particularly PEM, is required to substantiate the above-discussed factors. Various studies which have been conducted, dictate that malnutrition and protein

cavity against infection and its ability to buffer plaque acids. In a study, it was suggested that moderate malnutrition, principally, a lack of protein and other micronutrients such as vitamins, zinc, and iron, limits the eruption of permanent dentition

energy malnutrition affect dentition. The resultant defects include the effects on tooth eruption patterns, enamel hypoplasia, dental caries prevalence, and periodontal ligament. They also have other effects on the oral cavity, like inflammation of the lining of the oral cavity and the tongue and oral ulcers. A detailed case analysis of malnutrition, particularly PEM, is required to substantiate the above-discussed factors. Such an in-depth analysis of PEM might reveal other milestones that might be affecting the healthy oral cavity the analysis of PEM might reveal other milestones that might be affecting healthy oral cavity

II.5.2 AFRICA

Table III : Summary of some published works in the Africa

Title and place of study	Authors and year of study	Sample and setting	Results
Effect of Childhood Malnutrition on Salivary Flow and pH Cairo, Egypt	Doaa S. Hashem, Samy Y. El-Bayoumy, Wafaa A. Fahmy, and Magda A. El Malt 2016	Case-control study The children were divided into two main groups according to their nutrition status, Group (A): two hundred children representing the malnourished children, and Group (B): two hundred children representing the control group. Within Group (A) Children were further divided into 2 subgroups, subgroup (1): one hundred stunted children and subgroup (2): one hundred underweight children. Every child was subjected to unstimulated and stimulated saliva flow and pH measurements and caries status evaluation using dmf index for primary and DMF index for permanent teeth	The results showed undernutrition (underweight) and stunting reduced the secretion rate of stimulated saliva and had no effect on the unstimulated salivary flow rate or saliva pH. Moreover, undernutrition (underweight) increased the caries index of primary teeth, while stunting increased the caries index of permanent teeth. It was concluded that malnutrition causes enamel hypoplasia, salivary gland hypofunction, and saliva compositional changes and these might be the mechanisms through which malnutrition is associated with caries.

Correlation between body mass index and dental caries among a sample of Sudanese children. Sudan	Tyseer E, Seid Ahmed, Amal H. Abuaffan 2015	A Cross-sectional school-based study was conducted. A total of 360 children (50% boys, 50% girls) were examined for body mass index and dental caries prevalence. Physical examination was done by recording the child's height and weight to calculate the body mass index. The dental caries index was carried out following the WHO criteria.	The most prevalent body weight category was normal weight (60.6%) in both genders followed by the underweight group (28.3%), the overweight group (6.4%), and the obese group (4.7%). Boys exhibited a higher prevalence in the underweight category than girls, while overweight was more prevalent in girls (8.3%) than boys (4.4%). The mean DMFT for primary teeth was 4.68 in both genders and the mean DMFT for permanent teeth was 2.52 and 1.88 for girls and boys respectively. There was a negative correlation between DMFT and the body weight category. No correlation between the body weight category and DMFT was found.
Dental Caries, Body Mass Index, and Diet among	Ntombizodwa R Nkambule1, Thomas K Madiba,	A cross-sectional study was carried out. Learners underwent an oral and anthropometric examination, while the information on dietary intake	Of a possible 529 learners, 440 (83%) participated of whom 53% were boys. The mean age was 11.8 years, and 50% fell into the

Learners at Selected Primary Schools in Pretoria, Gauteng Province, South Africa	Ahmed Bhayat. 2019	and SES was collected using a standardized questionnaire.	"medium" SES category. The prevalence of DC was 43%. The mean decayed, missing, and filled teeth (DMFT) score was 1.19 (SD = ±1.79), of which the decayed (D) component was the largest at 1.07 (SD = ±1.59). Two-thirds (62%) of learners had a normal BMI, and 26% were underweight. Less than half (47%) reported brushing their teeth twice a day; 71% claimed to drink up to one and a half glasses of sugar-sweetened beverages (SSBs), and 67% reported eating one to three sweets a day. The prevalence of DC was not significantly associated with BMI, diet, or SES, although having no caries was associated with eating less than three sweets a day.

II.5.3 CAMEROON

Table IV: Summary of some published works in Cameroon.

Title and place of study	Authors and year of study	Sample and setting	Results
Oral pathology and overweight among pupils in government primary schools in Cameroon: a cross-sectional study Cameroon	Boukeng Berthold L, Minkandi CA, Dapi LN 2023	A cross-sectional study was carried out from June to August 2020 in four government primary schools selected through cluster sampling in Yaounde. 650 pupils aged between 6 and 11 years were enrolled. Data collected included anthropometrics, oral pathologies, quality of oral hygiene, and feeding habits. Data were analyzed with the SPSS 26.0 statistical software and binary logistic regression was used to determine the risks of oral pathologies in overweight pupils. p-value of 0.05 was considered statistically significant.	The prevalence of overweight was 27% (95% CI: 23.5—30.5). The main oral pathologies were tooth decay (60.3%). Binary logistic regression revealed that overweight pupils were significantly 1.5 times more likely to develop tooth decay than non-overweight pupils (95% CI: 1.1—2.4).
Overweight and obesity in children aged 3–13 years in urban Cameroon: a cross-sectional study of	Simeon-Pierre Choukem, Josiane Kamdeu-Chedeu, Sam D. Jean	In this cross-sectional study, we included by multi-staged cluster random sampling 1343 children from high (HSES, n = 673) and low (LSES, n = 670) socioeconomic status schools in Douala. Parent/child demographic data were collected, and children's	The prevalence of overweight/obesity was 12.5% (13.2% in girls, 11.8% in boys). The risk of overweight/ obesity was 2.40 (95% CI 1.70, 3.40) higher in HSES children compared to LSES after

prevalence and association with socio-economic status	Claude Mbanya	anthropometric parameters were measured using validated methods. The World Health Organization body mass index-for-age reference curves were used.	adjusting for age and gender. However, this association was attenuated to 1.18 (95% CI 0.59, 2.35) once adjustment had been made for a range of potential confounders.

II.7 POTENTIAL MECHANISMS LINKING MALNUTRITION AND SALIVARY pH ALTERATIONS

Proposed mechanisms explaining the relationship between malnutrition and salivary pH changes.

a. Firstly, malnutrition-induced changes in salivary gland function, such as reduced flow rate or altered composition, can directly influence pH. For instance, decreased salivary flow diminishes its buffering capacity, making it more susceptible to dietary acids and potentially leading to acidic shifts [47].

b. Secondly, specific micronutrient deficiencies, particularly in calcium and phosphate, can disrupt the buffering system within the saliva, contributing to pH imbalances [49, 50].

c. Thirdly, altered microbial composition in the oral cavity due to malnutrition may influence salivary pH. Malnutrition can promote the overgrowth of acidogenic bacteria, further lowering pH and increasing the risk of dental caries [51].

There is a paucity of data in the literature to confirm these either globally or in Africa…

CHAPTER III: RESEARCH METHODS

III.1 STUDY DESIGN

We carried out a school-based cross-sectional analytical study.

III.2 STUDY AREA AND SETTING

Out of the three high schools in Ntui, we selected two: "Lycée De Ntui" And "Lycée Technique de Ntui". Both schools had the largest adolescent population that is also participating in the SUN-APP project which is a large school educational nutrition intervention project [52].

III.3.1 Location of Ntui

Ntui is a semi-urban area and headquarters of the Mbam-et-Kim division of the Center region of Cameroon. It is located 100 km from Yaoundé with an area of 1,650 km2. The Municipality of Ntui has 27 villages with three 2nd-degree chiefdoms. Ntui has 4,057 students in three schools (two public schools namely: "Lycée de Ntui"(1,799 students), "Lycée Bilingue de Ntui"(708 students), and a private school: "Lycée Technique De Ntui"(1550 students).

It is limited:

- To the North by the municipality of Yoko in the Mbam and Kim division (176 km)
- To the South by the municipality of Batschenga in the Lekie division (20 km)
- To the West by the municipality of Sa'a in the Lekie division (37 km)
- To the East and North-East by the Sanaga River

The three schools in Ntui had an enrollment rate of 4057 students with each school made up of a first cycle (form 1 to form 5) and a second cycle (lower-sixth and upper-sixth).

III.3 STUDY DURATION AND PERIOD

This study was carried out over a period of 7 months: November 2023 to May 2024. The thesis proposal was written from November 2023 to January 2024. Administrative authorization was obtained in January 2024. The patients were recruited in February 2024. Data analysis was performed throughout March and April 2024.

III.4 STUDY POPULATION

Our study population consisted of adolescents between 10-19 years present at the study site.

III.4.1 INCLUSION CRITERIA

- Adolescents living in Ntui, enrolled and regularly attending classes in these two schools who agreed to participate and whose parents signed the assent form for participation.

III.4.2 EXCLUSION CRITERIA

- Adolescents with diseases that require specific diets, including diabetes type 1 and severe food intolerances [53].

III.5 SAMPLING

Ntui has 03 schools: "Lycée de Ntui" with 1,799 students, "Lycée Bilingue de Ntui" with 708 students, and "Lycée Technique De Ntui" with 4,550 students.

In each school, a multistage sampling method was used to select adolescents. At the first level, 2 schools were selected. At the second level, classes were selected. Using a sampling frame of all the schools in the center region containing the type of schools, and the enrolled number of students per school; schools were selected from the Ntui municipality to reflect 80% of the entire population of school-going adolescents. These schools were chosen based on their high enrollment rate.

III.5.1 SAMPLE SIZE

A Multiple Logistic Regression formula of Hsieh et al for calculating the sample size was used in this study [54], which is:

$$N = \frac{(Z\alpha + Z\beta)^2}{P0(1 - P0)\chi(log\,(OR))^2} \; \div \; P0(1 - R^2)$$

Where:
n = sample size (if only a single association)
N= sample size for multiple associations
p0 = expected proportion in population
OR= Odd ratio
$Z\alpha$ = standard normal variant at a
confidence interval of 95% (standard value
1.96).
$Z\beta$=1.64
R= Margin of error (5%)

CALCULATION

From the studies of Boukeng et al [2] on oral pathology and overweight among pupils in government primary schools in Cameroon, we had a prevalence of dental caries of 60.3% [2]. This gave us a p0 value of 0.603. From the study of Robert J. Schroth et al on the Association between Iron status, iron deficiency anemia, and severe early childhood caries, we had an Anemia Odd ratio equivalent to **2** [15]. Therefore, applying the formula above,

$$N = \frac{(1.96 + 1.64)^2}{P0(1 - 0.603)\chi(log\,(2))^2} \div 0.603(1 - 0.5)$$

Therefore, N= 226 school-going adolescents in the Ntui municipality. Accounting for a nonresponse or drop-out rate of 5%, the adjusted sample size is 238 adolescents.

This sample size was then distributed to the selected schools considering the proportion of enrolled adolescents.

Table V: Distribution of sample size in the two schools

Ntui			
Schools	Total Number of students(n) N=3,349	Proportion of enrolled students (p) (n/N)	Number of participants per school (p*238)
LYCEE DE NTUI	1,799	0.54	129
LYCEE TECHNIQUE DE NTUI	1,550	0.46	109
Total	3,349	1	238

III.6 STUDY PROCEDURE

III.6.1 DATA COLLECTION AND MANAGEMENT

Data collection was done using a questionnaire that was established, pretested on 20 students of "Lycée Leclerc" Yaoundé and modified accordingly. Data collectors were trained for two days on the objectives, the relevance of the study, confidentiality of information, anonymity of participation, respondent's rights, informed consent, and bio-physical measurement techniques.

A work schedule was drawn up based on school activity. Students within the study classes (form 1 to form 3) were approached by their teacher as a facilitator. A brief 10-minute lecture was

given to students on some basic knowledge of how to fill out the questionnaire correctly and understand the purpose of the study. The number of students required to meet the minimum sample size, taking into account proportionate allocations, were enrolled. The data was entered into Microsoft Excel, cleaned, and exported to SPSS for statistical analysis.

III.7 LIST OF STUDY VARIABLES

Dependent variable - Salivary pH, Dental caries.

Independent variable – Malnutrition (BMI, HFA, Anemia)

III.7.1 Socio-demographic variables.

Age, sex, class, religion, parent's level of education, pocket allowance.

III.7.2 Clinical variables

Weight, height, hemoglobin, salivary pH.

III.7.3 Variables of the different Oral diseases

DMFT index, oral hygiene index score (OHIS), abrasions/attrition, oral candidiasis, oral tumors, gingival recessions, caries, periodontitis, gingivitis, pericoronitis, dental abscess, pulpitis, malocclusions, dental erosion, enamel hypoplasia, fluorosis, others.

III.7.4 Variables of therapeutic aspects of oral diseases present.

