

**SCHOOL OF PUBLIC HEALTH
COLLEGE OF HEALTH SCIENCES
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**PREVALENCE OF DENTAL MALOCCLUSION AND OCCLUSAL
TRAITS AMONG 12- 16-YEAR-OLD CHILDREN IN SHAI-
OSUDOKU DISTRICT**

BY

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DECLARATION

I, Richard Nii Armah, hereby declare that all information provided in this dissertation is the result of my own work under the supervision of Dr Uri Selorm Markakpo of the department of Biological, Environmental and Occupational Health Sciences of the School of