Awareness of dental care, number of times tooth brushing is carried out in a day, number of patients that know the ideal time and method of teeth care, number of patients aware of dental visits

III.8 PARAMETERS STUDIED

III.8.1 ANTHROPOMETRIC DATA

The following parameters were recorded: weight, height, and body mass index. The standard technique for measuring various parameters was adopted and the equipment used was calibrated at regular intervals

III.8.1.1 Measurement of height and weight for the calculation of BMI

BMI for adolescents was calculated with the help of the BMI percentile calculator in metric version by filling in age [years; months], sex, height [cm], and weight [kg] given by the Centres for Disease Control and Prevention for Children and teens. See the diagram of the instrument used in iconography.

a. Weight measurement

We measured weight using an electronic digital scale [Venus Digital LCD Weighing Scale, Ace Incorporation, Jaipur, India]**.** The scale was adjusted to 0 kg before each measurement. The students were asked to remove shoes and socks; as well as sweaters, coats, his jackets; and the bladder emptied. Then, they were asked to climb on the scales, and remain standing still looking straight ahead. We read the displayed weight and reported it on the technical sheet. His weight in kilograms was recorded to the nearest 0.5 kilograms.

b. Height

We used a Stadiometer. The student was asked to stand straight, back against the vertical base of the height board, heels together, toes slightly apart to allow an even distribution of weight on both legs and shoes and socks stripped off. We used a measuring rod with a sliding plate (graduated to within 0.5 cm) which made it possible to locate the upper mark.

c. BMI calculation

Using the formula: BMI = weight/height² Weight in kilograms (kg) and height in meters (m). We carried out the calculation and the result had the unit kg/m².

III.8.1.2 24-HOUR DIETARY RECALL (FEEDING HABITS)

We used the Cameroon diet quality questionnaire (DQQ) which is a 24-hour dietary recall method used to assess someone's food and beverage intake over the past 24 hours. This questionnaire is adapted to the specific foods and beverages that are commonly consumed in Cameroon. The questionnaire is equally designed in a way that is easy to understand and complete, even for people with low literacy levels answering with "YES or NO". A trained interviewer asked the participants to recall everything they ate and drank in detail the previous day using a self-administered questionnaire. This information was then used to estimate the participant's intake of nutrients,

energy, and other dietary components.

Table VI: Food Group Diversity Score (FGDS)
1 point for each "YES" answer to the following food groups[55]:

Food Group	DQQ Question numbers	Possible points
Grains, white roots and tubers, and plantains	1, 2, 3	1
Pulses (beans, peas and lentils)	4	1
Nuts and seeds	21	1
Dairy	14, 15, 25	1
Meat, poultry, and fish	16, 17, 18, 19, 20	1
Eggs	13	1
Dark green leafy vegetables	6*	1
Other vitamin A-rich fruits and vegetables	5, 8	1
Other vegetables	7*	1
Other fruits	9, 10*	1
TOTAL		**SUM (0-10)**

*Note that these groups may be asked two or more questions (e.g. 6.1 and 6.2).

III.8.2 CLINICAL EXAMINATION

A. HEMOGLOBIN COLLECTION

We measured hemoglobin using the HemoCue Hb 301 System (Kit) [Manufactured by HemoCue AB, Kuvettgatan1, SE-262 71 Ängelholm, Sweden] from capillary blood collected from the fingertip using disposable lancets on micro cuvettes. The HemoCue Hb 301 system (kit) is a safe and convenient solution for conducting mobile anemia screening programs. Digital hemoglobin meters are modern marvels that provide fast, convenient, and relatively painless measurements of hemoglobin in red blood cells. Blood samples were collected on the day of the study. Hemoglobin levels were measured chair-side with the HemoCue Hb 301 System (kit)[55]. 4 sampling stations were set up:

Fingertip capillary sampling:

Here, either the middle or ring finger was chosen for the procedure. The fingertip was disinfected using water-soaked absorbent cotton. To encourage blood flow, the finger chosen was squeezed several times. Lancets were then used to prick the fingertips. The first drops of blood were

discarded. Finally, new pressure was applied to the fingertip to obtain a large enough drop for the micro cuvette. This ensured the micro cuvette could be filled at once, without any air bubbles. As a precaution, the outside of the micro cuvette was wiped to keep it clean in case of any overflow.

Sample passage

The microcuvette unit was switched on and we extracted the cuvette holder from its loading position. The display of the cuvette showed "Hb", then after 10 seconds three flashing dashes appeared on the screen. We then placed the micro cuvette on the holder and closed it for reading. An hourglass ("sable") appeared until the result was displayed. Results are then automatically displayed in grams per deciliter (g/dL). Before the study, the Hemocue Hb 301 System (Kit) was calibrated by the research team.

Figure 4: Hemoglobin collection during recruitment in "Lycée de Ntui"

III.8.3 ORAL EXAMINATION
Procedure

Each adolescent was examined on an upright chair and the head bent backwards. Dental consultation trays were made up of (a clean and sterilized mouth mirror, and tweezer) under adequate natural light or with the use of a head torch. To assess oral hygiene, information on basic

knowledge was asked in the questionnaire to make sure the students carried out good oral hygiene. Clinical variables such as oral hygiene were examined in the adolescent's oral cavity [43]

Examination for dental caries was carried out using the dental explorer and disposable plane mouth mirror for an indirect look at lingual areas of the teeth on a chair after cleaning the teeth with cotton rolls, when necessary. This was done according to the World Health Organization's criteria and methods.

Figure 5: Oral examination during recruitment in "Lycée de Ntui".

III.8.3. 1 Determination Of Decayed, Missen, and Filled Teeth

The DMFT index is the sum of all adult decayed, missing, and filled teeth due to caries. When the unit of measurement is the tooth, we talk of DMFT. It can be measured in both adult dentition and deciduous dentition. In the deciduous dentition, we talk of DMFT. The DMFT value for an individual can be gotten by:

Individual DMFT= sum of decayed teeth + sum of missing teeth due to caries

DMFT for the population= sum of individual DMFT ÷number of patients examined

The value obtained permitted us to evaluate the level of susceptibility of the population to dental caries. Note that the wisdom tooth is not included in the DMFT index.

- Very low level when $0 < $ DMFT index $ < 1.1$

- Low level when $1.2 <$ DMFT index < 2.6
- Average level when $2.7 <$ DMFT index < 4.4
- High level when $4.5 <$ DMFT index < 6.5
- Very high level when DMFT index > 6.5

i.   **Prevalence of dental caries**

The prevalence of dental caries was obtained by simply dividing the number of participants with a decayed tooth by the total number of participants examined.

$$\textbf{Prevalence of dental caries} = \frac{\textbf{Number of participants with a decayed tooth}}{\textbf{Total number of examined participants}}$$

III.8.4 PERIODONTAL PARAMETERS

To facilitate the periodontal examination for both the examiner and the patient, the dental arches were divided into six sectors excluding the wisdom teeth according to WHO recommendations. These sectors are called sextants.

- The first sextant goes from the upper right second molar to the upper right first premolar;
- The second sextant runs from the upper right canine to the upper left canine;
- The third sextant goes from the upper left first premolar to the upper left second molar;
- The fourth sextant goes from the lower left second molar to the lower left first premolar;
- The fifth sextant goes from the lower left canine to the lower right canine;
- The sixth sextant runs from the lower right first premolar to the lower right second molar.

III.8.5 ORAL HYGIENE INDICES (OHI) [56]

$$\boxed{\textbf{OHI = PI + CI}}$$

Table VII: Oral hygiene index scores

OHI Scores	Interpretation
0 – 1.2	Good
1.3 – **3.0**	Fair
3.1 – 6.0	Poor

1. PLAQUE INDEX (SILLNESS AND LOE) (PI) [56]

It is unique among the indices used for the assessment of plaque because it ignores the coronal extent of plaque on the tooth surface area and assesses only the thickness of plaque at the gingival area of the tooth.

Table VIII: Plaque Index (Silness and Loe)

Scores	Criteria
0	No plaque in the gingival area
1	A film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may be recognized only by running a probe across the tooth surface
2	Moderate accumulation of soft deposits within the gingival pocket and on the gingival margin and/ or adjacent tooth surface that can be seen by the naked eye
3	Abundance of soft matter within the gingival pocket and/or on the gingival margin and adjacent tooth surface.

$$\text{Plaque index} = \frac{\text{Total plaque scored}}{\text{Number of segments scored}}$$

2. CALCULUS INDEX (CI) [56]

Still, by using the sextant method, we got the scores for each sextant and divided by the number of sextants.

Table IX: Calculus Index Simplified (Greene and Vermillion)

Scores	Criteria
0	No calculus present
1	Supragingival calculus covering not more than a third of the exposed tooth surface
2	Supragingival calculus covering more than one-third but not more than two-thirds of the exposed tooth surface or the presence of individual flecks of subgingival calculus around the cervical portion of the tooth or both
3	Supragingival calculus covering more than two-thirds of the exposed tooth surface or a continuous heavy hand of subgingival calculus around the cervical portion of the tooth or both

$$\text{Calculus index} = \frac{\text{Total calculus scored}}{\text{Number of segments scored}}$$

III.8.6 GINGIVAL INDEX(GI) BY LOE AND SILNESS[56]

Table X: Gingival Index

Scores	Criteria
0	No inflammation
1	Mild inflammation, no bleeding elicited on probing
2	Moderate inflammation, bleeding on probing
3	Severe inflammation

III.8.7 SALIVA COLLECTION AND pH DETERMINATION

This test was performed in the morning. The school-going children were requested to perform oral hygiene procedures immediately after breakfast before saliva sampling [1 hour 30 minutes after breakfast]. They were asked to collect saliva in their mouth, swallow repeat a few times. Then asked to spit saliva into a small plastic cup. The investigator then dipped two test pad of the pH test strip and excess saliva was removed from the test strip. The strip was dipped for 3-4 seconds and the results were read within the next 15 seconds. The strip changed colors according to the pH level, red being the lowest (acidic) and purple being the highest (basic). The test strips were then compared with the color chart from the bottle, box, or user guide. After this, we Matched the test strips' color change with the color chart and recorded our results. Color changes that appeared after 30 seconds had no diagnostic significance. The test strips were then discarded with the plastic cups.

III.9 DATA MANAGEMENT AND STATISTICAL ANALYSIS

All the data was entered using Excel. After that, the data was cleaned. Also, data with incomplete clinical parameters were deleted. The data was then exported to SPSS 23 and each variable was coded. Both descriptive and inferential statistical analysis was carried out using Windows software and IBM Statistical Package for the Social Sciences (SPSS) version 23. The BMI for age and

height-for-age z scores were computed using WHO Anthroplus. For nominal data; frequencies and percentages were reported. We used the Saphiro-Wilktest to assess the distribution of numerical data and described them using mean and standard deviation. Binary logistics was used for the existence of caries and malnutrition whereby our dependent variable was pH and our independent variable was malnutrition or dental caries. Oral diseases represented were transformed into a binary scale using a Binary logistic regression model. Binary logistic regression was used to establish the relationship between salivary pH and malnutrition, dental caries, and DMFT index. Linear regression was used to bring out factors associated with pH. Analytic data were presented as OR and 95% Confidence interval and a p-value less than 0.05 was considered statistically significant.

III.10 ETHICAL AND ADMINISTRATIVE PROCEDURE

Our study population was recruited through the SUN-APP project, a large school-based educational nutrition intervention project [52]. This project already had ethical clearance (APPENDIX III). The study protocol was presented and defended before a jury and after approval, it was deposited to the institutional ethics committee of the Faculty of Medicine and Biomedical Sciences for obtaining an ethical clearance. After approval, we deposited the protocol with the institutional ethics committee. We equally obtained a research authorization from the secondary schools selected for the study. Informed consent was obtained from the participant's parents. We provided a detailed explanation of the study's purpose, objectives, and the participants' roles. We also explained the potential benefits and risks of participation, emphasizing their right to withdraw freely. To ensure anonymity, we assigned random codes to each participant. These codes were used throughout the study documentation, and confidentiality was maintained by limiting access to data to persons not directly involved in the study.

CHAPTER IV: RESULTS

SAMPLING CHART

The information was collected from adolescents in 02 secondary schools (public: "Lycée de Ntui" and private: "Lycee technique de Ntui". Out of the 379 eligible adolescents, we finally included 261 adolescents (See chart below),
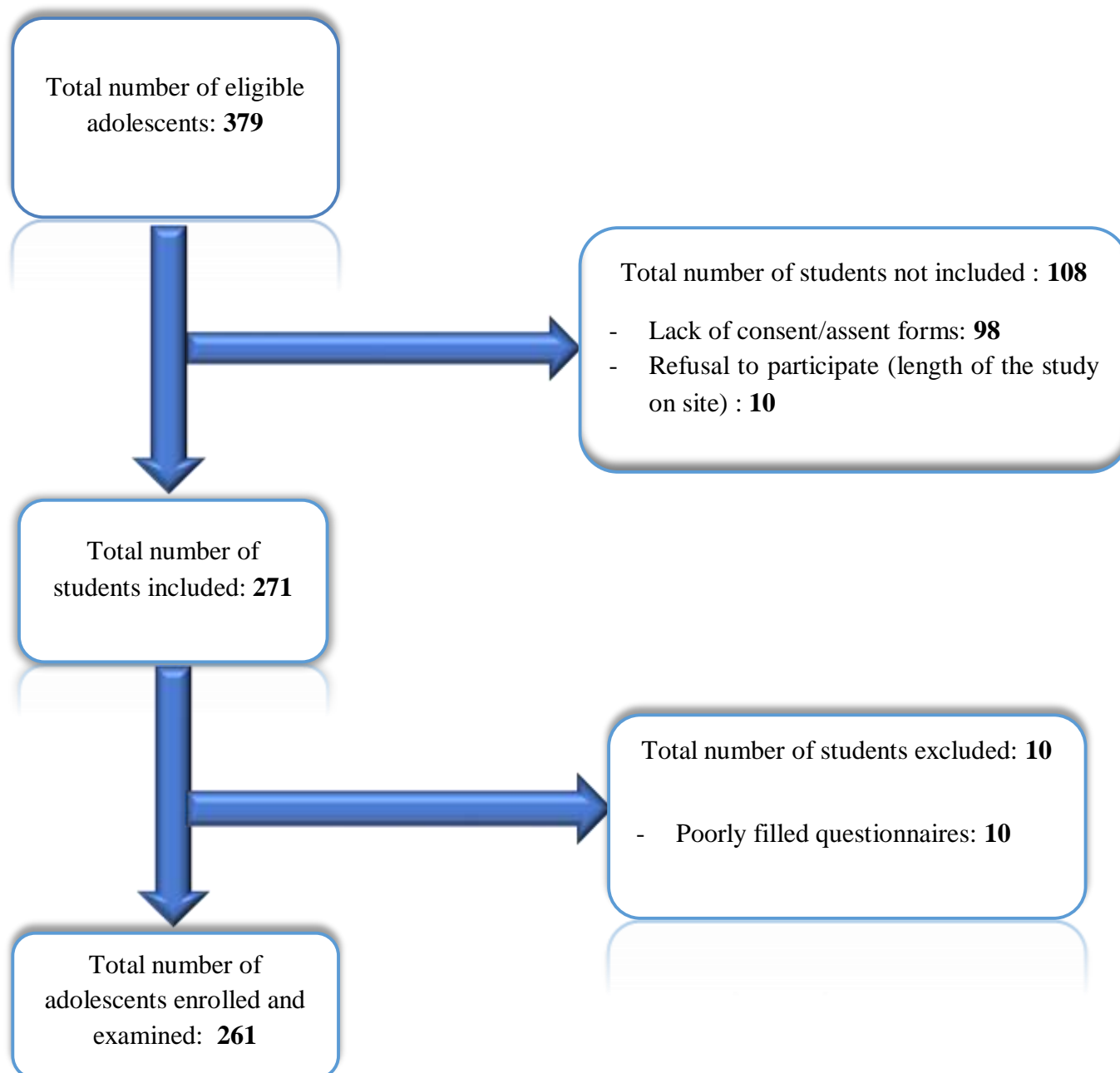
Figure 6: Flow chart of recruitement

IV.1 SOCIODEMOGRAPHIC PROFILE OF THE STUDY POPULATION

IV.1.1 Age, Gender, Schools, Class, Parent's Educational level, and Pocket allowance.

A total of 261 participants were recruited for the study with ages ranging from 10-14 years and the mean age was 12.90(±1.14). Females represent 70.5% of our population. Likewise, form 2 was highly represented, with 57.9%. Most (36.8%) mothers had completed secondary education and most fathers (33.7%) had pursued university education (table IX).

Table XI: Distribution of the study population according to Socio-demographic variables.

Category	Variable	Effective n = 261	Percentage (%)
Mean Age	12.90		
Age range (years)	[10-14]	**248**	**95.0**
	[15-19]	13	5.0
Gender (N)	Female	**184**	**70.5**
	Male	77	29.5
	Form 1	72	27.6
Class(N)	Form 2	**151**	**57.9**
	Form 3	38	14.6
School(N)	"Lycée de Ntui"	164	62.8
	"Lycée technique de Ntui"	97	37.2
Parent Educational level	No Education	3	1.1
	Primary	36	13.8
Mother(N)	Secondary	**96**	**36.8**
	University	58	22.2
	I don't know	68	26.1
	No Education	1	0.4
	Primary	10	3.8
Father(N)	Secondary	74	28.4
	University	**88**	**33.7**
	I don't know	88	33.7
Pocket allowance(FCFA)	Yes	**223**	**85.4**
	No	38	14.6

IV.2 PERCENTAGE OF MALNUTRITION IN THE STUDY POPULATION

IV.2.1 MALNUTRITION

There is a minute proportion of obese and thin individuals (1.9% and 3.4%) with a similarly higher portion of overweight individuals (11.5%). There is a minimal proportion of stunting (7.6%). However, mild malnutrition exists as seen in overweight individuals and mild stunting. Furthermore, anemia, a micronutrient deficiency, affects over 49% of the population (31.4% mild, 17.6% moderate).

Table XII: Distribution of the study population according to Malnutrition.

Variable	Category	Effective (n = 261)	Percentage (%)
Body mass index for Age (kg/m²)			
	Normal	217	83.2
	Obesity	**5**	**1.9**
	Overweight	**30**	**11.5**
	Thinness	**9**	**3.4**
Height for Age(m)			
	Moderately stunted	**15**	**5.7**
	Severely stunted	**5**	**1.9**
	Normal	241	92.4
Anemia status (g/dl)			
	Moderate	**46**	**17.6**
	Mild	**82**	**31.4**
	Non-Anemia	133	51.0

IV.2.2 FEEDING HABITS

As seen in Table X, Starchy foods were consumed by 95.0% of participants. Other vegetables were consumed by 68.6% of the participants. Other fruits were consumed by 65.9% of adolescents.

Table XIII: Distribution of Population according to Feeding Habits.

	Variable	Effective n = 261	Percentage (%)
Starchy foods	Yes	**248**	**95.0**
	No	13	5.0
Pulses (Legumes)	Yes	63	24.1
	No	198	75.9
Nuts and seeds	Yes	154	59.0
	No	107	41.0
Diary	Yes	96	36.8
	No	165	63.2
Meat	Yes	192	73.6
	No	69	26.4
Eggs	Yes	79	30.3
	No	182	69.7
Dark Green Leafy Vegetables	Yes	112	42.9
	No	149	57.1
Other Vit AFV	No	150	57.5
	Yes	111	42.5
Other Vegetables	Yes	**179**	**68.6**
	No	82	31.4
Other Fruits	Yes	**172**	**65.9**
	No	89	34.1
Food Group Diversity Score	< 5	96	36.8
	≥ 5	165	63.2

IV.3 ORAL HEALTH STATUS

Concerning oral hygiene, table XI, most adolescents brush once daily (64.8%). Most adolescents replace their toothbrushes (18.4%) when the bristles are worn. There's also a lack of consensus on the brushing technique, with nearly equal portions reporting brushing from up to down (28.7%), left-right (18.8%), and circular motions (29.1%).

IV.3.1 DENTAL CONSULTATION, TREATMENT DONE, BRUSHING TIME AND METHOD, TOOTHBRUSH USED.

Table XIV: Distribution according to Oral hygiene Practices.

Variables	Effective n = 261	Percentage (%)
Bucco-dental state		
Excellent	56	21.5
Very good	62	23.8
Good	40	15.3
Fair	**92**	**35.2**
Poor	11	4.2
Brushing frequency		
1	**169**	**64.8**
>1	92	35.2
Brushing Time		
Before breakfast	**132**	**50.6**
After every meal	46	17.6
Before bedtime	37	14.2
Before breakfast and before bedtime	46	17.6
Brushing Method		
From Up to Down	75	28.7
From Left to Right	49	18.8
Circular manner	**76**	**29.1**
All the above	61	23.4
Percentage of changing toothbrush		
Every month	88	33.7
After 3 months	103	39.5
After 6 months	22	8.4
When it gets bad	**48**	**18.4**
Type of toothbrush		
Hard	36	13.8
Soft	**161**	**61.7**
Medium	64	24.5

IV.3.2 DENTAL VISIT

81.6% have never consulted a dentist. Even among those who visited the dentist last year (25.7%), the most common reason was pain (11.9%)-table XII.

Table XV: Distribution according to Dental Visit.

Variables	Effective n = 261	Percentage (%)
Dental consultation		
Yes	48	18.4
No	**223**	**81.6**
If yes, treatment done		
1	71	27.3
>1	14	5.4
Visit to the dentist last year		
0	194	74.3
≥1	**67**	**25.7**
Reason for visiting dentist last year		
Pain	**31**	**11.9**
Follow-up	3	1.1
Check-up	14	5.4

IV.3.3 BRUSHING SUBSTANCE

A significant minority 33.7% and 37.9% respectively use unconventional cleaning methods like ash or salt.

Table XVI: Substance used to brush teeth in our study population.

Substance used to brush teeth	Effective n = 261	Percentage (%)
Toothpaste		
Yes	224	85.8
No	37	14.2
Toothbrush		
Yes	248	95.0
No	13	5.0
Soap		
Yes	77	29.5
No	184	70.5
Ash		
Yes	**88**	**33.7**
No	173	66.3
Salt		
Yes	**99**	**37.9**
No	162	62.1
Charcoal		
Yes	92	35.2
No	169	64.8
Dental Floss		
Yes	43	16.5
No	218	83.5
Toothpick		
Yes	56	21.5
No	205	78.5
Interdental brush		
Yes	50	19.2
No	209	80.1
Stick		
Yes	41	15.7
No	220	84.3
Commercial mouthwash		
Yes	88	33.7
No	173	66.3
Others*		
Yes	34	13.0
No	227	87.0

Others*: Bicarbonate, Baking soda, Neem, Crushed charcoal.

IV.3.4 DENTAL CARIES

Most people understand that sugar and lack of brushing cause cavities (71.6%) and that cavities impact teeth (70.1%). When it comes to prevention, there's some awareness about avoiding sugary things (46.5%), but knowledge about the most effective method, using fluoride toothpaste, seems lower (24.9%).

Table XVII: Knowledge of dental caries

	Effective (n = 261)	Percentage (%)
Cause of dental caries		
Sugar consumption and no brushing	**187**	**71.6**
Fruits	20	7.7
Don't know	54	20.7
Does dental caries affect?		
Teeth	**183**	**70.1**
Gingiva	24	9.2
I don't know	54	20.7
Prevention of dental caries		
Avoiding sugary stuff	**121**	**46.5**
Brushing with fluoride toothpaste	**65**	**24.9**
Auto-medication	9	3.4
No possible prevention	**3**	**1.1**
Avoid sugar and brushing	36	13.8
I don't know	27	10.3
Treatment of dental caries		
Extraction	**86**	**33.3**
Treatment	20	7.7
Auto-medication	60	23
I don't know	94	36
What you did do when last you had a toothache?		
Never had	141	55.2
Nothing	30	11.5
Auto-medication	**55**	**21.1**
Dental Consultation	15	5.7
Other treatment	17	6.5
Toothache during the last 12 months?		
No	160	61.4
Rarely	63	24.1
Sometimes	22	8.4
Most of the time	12	4.6
Always	4	1.5

IV.3.5 ORAL HEALTH IMPACT

26.8% of adolescents experience difficulty eating due to oral health issues. While 12.3% reported challenges speaking clearly. Poor oral health also impacts emotional well-being, with over half (56.9%) admitting a negative effect on their self-esteem due to the appearance of their teeth. This can further affect social interactions as 15.8% reported difficulty smiling or laughing freely.

Table XVIII: Oral health impact on social life

Variable	Effective n = 261	Percentage (%)
Eating difficulty		
Yes	**70**	**26.8**
No	191	73.2
Talking difficulty		
Yes	**32**	**12.3**
No	229	87.7
Insomnia		
Yes	39	14.9
No	222	85.1
School attendance		
Yes	39	14.9
No	222	85.1
Self-love (teeth)		
Yes	**148**	**56.9**
No	113	43.1
Smiling/laughing		
Yes	**41**	**15.8**
No	220	84.2

IV.3.6 ORAL DISEASES

The most prevalent oral disease observed was dental caries, with a percentage of 49.8% experiencing this condition. Malocclusions were present in 12.6%.

Table XIX: Distribution of oral diseases.

Oral diseases	Variable	Effective (n = 261)	Percentage (%)
Dental Caries	Yes	**130**	**49.8**
	No	131	50.2
Malocclusions	Yes	**33**	**12.6**
	No	228	87.4
Pericoronitis	Yes	4	1.5
	No	257	98.5
Pulpitis	Yes	17	6.5
	No	244	93.5
Gingivitis	Yes	47	18
	No	214	82
Periodontitis	Yes	17	6.5
	No	244	93.5
Gingival Recessions	Yes	17	6.5
	No	244	93.5
Enamel Hypoplasia	Yes	2	0.8
	No	259	99.2
Abrasion/Attrition	Yes	14	5.4
	No	247	94.6
Dental Abscess	Yes	3	1.1
	No	258	98.9
Dental Erosions	Yes	1	0.4
	No	260	99.6
Oral Tumor	Yes	0	0
	No	261	100
Oral candidiasis	Yes	1	0.4
	No	260	99.6
Fluorosis	Yes	1	0.4
	No	260	99.6
Others	Yes	7	2.7
	No	254	97.3

IV.3. 7 ORAL HYGIENE AND CARIES INDEX

The mean DMFT of the population is 1.61 and 61.7% have good oral hygiene, which contributes to the high number (50.2%) of participants with no cavities nor fillings (DMFT score of 0).

Table XX: Results from Evaluation of Oral Indices

Variable	Score	Effective (n = 261)	Percentage (%)
Oral Hygiene Index Score	**Good**	**161**	**61.7**
	Fair	63	24.1
	Poor	37	14.2
DMFT INDEX	**0**	**131**	**50.2**
	1	31	11.9
	2	29	11.1
	3	24	9.2
	4	19	7.3
	5	6	2.3
	6	9	3.4
	7	3	1.1
	8	6	2.3
	9	2	0.8
	10	1	0.4
Mean DMFT of the population	**1.61**	**1.61**	**1.61**

IV.3.8 SALIVARY pH

This data explores two aspects of salivary pH in the study population. It reveals a varied distribution of pH levels. Almost 40% (39.9%) of the population has acidic pH, a third (33.3) has neutral pH, and the remaining quarter (26.8%) has basic pH. Also, the data introduces a categorization system where only a neutral pH is considered "normal" (33.3%), while any deviation towards acidic or basic is classified as "abnormal" (66.7%).

Table XXI: Distribution of the study population according to salivary pH.

Variable	Category	Effective	Percentage (%)
pH	Acidic	104	39.9
	Neutral	87	33.3
	Basic	70	26.8
	Total	261	100

IV.4 RELATIONSHIP BETWEEN MALNUTRITION AND SALIVARY pH

IV.4.1 DISTRIBUTION OF SALIVARY pH AMONGST DIFFERENT NUTRITIONAL STATUS CATEGORIES.

IV.4.1.1 pH versus Body mass index

39.9% of the study population had acidic saliva, regardless of BMI category. Interestingly, the percentage of people with neutral saliva remained consistent across nutritional status groups (33.3%). Basic saliva, on the other hand, was less common(26.8%). Acidic pH is highest among those with normal BMI (80.7%) and lowest among those with thinness (5.8%). The percentage of people with basic pH is highest among those with overweight (11.4%) and lowest among those with obesity (1.0%).

Table XXII: Distribution of salivary pH versus Body mass index.

Variable	Normal		Obesity		Overweight		Thinness		Total	
	n	%	n	%	n	%	n	%	n	%
Body Mass Index										
Acidic	84	80.7	1	1.0	13	12.5	6	5.8	104	39.9
Basic	58	82.9	3	4.3	8	11.4	1	1.4	70	26.8
Neutral	75	86.3	1	1.1	9	10.3	2	2.3	87	33.3
Total	217	83.1	5	1.9	30	11.5	9	3.5	261	100

IV.4.1.2 pH versus Height for Age.

The distribution of salivary pH across height for age categories reveals no clear association with height. Each height group has a spread of acidic, basic, and neutral pH levels, with the majority falling within the normal height range (acidic: 90.4%, basic: 94.3%, neutral: 93.1%).

Table XXIII: Distribution of Salivary pH versus Height for Age

Variable	Normal		Severely stunted		Moderately stunted		Total	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Height For Age								
Acidic	94	90.4	3	2.9	7	6.7	104	39.9
Basic	66	94.3	1	1.4	3	4.3	70	26.8
Neutral	81	93.1	1	1.1	5	5.8	87	33.3
Total	241	92.3	5	2.0	15	5.7	261	100

IV.4.1.3 pH versus Height for Anemia status.

Each anemia category has a spread of acidic, basic, and neutral pH levels, with a relatively even distribution across groups. For example, among those with non-anemia, roughly half have acidic pH (52.9%), with the remaining percentages split between basic (48.6%) and neutral (50.6%). Similarly, the distribution of pH levels is fairly even for mild anemia (acidic: 31.7%, basic: 30.0%, neutral: 32.2%) and moderate anemia (acidic: 15.4%, basic: 21.4%, neutral: 17.2%).

Table XXIV: Distribution of Salivary pH versus Anemia status.

Variable	Non-Anemic		Mild Anemia		Moderate Anemia		Total	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Anemia status								
Acidic	55	52.9	33	31.7	16	15.4	104	39.9
Basic	34	48.6	21	30	15	21.4	70	26.8
Neutral	44	50.6	28	32.2	15	17.2	87	33.3
Total	133	51.0	82	31.4	46	17.6	261	100

IV.4.2 BIVARIATE ANALYSIS

Statistically significant associations were absent though some traits emerged. There is no clear link between dietary diversity (score < 5 vs ≥ 5) and salivary pH (OR: 1.55, p-value: 0.103). Also, no significant connections were found between abnormal BMI (obesity, overweight, thinness) or stunting Yes (Moderately + Severely Stunted) and salivary pH (OR 1.4, p-values over 0.35). Equally, People with anemia don't have a higher or lower chance of abnormal pH (odds ratio: 0.98, p-value: 0.930). A trend suggests better hygiene (good index) might be associated with normal pH (OR: 1.49), but the p-value (0.151) indicates further investigation is needed.

Table XXV: Bivariate analysis between pH and Malnutrition, and Oral Hygiene

Variable	Normal pH n = 87	Abnormal pH n = 174	Crude odd ratio	P value
Nutrition				
Dietary diversity score < 5	38	58	1	0.103
Dietary diversity scores ≥ 5	49	116	1.55(0.91-2.63)	0.103
Body mass index				
Normal	75	142	1	0.351
Abnormal*	12	32	1.4(0.69-2.89)	0.351
Stunting*				
Yes	6	14	1.18(0.44-3.20)	0.742
No	81	160	1	0.742
Status Anemia				
Yes	43	85	0.98(0.58-1.64)	0.930
No	44	89	1	0.930
Oral hygiene				
Index				
Good	59	102	1.49(0.87-2.56)	0.151
Poor	28	72	1	0.151

OR= Odd ratio

Abnormal BMI= Obesity + Overweight + Thinness

Stunting YES = Moderately + Severely Stunted.

LOGISTIC REGRESSION

No significant associations were found between "abnormal BMI" and salivary pH (odds ratios around 1.19, p-values over 0.65).

Relationship between pH and malnutrition

Variable	pH normal n=87	pH anormal n=174	Crude OR	p value	Adjusted OR	p value
BMI						
Normal	75	142	1		1	
Abnormal	12	32	1.4(0.69-2.89)	0.351	1.19(0.58-2.34)	0.656
Anemia						
Yes	43	85	0.98(0.58-1.64)	0.930	0.94(0.56-1.59)	0.821
No	44	89	1		1	

IV.4.3 LINEAR REGRESSION

Consuming a diet richer in starches is linked to a statistically significant decrease in salivary pH (more acidic) by a range of -1.07 to -0.18 (p-value = 0.006). However, the significant p-value (0.039) suggests a link worth exploring further to understand the precise nature of this relationship between brushing and pH. Concerning dental health, the presence of dental caries (cavities) is associated with a lower salivary pH (coefficient: 0.16, -0.55; p-value < 0.001). Also, the DMFT index likely reflects the number of decayed, missing, and filled teeth. A higher DMFT score is linked to a slight decrease in salivary pH (-0.11, -0.02), with a significant p-value (0.007). Similar to brushing time, the coefficient's direction might not directly translate to cause and effect, but it highlights a connection that deserves further exploration.

Table XXVI: Linear Regression analysis of factors associated with pH
(continuous variable)

Variable	Coefficient	95% confidence interval (aR²= 0.089)	p value
Starchy foods	-0.15	(-1.07, -0.18)	**0.006**
Brushing time	-0.12	(-0.17, -0.01)	**0.039**
Dental caries	0.19	(0.16, -0.55)	**< 0.001**
DMFT index	-0.39	(-0.11, -0.02)	**0.007**

DMFT index: Decayed, Missing, and Filled Tooth

IV.5 RELATIONSHIP BETWEEN MALNUTRITION AND DENTAL CARIES

IV.2.5 MULTIPLE LOGISTIC REGRESSION

The analysis suggests that individuals with overweight, obesity, thinness, or stunted growth may have a lower risk of caries compared to their normal reference groups. Obese adolescents had a COR: 0.51 (95% CI: 0.23-1.13), p-value: 0.10 (49% lower odds, marginally significant) and an AOR: 0.48 (95% CI: 0.22-1.06), p-value: 0.07 (52% lower odds, closer to significance). Thin adolescents had a COR: 0.25 (95% CI: 0.05-1.25), p-value: 0.09 (75% lower odds, marginally significant). Stunted Growth had a COR: 0.41 (95% CI: 0.15-1.09), p-value: 0.065 (59% lower odds, marginally significant) and an AOR: 0.42 (95% CI: 0.15-1.14), p-value: 0.09 (58% lower odds, marginally significant). Anemia is not a statistically significant factor for caries occurrence in this study population. Anemia status had a COR: 0.79 (95% CI: 0.49-1.29), p-value: 0.352 (21% lower odds) and an AOR: 0.84 (95% CI: 0.51-1.38), p-value: 0.49 (16% lower odds).

Table XXVII: Binary logistic regression analysis between Malnutrition and caries

Variable	Caries(Yes)	Caries (No)	COR	p-value	AOR	p-value
Weight status						
Normal	115	102	1		1	
Overweight	2	3	0.59(0.10-3.61)	0.57	0.56(0.92-3.46)	0.53
Obesity	11	19	0.51(0.23-1.13)	**0.10**	0.48(0.22-1.06)	**0.07**
Thinness	2	7	0.25(0.05-1.25)	**0.09**	0.31(0.06-1.58)	0.16
Height for age						
Normal	124	117	1		1	
Stunted	6	14	0.41(0.15-1.09)	**0.065**	0.42(0.15-1.14)	**0.09**
Hemoglobin status						
Anemia	60	68	0.79(0.49-1.29)	0.352	0.84(0.51-1.38)	0.49
No Anemia	70	63	1		1	

CHAPTER V: DISCUSSION

This study sought to investigate the relationship between malnutrition and salivary pH among school-going adolescents in Ntui Municipality. In that light, we carried out a school-based cross-sectional study. We enrolled and examined a total of 261 participants. The participants' data on socio-demographic characteristics, dietary intake, oral hygiene status, oral examination, anthropometric, hemoglobin level, and salivary pH were collected.

STRENGTH OF THE STUDY

- **Non-invasive measure**: Salivary pH is a relatively easy and non-invasive way we used to assess oral health status. Using this makes it a potentially useful tool for screening large populations of adolescents.

- **Public health significance**: Malnutrition and oral health problems are both prevalent issues among adolescents, especially in resource-limited settings. Our study brought out how prevalent oral health is neglected in Rural areas.

- **Investigating the association of pH and Anemia**: Investigating a potential link with micro-nutrient undernutrition has not been explored in our context.

LIMITATIONS OF THE STUDY

- **Measurement limitations:** pH test strips, offer a snapshot but do not capture the full dynamic range, potentially missing subtle variations.

- **Micro-nutrient deficiencies:** Only iron deficiency was evaluated. Other nutrient deficiencies exist; like Vitamin A, B12, and D, Zinc, Iodine, Calcium, Magnesium, and other deficiencies.

- **Longitudinal vs. Cross-sectional:** A cross-sectional study (measuring both factors at one point) did not definitively prove a cause-and-effect relationship. A longitudinal study, tracking adolescents over time, would have brought out a stronger evidence.

➢ SOCIO-DEMOGRAPHIC CHARACTERISTICS

Out of the 261 participants with a mean age of 12.90 ± 1.1 and an age range of $10 - 19$ years. The percentage of females and males examined was 184 (70.5%) and 77 (29.5%) respectively. Agbor et al. in 2020 in Cameroon, equally reported a higher prevalence among females, which is consistent with our findings [57]. This mean age and age range are similar to the studies carried out

by A. E. González-Aragón in 2020 in Mexico and Georgiana et al in Romania, western Europe in 2023 [43, 58]. However, they differ from that of Lifoter et al. in 2015 who found 51.5% of male pupils in their study in urban and rural primary schools in the North West Region [59] indicating that there is no gender discrimination in our education system. We observed that for parents, 33.7% of fathers attained the tertiary level of education while most mothers 36.8% ended at the secondary level of education which is controversial to the study carried out by Henry A. Akinsola et al in Ebonyi State, south-eastern Nigeria whereby parents ended at the primary level of education in a rural setting thereby promoting a high prevalence of malnutrition and oral diseases [60].

➢ THE PROPORTION OF MALNUTRITION

Our study population revealed a complex nutritional landscape. While the majority (83.2%) had a normal weight for their age, indicating adequate calorie intake, a small percentage (3.4%) showed signs of thinness and potential macro-nutrient (overweight and obesity at 13.4%) deficiency. Our results are similar to the study of Henry A. Akinsola in 2018 in Ebonyi state, Nigeria whereby they had more of normal weight adolescents than malnourished individuals in a Rural setting [60]. This could be explained by access to fresh food due to the fact most people living in Ntui are farmers. However, this is controversial to the study of Bede F et al in 2020 in Cameroon whereby they had a high proportion of malnourished individuals due to high-calorie, low-nutrient options and limited access to fresh products which lead to reliance on processed foods high in calories but low in nutrients. The results of other studies among school children in Cameroon, agree with this finding, which shows the occurrence of undernutrition in some regions of Cameroon [3, 64, 71].

Similarly, height measures showed normal growth for most (92.4%), but a small portion (7.6%) exhibited stunted growth, possibly due to childhood malnutrition. These findings indicate our study population does not eat balanced meals and does not meet their daily nutrient requirements for it is recommended to eat fruit daily and vegetables regularly in addition to eating three main meals a day to meet the daily nutrients and energy requirements [72]. They rather consume more starch (95%) meals. However, a more prevalent concern was anemia, a micro-nutrient deficiency, affecting nearly half the population (49%). This widespread anemia, with varying degrees of severity (31.4% mild, 17.6% moderate), occurred even among those with normal weight for age. This could be explained by lack of awareness about balanced diets, no taking of iron supplements

during menstruation, and Inadequate sanitation which could increase the risk of infections, further compromising nutrient absorption [32, 73]. These results suggest that iron levels in children's diets were insufficient to sustain the required level of hemoglobin. This is similar to the study of Zegeye et al in 2021 in Mbouda in Western Cameroon who had revealed that 17.64 % of adolescents aged 10-12 years were anemic, compared to 82.4 % for those aged 13-19 years, which revealed that the prevalence of iron deficiency anemia increased with adolescents' age [74].

➢ **ORAL HEALTH STATUS**

Dental caries was observed in 49.8% of participants, similar to Boukeng et al's 2023 study [2]. However, Agbor et al. in 2020 reported 28.1% of dental caries in the Western Region, of Cameroon[57, 61] and Trinita et al. in 2015 in the Mfoundi Division found 43% of pupils from 6 to 12 years old suffering from dental caries [62].

Dental care was not a priority for many people, as only 18.4% of our study population attends regular dental check-ups probably due to the absence of dental clinics and poor oral health education. This is similar to a study carried out by Ashu Michael et al in Yaoundé in 2023 whereby late consultation counted for more than 70% of the people and led to dental caries complications, such as pulpitis [63]. Among those who visited the dentist last year (25.7%), the most common reason for the visit was due to pain (11.9%). This is similar to the study of Guillaume Aimond et al in Bamendou -Cameroon in 2023 who found that no local dental care was available[64] and similar to the study of Ngancha Mbanya et al in 2019 in Cameroon who found that more than a third of 80(38.5%) of the patients self-medicated because of pain, 28.4% because of financial difficulties, and 18.8% because of lack of time to consult a dentist [65]. This suggests that early intervention could prevent potential dental problems. Around a third of individuals use unconventional cleaning methods such as ash or salt (33.7% and 37.9% respectively) which is similar to the study of Guillaume Aimond et al in Bamendou-Cameroon in 2023 who found that while only 35.2% of children brushed their teeth at least twice a day, 13% worryingly reported the use of products other than toothpaste (ash, soap, salt, or bicarbonate) [64]. There's also a lack of consensus on the brushing technique, with nearly equal portions reporting brushing from up to down (28.7%), left-right (18.8%), and circular motions (29.1%). Similarly, a study by H. Blaise Nguendo et al in Bafia-Cameroon in 2021 reported that 12.0% brush their teeth according to the WHO recommendations [66]. 39.9% of our population had an acidic pH. This could be explained

by the consumption of starchy foods which showed a statistically significant decrease in salivary pH (more acidic) from -1.07 to -0.18 (p-value = 0.006). Starchy foods create an acidic oral environment by providing slow-metabolizing sugars, ideal for the growth of bacteria like Staphylococcus aureus and Streptococcus mutans [62]. Bacteria break down sugars and produce lactic acid, which degrades tooth enamel causing white spots. In Cameroon, Fala Bede et al found that 40.8% of students snack daily, while their daily intake of milk, fruits, vegetables, and meat is low. (6.2%, 4.3%, 20.0%, and 21.3% respectively) [69, 70].

> ### THE RELATIONSHIP BETWEEN SALIVARY PH AND MALNUTRITION

Intriguingly, our study didn't reveal significant relationship between malnutrition and salivary pH. This is similar to the study of Baliga et al in 2013 in India whose results showed undernutrition (underweight) and stunting had no effect on unstimulated salivary flow rate or saliva pH[46]. This result is similar to the study of Doaa et al in 2016 in Egypt which showed undernutrition (underweight) and stunting had no effect on saliva pH [11]. While the observed distribution between malnutrition and saliva pH in the table might suggest a connection, statistical analysis (including OR and p-values) paints a different picture. No significant connections were found between "abnormal BMI" or "stunting Yes" and salivary pH (odds ratios around 1.4, p-values over 0.35). Also, adolescents with anemia don't have a higher or lower chance of abnormal pH (OR: 0.98, p-value: 0.930). This could be explained by the fact that

- The prevalence of malnourished adolescents in our study was low to detect a statistically significant difference with salivary pH.

- Also, other factors beyond malnutrition could significantly influence salivary pH. For instance, medications, diet composition beyond just caloric intake (acidity of food), and even hydration status could all influence.

- Dietary habits could be playing a bigger role in determining salivary pH in our study group. Whereby in our population, consuming a diet richer in starches was linked to a statistically significant decrease in salivary pH (more acidic) by a range of -1.07 to -0.18 (p-value = 0.006) [67, 68].

CONCLUSION AND RECOMMENDATIONS

CONCLUSION

Our study aimed to investigate the relationship between malnutrition and salivary pH among school-going adolescents in Ntui Municipality, Centre Region of Cameroon. At the end of this study, we arrived at the following conclusions;

- A substantial portion (16.8%) had abnormal Body Mass Index (BMI) for their age, 11.5% were overweight, 3.4% were thin, 1.9% were obese and a high percentage (49%) had anemia.

- Nearly half (49.8%) of adolescents suffered from dental caries. A significant portion (39.9%) presented with acidic salivary pH, a factor known to contribute to cavities.

- No significant association was found between the various forms of malnutrition and salivary pH and caries.

RECOMMENDATION

To the scientific community:

- Investigate the high burden of anemia found in this population with so low BMI problems.
- Conduct larger-scale studies to investigate the putative relationship between malnutrition and salivary pH with a larger sample size and a better pH machine.
- Future studies could specifically focus on individuals with anemia to see if there are any trends in salivary pH compared to healthy controls.

To clinicians:

- Promote preventive dentistry by encouraging regular dental checkups and cleanings, emphasizing the importance of early intervention for dental problems.
- Consider salivary testing as a supplementary diagnostic testing

To the ministry of public health:

- Public education campaigns to raise awareness about the importance of oral hygiene by increasing oral health education and promotion in the school milieu.
- Increase access to dental care by improving and increasing dental clinics and programs for school-going adolescents, particularly in underserved areas.
- Health promotion for preventing adolescent malnutrition by implementing programs to promote balanced diets rich in fruits, vegetables, and iron-fortified foods in schools and communities.
- Promote existing or implement anemia control programs all over the nation.

To Adolescents:

- Maintain good oral hygiene by brushing twice daily with fluoride toothpaste, floss regularly, and visit the dentist for regular checkups.
- Improve dietary choices by consuming more balanced diets; rich in fruits, vegetables, whole grains, and lean protein.

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APPENDIX I: ETHICAL CLEARANCE OF THE FACULTY OF MEDICINE AND BIOMEDICAL SCIENCES

UNIVERSITÉ DE YAOUNDÉ I

FACULTÉ DE MÉDECINE ET DES SCIENCES BIOMÉDICALES

COMITÉ INSTITUTIONNEL D'ÉTHIQUE DE LA RECHERCHE

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THE UNIVERSITY OF YAOUNDE I

FACULTY OF MEDICINE AND BIOMEDICAL SCIENCES

INSTITUTIONAL ETHICAL REVIEW BOARD

Ref. : N° 0681 /UY1/FMSB/VDRC/DAASR/CSD

CLAIRANCE ÉTHIQUE   10 JUIN 2024

Le COMITÉ INSTITUTIONNEL D'ÉTHIQUE DE LA RECHERCHE (CIER) de la FMSB a examiné

La demande de la clairance éthique soumise par :

M.Mme : AYENI OMOWUMI BORIS   Matricule: **17M204**

Travaillant sous la direction de :

- Pr SOBNGWI Eugene
- Dr NOKAM TAGUEMNE Marie Elvire Epse ABENA
- Dr GUEWO Magellan

Concernant le projet de recherche intitulé :   Malnutrition and salivary PH amongst school going adolescents in secondary schools in Ntui

Les principales observations sont les suivantes

Evaluation scientifique	
Evaluation de la convenance institutionnelle/valeur sociale	
Equilibre des risques et des bénéfices	
Respect du consentement libre et éclairé	
Respect de la vie privée et des renseignements personnels (confidentialité) :	
Respect de la justice dans le choix des sujets	
Respect des personnes vulnérables :	
Réduction des inconvénients/optimalisation des avantages	
Gestion des compensations financières des sujets	
Gestion des conflits d'intérêt impliquant le chercheur	

Pour toutes ces raisons, le CIER émet un avis **favorable** sous réserve des modifications recommandées dans la grille d'évaluation scientifique.

L'équipe de recherche est responsable du respect du protocole approuvé et ne devra pas y apporter d'amendement sans avis favorable du CIER. Elle devra collaborer avec le CIER lorsque nécessaire, pour le suivi de la mise en œuvre dudit protocole. La clairance éthique peut être retirée en cas de non - respect de la réglementation ou des recommandations sus évoquées. En foi de quoi la présente clairance éthique est délivrée pour servir et valoir ce que de droit

LE PRÉSIDENT DU COMITE ETHIQUE

APPENDIX II: RESEARCH AUTHORIZATION FROM THE FACULTY OF MEDICINE AND BIOMEDICAL SCIENCE

RÉPUBLIQUE DU CAMEROUN
Paix – Travail – Patrie

UNIVERSITE DE YAOUNDE I

FACULTE DE MEDECINE ET DES SCIENCES BIOMEDICALES

E.mail : decanatfmsb@hotmail.fr

REPUBLIC OF CAMEROON
Peace – Work – Fatherland

THE UNIVERSITY OF YAOUNDE I

FACULTY OF MEDICINE AND BIOMEDICAL SCIENCES

Yaoundé, **2 7 MAI 2024**

N° 3351 /UY1/FMSB/VDRC/DAASR/CSD

AUTORISATION DE RECHERCHE

Je soussigné, **Professeur Jacqueline ZE MINKANDE**, Doyen de la Faculté de Médecine et des Sciences Biomédicales de l'Université de Yaoundé I,

Autorise Mlle **AYENI OMOWUMI Doris**, Matricule **17M204** étudiante en 7ème année d'Etudes médicales, dans la filiere Médecine Bucco-dentaire à la Faculté de Médecine et des Sciences Biomédicales de l'Université de Yaoundé I, à mener ses recherches sur le Thème intitulé, « **The association between malnutrition and salivary pH amongst school-going adolescents in secondary schools in Ntui**».

Cette enquête se fera sous la Direction du **Pr Sobngwi Eugène**, et la co-direction du **Dr Nokam Abena Marie Elvire** et du **Dr Guewo Fokeng Magellan**.

En foi de quoi la présente autorisation lui est délivrée pour servir et valoir ce que de droit. /-

LE DOYEN,

APPENDIX III: ETHICAL CLEARANCE OF SUN-APP PROJECT UNDER THE MASSIVE SCHOOL EDUCATIONAL NUTRITION PROJECT

REPUBLIQUE DU CAMEROUN Paix -Travail- Patrie	REPUBLIC OF CAMEROON Peace -Work- Fatherland
MINISTERE DE LA SANTE PUBLIQUE	MINISTRY OF PUBLIC HEALTH
SECRETARIAT GENERAL	SECRETARIAT GENERAL
COMITE NATIONAL D'ETHIQUE DE LA RECHERCHE POUR LA SANTE HUMAINE	NATIONAL ETHICAL COMMITTEE FOR RESEARCH ON HUMAN HEALTH
SECRETARIAT TECHNIQUE	TECHNICAL SECRETARIAT

N° 2023/08/**456**/CE/CNERSH/SP

Yaoundé, le **0 4 SEPT 2023**

CLAIRANCE ETHIQUE

Le Comité National d'Ethique de la Recherche pour la Santé Humaine (CNERSH), en sa session extraordinaire du 17 août 2023, a examiné le projet de recherche intitulé : «Scaling Up Healthy Nutrition in Adolescents and Pregnancy for the Early Prevention of Non-Communicable Diseases (SUN-APP) in Cameroon» soumis par le Professeur Eugène SOBNGWI, Investigateur Principal, Université de Yaoundé 1.

Le projet est d'un grand intérêt scientifique et social. Cette étude vise à promouvoir la nutrition et l'activité physique chez les adolescents et les femmes enceintes par le biais d'interventions nutritionnelles à plusieurs niveaux et à plusieurs composantes dans la communauté, les écoles et les centres de soins prénatals au Cameroun. La procédure de l'étude est bien documentée et claire. Cette étude se déroulera dans les Régions du Nord, de l'Ouest, du Littoral, du Sud-Ouest et du Centre-Cameroun. Les risques liés à l'étude sont précisés ainsi que les mesures pour les éviter et les minimiser. La notice d'information et le formulaire de consentement éclairé, en français et en anglais, sont bien élaborés et simples à comprendre. Les mesures prises pour garantir la confidentialité des données collectées sont présentes dans le document. Les CVs des Investigateurs les décrivent comme des personnes compétentes, capables de mener à bien cette étude. Pour toutes ces raisons, le Comité National d'Ethique approuve pour une durée d'un an, la mise en œuvre de la présente version du protocole.

Les Investigateurs sont responsables du respect scrupuleux du protocole approuvé et ne devraient y apporter aucun amendement aussi mineur soit-il, sans avis favorable du CNERSH. Les investigateurs sont appelés à collaborer pour toute descente du CNERSH pour le suivi de la mise en œuvre du protocole approuvé. Le rapport final du projet devra être soumis au CNERSH et aux autorités sanitaires du Cameroun.

La présente clairance peut être retirée en cas de non-respect de la réglementation en vigueur et des recommandations susmentionnées.

En foi de quoi, la présente clairance éthique est délivrée pour servir et valoir ce que de droit.

Ampliations

MINSANTE

Le Président

Pr MBACHAM Wilfred

N.B : cette clairance éthique ne vous dispense pas de l'autorisation administrative de recherche (AAR), exigée pour mener cette étude sur le territoire camerounais. Cette dernière vous sera délivrée par le Ministère de la Santé Publique.

- N° d'enregistrement : IORG0007861-IRB00009439-FWA00016054 - setcominae@gmail.com
- Arrêté N° 0977/A/MSP/SESP/SG/DROS du 18 avril 2012 portant création, organisation et fonctionnement des Comités d'Ethique de la Recherche pour la Santé Humaine au sein des structures relevant du ministère en charge de la santé publique.

APPENDIX IV : "ACCORD DE PRINCIPE"

REPUBLIQUE DU CAMEROUN	REPUBLIC OF CAMEROON
Paix-Travail-Patrie	Peace- Work- Fatherland
**********	**********
MINISTERE DES ENSEIGNEMENTS SECONDAIRES	MINISTRY OF SECONDARY EDUCATION
**********	**********
DELEGATION REGIONALE DU CENTRE	CENTER REGIONAL DELEGATION
**********	**********
SOUS DIRECTION DES AFFAIRES GENERALES	SUB-DIRECTORATE OF GENERAL AFFAIRS
**********	**********
INSPECTION MEDICO-SCOLAIRE	SCHOOL MEDICINE INSPECTORATE

BP 5281 YAOUNDE-NLONGKAK – Tél. / Fax 222 23 51 87 – 222 22 95 07
E-mail drescentre@yahoo.fr

Yaoundé, le **2 4 JAN 2024**

Accusé de réception N° **070** / 24/ MINESEC / DRES-CE/SDAG/IMS

LE DÉLÉGUÉ RÉGIONAL

A

Monsieur l'investigateur Principal du Projet SUN-APP

Objet : Demande d'accord de principe

En accusant réception de votre correspondance du 11/01/24 relative à la demande d'accord de principe pour le démarrage et la mise en œuvre du projet intitulé : « **Scalling Up Nutrition in Adolescents and Pregnancy for the early Prevention of Non-Communicable Diseases (SUN-APP) in Cameroon** », développé dans le cadre du MoU entre RSD Institute et le Ministère des Enseignements Secondaires signé le 08 mai 2018,

J'ai l'honneur de marquer mon accord pour la descente des équipes en vue de l'identification des comportements favorables à la promotion de l'alimentation saine et équilibrée ainsi que l'activité physique régulière chez les adolescents dans les établissements du secondaire de la commune de Ntui et de Yaoundé IV.

Le Délégué Régional

Le Sous-Directeur des
Affaires Générales

Ambassa Amadiang
épse Mbock Eveline
Ingénieur de Conception
PLET Hors-Echelle

APPENDIX V: QUESTIONNAIRE

ORAL HEALTH QUESTIONNAIRE (ENGLISH)

I. SOCIO-DEMOGRAPHIC CHARACTERISTICS

	IDENTIFICATION	CODE
1.	File number	
2.	Sex: **1**=male **2**= Female	
3.	Age:	
4.	Class: 1= No formal Education 2= primary 3=Secondary 4=Tertiary 5= I don't know	

II. GENERAL INFORMATION

1.	WEIGHT	…………………………………………………………………Kg
2.	HEIGHT	…………………………………………………………………m
3.	BMI	…………………………………………………………………Kg/m^2
4.	HEMOGLOBIN	…………………………………………………………………g/dl
5.	Salivary pH	

III. ORAL HEALTH

<u>ORAL HYGIENE</u>

1.	How would you describe the health of your mouth, teeth, and gums, in general? **1**=Excellent **2**=Very good **3**=Good **4**=Fair **5**=Poor	☐
2.	Have you ever visited a dentist? **1**=YES **2**= NO	☐
3.	If yes what treatment was done? **1**=Extraction **2**= Scaling and polishing **3**=Root canal treatment **4**=Others	☐
4.	How often did you visit a dentist last year? **1**=None **2**=Once **3**=twice **4**=Have never visited a dentist	☐
5.	What was the main reason for your last visit to the dentist? **1**=I have never been to the dentist **2**=Something was wrong with my mouth, teeth, or gums **3 For** follow-up treatment from an earlier visit **4**=For a check-up or exam **5**=I do not know	☐
6.	During the past 12 months, how often did you have a toothache?	☐

	1=Never **2**=Rarely **3**=Sometimes **4**=Most of the time **5**=Always	
7.	What causes dental caries? **1**=Frequent eating of sweet foodstuff and not brushing with fluoride toothpaste. **2**=Eating fruits **3**=I don't know	☐
8.	Dental caries is associated with: **1**=Cavity on the tooth, pain, sometimes swelling **2**=Bleeding gums **3**=I don't Know	☐
9.	Dental caries can be prevented by? **1**=Avoiding sweets and brushing with fluoride **2**=tooth paste **3**=Medicines from drug stores **4**=It cannot be prevented	☐
10.	What is the best treatment for decay? **1**=Tooth extraction (removing tooth) **2**=Filling of the decayed part **3**= Use of medicines from drug stores	☐
11.	The last time you had a toothache, what was the **first thing** you did to treat the pain? **1**=I have never had a toothache **2**=I did not do anything **3**=I took some medicine to relieve the pain **4**=I saw a dentist **5**= I did something else	☐
12.	How long do you brush your teeth each time? **1**=Less than 1 minute **2**=1-2 minutes **3**=2-3 minutes **4**=More than 3 minutes	☐
13.	During the past 30 days, did you have difficulty eating because of problems with your mouth, teeth, or gums? **1**=Yes **2**=No	☐
14.	During the past 30 days, did you have difficulty speaking clearly because of problems with your mouth, teeth, or gums? **1**=Yes **2**=No	☐
15.	During the past 30 days, did you have difficulty sleeping because of problems with your mouth, teeth, or gums? **1**=Yes **2**=No	☐
16.	During the past 30 days, did you have difficulty going to school, learning in class, or doing your homework because of problems with your mouth, teeth, or gums? **1**=Yes **2**=No	☐
17.	Are you satisfied with the appearance of your teeth? **1**=Yes **2**=No	☐
18.	Do you avoid smiling or laughing because of how your teeth look? **1**=Yes **2**=No	☐
19.	How many times do you brush your teeth per day? **1**=once 2= twice **3**= ≥ 3times **4**=unable to brush	☐
20.	How often do you change your toothbrush? **1**=Every month **2**= After 3 months **3**= After 6 months **4**= when I notice the toothbrush is getting bad	☐

21.	Which type of toothbrush do you use? 1= Hard **2**= soft 3= medium	☐
22.	When do you brush your teeth? **1**=before breakfast **2**=After each meal **3**=Before going to bed **4**=1 and 3	☐
23.	How do you brush your teeth? **1**=From up to down **2**=From left to right **3**=Circular	☐
24.	For your oral hygiene; do you use**?** A toothbrush **1**=Yes **2**=No	☐
25.	For your oral hygiene; do you use**?** A toothpaste **1**=Yes **2**=No	☐
26.	For your oral hygiene; do you use**?** Soap **1**=Yes **2**=No	☐
27.	For your oral hygiene; do you use**?** Ash **1**=Yes **2**=No	☐
28.	For your oral hygiene; do you use**?** Salt **1**=Yes **2**=No	☐
29.	For your oral hygiene; do you use**?** Charcoal **1**=Yes **2**=No	☐
30.	For your oral hygiene; do you use**?** Dental floss **1**=Yes **2**=No	☐
31.	For your oral hygiene; do you use**?** Toothpick **1**=Yes **2**=No	☐
32.	For your oral hygiene; do you use**?** Interdental brush **1**=Yes **2**=No	☐
33.	For your oral hygiene; do you use**?** Stick **1**=Yes **2**=No	☐
34.	For your oral hygiene; do you use**?** Commercial mouthwash **1**=Yes **2**=No	☐

DENTAL EXAMINATION

Facial and Oral Examination

1.	Does the patient have any adenopathy?	Yes=1 No=2	
2.	Homogeneous coloration of teguments?	Yes=1 No=2	
3.	Facial symmetry	Yes=1 No=2	
4.	Tumefaction?	Yes=1 No=2	
5.	Does the patient have lesions on the lips?	Yes=1 No=2	
6.	Nature of gums?	Normal =1 Dry and pale =2 Swollen and bleeding =3	

7.	Nature of the tongue?	Normal=1 Contains fissures =2 Red/white patches =3 Ulcerated=4	
8.	Other diseases?	1=Abrasions/attrition 2=Oral candidiasis 3=Oral tumors 4=Gingival recessions 5=Caries 6=Periodontitis 7=gingivitis 8=pericoronitis 9=dental abuses 10=Pulpitis 11=Malocclusions 12= Dental erosion 13=Enamel Hypoplasia 14=Fluorosis 15=Others	

I.   Dental exams: DMFT Index

DECAYED	MISSING	FILLED

DMFT INDEX--

II.   PERIODONTAL EXAMS

1- PLAQUE INDEX SILNESS AND LOE

MAXILLARY

0: absence of plaque   1: plaque visible on probing   2: plaque visible to naked eyes   3: abundant deposits

Vestibular													
Teeth	17	16	15	14	13	12	11	21	22	23	24	25	26	27
Lingual													

MANDIBULAR

Vestibular													
Teeth	37	36	35	34	33	32	31	41	42	43	44	45	46	47
Lingual													

2- CALCULUS INDEX SILNESS AND LOE

Calculus index score: 0: absence of calculus

1: Supragingival calculus covering not more than 1/3 of the exposed tooth surface.

2: Supragingival calculus covering more than 1/3 but not more than 2/3 the exposed tooth surface or the presence of individual flecks of subgingival calculus around the cervical portion of the tooth or both

3: Supragingival calculus covering more than 2/3 of the exposed tooth surface or a continuous heavy band of subgingival calculus around the cervical portion of the tooth or both abundant deposits

MAXILLARY

1 = score 0   2 = score 1   3 = score 2   4 = score

Vestibular														
Teeth	17	16	15	14	13	12	11	21	22	23	24	25	26	27
Lingual														

MANDIBULAR

Vestibular														
Teeth	37	36	35	34	33	32	31	41	42	43	44	45	46	47
Lingual														

3- GINGIVAL INDEX LOE AND SILNESS

MAXILLARY

0: healthy gums   1: mild inflammation, no bleeding on probing   2: moderate inflammation, bleeding on probing   3: severe inflammation, spontaneous bleeding

Vestibular														
Teeth	17	16	15	14	13	12	11	21	22	23	24	25	26	27
Lingual														

MANDIBULAR

Vestibular														
Teeth	37	36	35	34	33	32	31	41	42	43	44	45	46	47
Lingual														

4- PERIODONTAL POCKET

MAXILLARY

0: invalid sextant.   1: 0-3mm.   2: 4-6mm   3: >6mm

Vestibular													
Teeth	17	16	15	14	13	12	11	21	22	23	24	25	26	27
Lingual													

MANDIBULAR

Vestibular													
Teeth	37	36	35	34	33	32	31	41	42	43	44	45	46	47
Lingual													

QUESTIONNAIRE SUR LA SANTÉ BUCCODENTAIRE (FRENCH)

I.   CARACTÉRISTIQUES SOCIODÉMOGRAPHIQUES

	IDENTIFICATION	CODE
1.	Numéro de dossier	
2.	Sexe: 1 = Masculin 2 = Feminin	
3.	Age:	
4.	Région d'origine : 1=Extrême-Nord 2=Centre 3=Nord 4=Littoral 5=Adamawa 6=Est 7=Nord 8=Nord-Ouest 9=Sud-Ouest 10=Ouest	
5.	Réligion : Chrétien=1 Musulman=2 Athée=3 Autres=4	

II.   EXAMEN GÉNÉRAL

POIDS	………………………… kg
TAILLE	………………………… m
POIDS CORPORELLE	………………………… kg/m2
HÉMOGLOBINE	………………………… g/dl
pH DE LA SALIVE	

III. SANTÉ BUCCODENTAIRE

HYGIÈNE BUCCALE

1.	Comment décririez-vous la santé de votre bouche, de vos dents et de vos gencives, en général ? **1** = Excellent **2** = Très bien **3** = Bon **4** = Passable **5** = Mauvais	☐
2.	Avez-vous déjà consulté un dentiste ? **1**=Oui **2**=Non	☐
3.	Si oui, quel traitement avez-vous reçus ? **1**=Extraction **2**= Détartrage et polissage **3**=Traitement canalaire **4**=Autres	☐
4.	Combien de fois avez-vous consulté un dentiste l'année dernière ? **1**=Aucun **2**=Une fois **3**=deux fois **4**=N'a jamais consulté un dentiste	☐
5.	Quelle était la raison principale de votre dernière visite chez le dentiste ? **1**=Je n'ai jamais été chez le dentiste **2**=J'avais un problème avec ma bouche, mes dents ou mes gencives **3**=Pour un traitement de suivi d'une visite précédente **4**=Pour un contrôle ou un examen **5**=Je ne sais pas	☐
6.	Au cours des 12 derniers mois, à quelle fréquence avez-vous eu mal aux dents ? **1**=Jamais **2**=Rares **3**=De temps en temps **4**=La plupart du temps **5**=Toujours	☐
7.	Quelles sont les causes de la carie dentaire ? **1**=La consommation fréquente d'aliments sucrés et le fait de ne pas se brosser les dents avec un dentifrice au fluor. **2**=Manger des fruits **3**=Je ne sais pas	☐
8.	La carie dentaire est associée à **1**= Une Cavité sur la dent, douleur, parfois gonflement **2**= Un Saignement des gencives **3**=Je ne sais pas	☐
9.	Les caries dentaires peuvent être évitées en ? **1**=Éviter les sucreries et se brosser les dents avec du fluorure **2**=du dentifrice **3**=Médicaments en pharmacie **4**=Il n'y a pas de prévention possible	☐
10.	Quel est le meilleur traitement pour la carie : **1**=Extraction de la dent (enlever la dent) **2**=comblement de la partie cariée **3**=Utilisation de médicaments en pharmacie	☐
11.	La dernière fois que vous avez eu mal aux dents, quelle a été la première chose que vous avez faite pour soulager la douleur ? **1**=Je n'ai jamais eu mal aux dents **2**=Je n'ai rien fait **3**=J'ai pris des médicaments pour soulager la douleur **4**=J'ai consulté un dentiste **5**= J'ai fait autre chose	☐

12.	Pendant combien de temps vous brossez-vous les dents à chaque fois ? **1**=Moins d'une minute **2**=1-2 minutes **3**=2-3 minutes **4**=Plus de 3 minutes	☐
13.	Au cours des 30 derniers jours, avez-vous eu des difficultés à manger à cause de problèmes de bouche, de dents ou de gencives ? **1**=Oui **2**=Non	☐
14.	Au cours des 30 derniers jours, avez-vous eu des difficultés à parler clairement à cause de problèmes de bouche, de dents ou de gencives ? **1**=Oui **2**=Non	☐
15.	Au cours des 30 derniers jours, avez-vous eu des difficultés à dormir à cause de problèmes de bouche, de dents ou de gencives ? **1**=Oui **2**=Non	☐
16.	Au cours des 30 derniers jours, avez-vous eu des difficultés à aller à l'école, à apprendre en classe ou à faire vos devoirs à cause de problèmes avec votre bouche, vos dents ou vos gencives ? **1**=Oui **2**=Non	☐
17.	Êtes-vous satisfait de l'état de vos dents ? **1**=Oui **2**=Non	☐
18.	Évitez-vous de sourire ou de rire à cause de l'état de vos dents ? **1**=Oui **2**=Non	☐
19.	Combien de fois vous brossez-vous les dents par jour ? **1**=une fois **2**= deux fois **3**= ≥ 3 fois **4**=incapable de se brosser les dents	☐
20.	A quelle fréquence changez-vous de brosse à dents ? **1**=Tous les mois **2**= Après 3 mois **3**= Après 6 mois **4**= lorsque je remarque que la brosse à dents est en mauvais état	☐
21.	Quel type de brosse à dents utilisez-vous ? **1**= dure **2**= souple **3**= moyenne	☐
22.	Quand vous brossez-vous les dents ? **1**=avant le petit déjeuner **2**=Après chaque repas **3**=Avant de se coucher **4**=1 et 3	☐
23.	Comment vous brossez-vous les dents ? **1**=De haut en bas **2**=De gauche à droite **3**= De manière Circulaire	☐
24.	Pour votre hygiène bucco-dentaire, utilisez-vous ? Une brosse à dents **1**=Oui **2**=Non	☐
25.	Pour votre hygiène bucco-dentaire, utilisez-vous ? Un dentifrice **1**=Oui **2**=Non	☐
26.	Pour votre hygiène bucco-dentaire, utilisez-vous ? Du savon **1**=Oui **2**=Non	☐
27.	Pour votre hygiène bucco-dentaire, utilisez-vous ? De la cendre **1**=Oui **2**=Non	
28.	Pour votre hygiène bucco-dentaire, utilisez-vous ? Du sel **1**=Oui **2**=Non	☐
29.	Pour votre hygiène bucco-dentaire, utilisez-vous ? Du charbon **1**=Oui **2**=Non	☐
30.	Pour votre hygiène bucco-dentaire, utilisez-vous ? Du fil dentaire **1**=Oui **2**=Non	☐

31.	Pour votre hygiène bucco-dentaire, utilisez-vous ? Un cure-dent **1**=Oui **2**=Non	☐
32.	Pour votre hygiène bucco-dentaire, utilisez-vous ? Brosse interdentaire **1**=Oui **2**=Non	☐
33.	Pour votre hygiène bucco-dentaire, utilisez-vous ? Bâton **1**=Oui **2**=Non	☐
34.	Pour votre hygiène bucco-dentaire, utilisez-vous ? Rince-bouche commercial **1**=Oui **2**=Non	☐

IV.   EXAMEN DENTAIRE

Examen Facial et Oral

9.	Le patient présente-t-il une adénopathie ?	1 = Oui; 2= Non	
10.	Coloration homogène des téguments ?	1 = Oui; 2= Non	
11.	Symmetrie Faciale	1 = Oui; 2= Non	
12.	Tumefaction?	1 = Oui; 2= Non	
13.	Le patient présente-t-il des lésions sur les lèvres ?	1 = Oui; 2= Non	
14.	Nature/Etat des gencives ?	Normal =1 Sec et pâle =2 Enflée et saignant =3	
15.	Nature de la langue ?	Normal = 1 Contient des fissures =2 Taches rouges/blanches =3 Ulcéré=4	
16.	Autres pathologies ?	Autres pathologies? **1**=Abrasions/attrition **2**=Candidose buccale **3**=Tumeurs buccales **4**=Récessions gingivales **5**=Caries **6**=parodontite **7**=gingivite **8**=péricoronarite **9**=abcès dentaires **10**=Pulpite **11**=Malocclusions **12**= Érosion dentaire **13**=Hypoplasie de l'email **14**=Fluorose **15**=autres	

V.   Examen Dentaire: Indice CAO

CARIE	ABSENT	OBTURER

INDICE CAO--

VI.   EXAMEN PERODONTAL

5- INDICE DE TARTRE SILNESS ET LOE

MAXILLAIRE

1 = score 0   2 = score 1   3 = score 2   4 = score
0 : absence de tartre   1 : tatre visible sur sondage   2 : tartre visible à l'œil nu   3 : dépôt de tartre abondant

Vestibulaire													
Dent	17	16	15	14	13	12	11	21	22	23	24	25	26	27
Lingual													

MANDIBULAIRE

Vestibulaire													
Dent	37	36	35	34	33	32	31	41	42	43	44	45	46	47
Lingual													

6- INDICE DE CALCUL DE SILNESS ET LOE

Calculus index score :   0 : absence de calculs

1 : Calcul supra gingival ne couvrant pas plus de 1/3 de la surface de la dent.

2 : Calcul supra gingival couvrant plus de 1/3 mais pas plus de 2/3 de la surface exposée de la dent ou présence de taches individuelles de calcul sous-gingival autour de la partie cervicale de la dent ou les deux

3 : Calcul supra gingival couvrant plus de 2/3 de la surface exposée de la dent ou une bande lourde continue de calcul sous-gingival autour de la partie cervicale de la dent ou les deux.

MAXILAIRE

1 = score 0   2 = score 1   3 = score 2   4 = score

Vestibulaire														
Dent	17	16	15	14	13	12	11	21	22	23	24	25	26	27
Lingual														

MANDIBULAIRE

Vestibulaire														
Dent	37	36	35	34	33	32	31	41	42	43	44	45	46	47
Lingual														

7- INDICE GINGIVAL SILNESS ET LOE

MAXILAIRE

0 : gencives saines   1 : inflammation légère, pas de saignement au sondage   2 : inflammation modérée, saignement au sondage   3 : inflammation sévère, saignement spontané

Vestibulaire														
Dent	17	16	15	14	13	12	11	21	22	23	24	25	26	27
Lingual														

MANDIBULAIRE

Vestibulaire														
Dent	37	36	35	34	33	32	31	41	42	43	44	45	46	47
Lingual														

8- SAC PERIODONTAL

MAXILAIRE

0 : sextant invalide   1 : 0-3mm.   2 : 4-6mm   3 : >6mm

Vestibulaire														
Dent	17	16	15	14	13	12	11	21	22	23	24	25	26	27
Lingual														

MANDIBULAIRE

Vestibulaire														
Dent	37	36	35	34	33	32	31	41	42	43	44	45	46	47
Lingual														

CAMEROON DIET QUALITY QUESTIONNAIRE

DIET QUALITY QUESTIONNAIRE (DQQ)

CAMEROON

READ: Now I'd like to ask you some yes-or-no questions about foods and drinks that you consumed yesterday during the day or night, whether you had it at home or somewhere else.

First, I would like you to think about yesterday, from the time you woke up through the night. Think to yourself about the first thing you ate or drank after you woke up in the morning … Think about where you were when you had any food or drink in the middle of the day … Think about where you were when you had any evening meal … and any food or drink you may have had in the evening or late-night... and any other snacks or drinks you may have had between meals throughout the day or night.

I am interested in whether you had the food items I will mention even if they were combined with other foods. Please listen to the list of foods and drinks, and if you ate or drank ANY ONE OF THEM, say yes.

	Hier, avez-vous mangé l'un des aliments suivants ?	**(Encercler la réponse)**
1	**Riz, pain, spaghetti, macaroni, fufu de maïs, bouillie de maïs ou de riz ?** Rice, bread, spaghetti, macaroni, corn fufu, maize or rice porridge?	OUI ou NON
2	**Maïs braisé ou bouilli, mil, ou sorgho ?** Burning or boiling corn, millet, or sorghum?	OUI ou NON
3	**Manioc, bobolo ou bâton de manioc, foufou de manioc, igname, patate, pomme de terre, macabo, ou plantain ?** Cassava, bobolo, water fufu, yam, sweet potato, potato, macabo, or plantain?	OUI ou NON
4	**Haricots, koki, pomme pilé, voandzou ou galadji, ou poudre de soja ?** Beans, koki, pomme pilé, Bambara groundnuts, or soy powder?	OUI ou NON
	Hier, avez-vous mangé l'un des légumes suivants ?	
5	**Carottes, courge ou citrouille ?** Carrots, squash, or pumpkin?	OUI ou NON

6.1	**Feuilles de manioc, folon, feuilles de foléré, okok ou eru, feuilles de zom, okoribong, ou feuilles de ndolé ?** Cassava leaves, green, foléré sauce, eru, njama name, okoribong, or bitter leaves ?	OUI ou NON
6.2	**Ekwang, feuilles de kelen Kerlen, water leaves, feuilles de patate douce, ou feuilles de niebe ?** Ekwang, kelen kelen leaves, water leaves, sweet potato leaves, or bean leaves?	OUI ou NON
7.1	**Tomates, aubergine, jakkatou, chou, concombre, ou courgette ?** Tomatoes, eggplant, jakkatou, cabbage, cucumber, or zucchini?	OUI ou NON
7.2	**Gombo, poivron, haricots verts, champignons, ou salade?** Okra, green sweet pepper, green beans, mushrooms, or lettuce?	OUI ou NON
	Hier, avez-vous mangé l'un des fruits suivants ?	
8	**Mangue ou papaye ?** Mango or papaya ?	OUI ou NON
9	**Orange, mandarine, ou pamplemousse ?** Orange, mandarin, or grapefruit?	OUI ou NON
10.1	**Banane mûre, ananas, prunes, ou avocat ?** Ripe banana, pineapple, plums, or pear?	OUI ou NON
10.2	**Goyave, pastèque, saba saba / corossol, ou des fruits cueillis ou ramassés en forêt ?** Guava, watermelon, saba/soursop, or harvested or picked fruit from the forest?	OUI ou NON
	Hier, avez-vous mangé l'une des sucreries suivantes ?	
11	**Biscuits, beignets, galettes, ou chin chin ?** Sweet biscuits, puff puff, galettes, or chin chin?	OUI ou NON
12	**Bonbons, chocolats, caramel d'arachide, crème glacée, ou sucette ?** Candy, chocolates, groundnut caramel, ice cream, or Alaska?	OUI ou NON
	Hier, avez-vous mangé l'un des aliments d'origine animale suivants ?	
13	**Œufs ?** Eggs?	OUI ou NON
14	**Fromage ou La Vache Qui Rit ?** Cheese or La Vache Qui Rit?	OUI ou NON
15	**Yaourt, lait caillé ou kossam, pendidam ou dakéré ?** Yogurt, fermented milk or kossam, pendidam or dakéré?	OUI ou NON
16	**Saucisson, jambon, corne boeuf, ou paté ?** Saucisson, ham, corned beef, or paté?	OUI ou NON
17	**Bœuf, mouton, chèvre, ou des abats de ces animaux ?** Beef, sheep, goat, or organs from these animals?	OUI ou NON

18	**Porc ou viande de brousse ?** Pork or bush meat?	OUI ou NON
19	**Poulet, dinde, canard, ou pintade ?** Chicken, turkey, duck, or guinea fowl?	OUI ou NON
20	**Poisson frais, poisson congelé, poisson fumé, muandj'a moto / sout da mokka, sardines en boîte, ou crevettes** Fresh fish, frozen fish, smoked fish, muandj'a moto / sout da mokka, canned sardines, or shrimp?	OUI ou NON
	Hier, avez-vous mangé l'un des aliments divers suivants ?	
21	**Arachide, pâte d'arachide, sauce d'arachide, mets d'arachide, pistache, mets de pistache, ou noyaux de mango / ndo'oh ?** Groundnuts, groundnut butter, groundnut sauce, groundnut pudding, egusi, egusi pudding, or ndo'oh?	OUI ou NON
22	**Chips comme Pringles ou Kelon, ou beignets de crevettes ?** Chips such as Pringles or Kelon, or prawn crackers?	OUI ou NON
23	**Indomie?** Indomie?	OUI ou NON
24	**Frites de pomme de terre, patates frites, plantain frit / dodo, poulet frit, ou poisson frit ?** Fries from potato, fried sweet potato, fried plantain/dodo, fried chicken, or fried fish?	OUI ou NON
	Hier, avez-vous bu l'une des boissons suivantes ?	
25	**Lait liquide ou lait en poudre ?** Milk or powdered milk?	OUI ou NON
26	**Café sucré, thé sucré, chaï sucré, ou chocolat chaud comme Ovaltine ou Matinal?** Sweet coffee, sweet tea, sweet chaï, or hot cocoa drinks such as Ovaltine or Matinal?	OUI ou NON
27	**Jus de fruit, jus en sachet, Foster Clark's, folére, jus de tamarin / djabbé, ou djindja ?** Fruit juice, fruit drinks, Foster Clark's, bissap, tamarind drink / djabbé, or djindja?	OUI ou NON
28	**Boissons gazeuses ou jus comme Coca-Cola, Fanta, ou Top, Malta, ou boissons énergisantes comme Red Bull ou XXL ?** Sweet drinks such as Coca-Cola, Fanta, Top, Malta, or energy drinks such as Red Bull or XXL?	OUI ou NON
	Hier, avez-vous acheté de la nourriture dans n'importe quel endroit comme...	
29	**Des endroits qui servent des hamburgers, du shawarma ou des pizzas ?** Places that serve burgers, shawarma, and pizza?	OUI ou NON

APPENDIX VI: PARTICIPANT INFORMATION FORM

TITLE: "RELATIONSHIP BETWEEN MALNUTRITION AND SALIVARY pH AMONG ADOLESCENTS IN TWO SECONDARY SCHOOLS IN NTUI"

PRINCIPAL INVESTIGATOR: **Professor SOBNGWI Eugene.**

Professor of internal medicine, Endocrinology.

STUDENT INVESTIGATOR: **AYENI OMOWUMI Doris.**

7th-year medical student.

AIM OF STUDY: To investigate the relationship between malnutrition and salivary pH among school-going adolescents in Ntui Municipality, Centre Region of Cameroon.

SITE OF STUDY: NTUI

SCHOOLS SELECTED: The schools selected are **" LYCÉE DE NTUI"** and **" LYCÉE TECHNIQUE DE NTUI".**

DURATION OF STUDY: This study will be carried out from November 2023 to May 2024.

PROCEDURE: A self-administered questionnaire will be used to collect information on oral health and the diet quality questionnaire. Demographic determinants, anthropometric parameters, hemoglobin parameters, and salivary pH will be collected for each student. The sample population will be recruited from students on campus. Potential participants will be informed of the aim and objectives of the study. Before obtaining written informed consent, the ethical principles will be discussed with the students which will involve voluntary participation in the study, anonymity of the participants, confidentiality of the data, and their right to withdraw from the study at any point in time with no negative consequences.

Both descriptive and inferential statistical analysis will be carried out using Windows software and IBM Statistical Package for the Social Sciences (SPSS) version 23. The BMI for age and height-for-age z scores will computed using WHO Anthroplus. For nominal data; percentages and percentages will be reported. We will use the SapHiro-Wilktest to assess the distribution of numerical data and describe them using mean and standard deviation or median and interquartile

depending on distributions. Binary logistics will be used for the existence of caries and malnutrition whereby our dependent variable will be pH and our independent variable will be malnutrition (BMI, HFA, Anemia). Oral diseases represented will be transformed into a binary scale using a Binary logistic regression model. Binary logistic regression was used to establish the relationship between Salivary pH and malnutrition. A p-value less than 0.05 will be considered statistically significant.

BENEFITS: Participants will evaluate their oral health status, get a free dental check-up, and counseling, know their height, and weight, and know if they are anemic or not so they can take concrete measures towards being in health always.

RISKS AND INCONVENIENCES: The risks involved in participating in this study are minimal.

COST: You will not pay any money to be able to participate in this study. It is free.

INCENTIVE: You will also not be given any form of material or financial motivation to encourage you to participate or continue in the study. It should be your free will to participate.

ETHICAL ISSUES: Ethical clearance will be procured from the Institutional Research Ethical Committee of the Faculty of Medicine and Biomedical Sciences and also from the National Research Ethical Committee. You will be assigned an encryption code if you agree to participate in this study after carefully reading through this information form. In addition, you will be free to decline at any point in time during the study.

For more information or further clarifications about the study you can contact the investigator through the following phone number 678730249 and e-mail address: **dorisayeni123@gmail.com**

APPENDIX VII: PARENT'S CONSENT FORM

Mr. / Mrs. / Ms...

(Name, Surname)

Title**: "RELATIONSHIP BETWEEN MALNUTRITION AND SALIVARY pH AMONG ADOLESCENTS IN TWO SECONDARY SCHOOLS IN NTUI"**.

The final year medical student AYENI OMOWUMI Doris, proposed to me to participate in a study they are carrying out in Yaoundé given her M.D. Thesis. The principal investigator is Professor **SOBNGWI Eugene**, to investigate the relationship between malnutrition and salivary pH among school-going adolescents in Ntui municipality.

She told me that I was free to accept or deny the proposal. I have received and understood the following information:

☐ The aim of this study

☐ The procedure

☐ Possible constraints and risks

I accept that entries be consulted by the research personnel and used for research purposes only. My entries will be discussed with me at the end of the study if I wish. My participation can be interrupted at any time if the principal investigator deems it necessary or if I wish. All data concerning me will be strictly confidential. Only the research personnel, and eventually a health authority representative will be given access to my data. The research protocol for this study has been reviewed and validated by the National Research Ethical Committee. At any time, I can ask for supplementary information from the student investigator, **Ayeni Omowumi Doris**, using the phone number: **678730249**

I hereby accept to participate in the study under the aforementioned conditions. A signed copy of this consent form will be given to me and will serve its purpose in time of need.

Date: ..../........./.........

APPENDIX VIII: PARTICIPANT ASSENT FORM

My name is AYENI OMOWUMI Doris. I come on behalf of the Faculty of Medicine and Biomedical Sciences ("EX-CUSS") to ask you a few questions to carry out a research that can prevent malnutrition and promote good oral health.

The purpose of this survey is to investigate the relationship between malnutrition and salivary pH among school-going adolescents in Ntui municipality. Several students, from two schools in Ntui will participate in this survey. The information you give will be used to develop health programs tailored to the specific needs of teenagers like you.

You are free to choose to participate or not, and you are also free to refuse to answer any question. However, your opinion is very important in this study. The answers you give will remain confidential. Answer questions based on what you know or do. There are no right or wrong answers.

Whether or not you answer the questions will not affect your grades in class.

Would you like to participate in this study?

1-Yes   2-No ☐

Name: _____

Date: _____

Signature of Adolescent: _____

APPENDIX IX: STUDENT HEALTH REPORT (FRENCH)

Date : ………/02/2024

Nom :

Age :

Poids………………**Kg**

Taille………………**cm**

| Paramètres	Résultats	Valeur de Référence			
		Age	Anémie légère	Anémie modérée	Anémie sévère
Taux d'Hémoglobine		5-11ans	11-11.4g/dl	8-10.9g/dl	<8g/dl
		12-14ans	11-11.9g/dl	8-10.9g/dl	<8g/dl

Conduite à tenir :

☑ Consommer les aliments riches en fer (viandes, légumes verts etc.)

☑ Dormir sous moustiquaire imprégnée

☑ Se déparasiter deux fois par an

☑ Se brosser les dents deux fois par jour après les repas

☑ Changer la brosse à dent tous les trois mois

Voir Médecin : Oui ☐   **Non**   ☐

Signature

APPENDIX X: ICONOGRAPHY

pH test strips
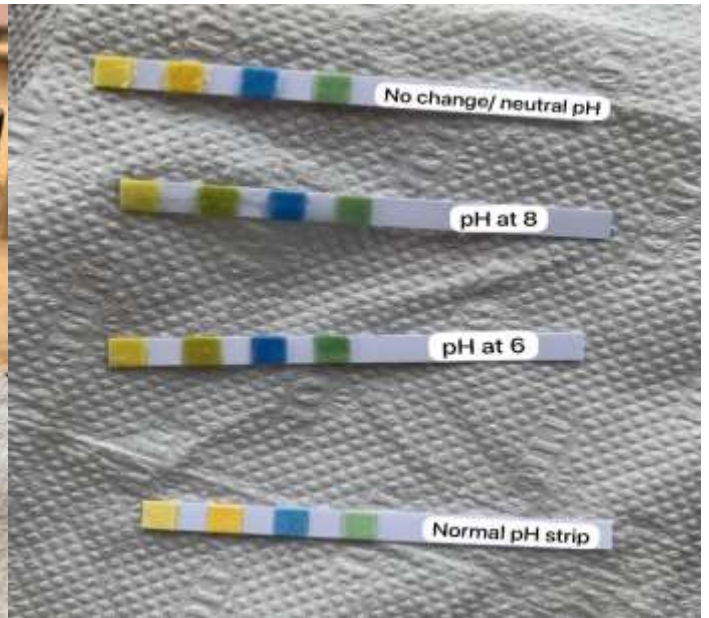
pH test strips showing the different pH levels

Dental equipment: Gloves, mirrors, tweezers, trays

Student on stadiometer to measure Height

Signboard of "Lycée technique de Ntui"

Students in "Lycée technique de Ntui"

Table of hemoglobin collection

Stand for height and weight measurements

Dental caries

Dental plaque and periodontitis

NB: All the pictures were taken by Ayeni and a member of the research team at the 2 schools in Ntui during the recruitment.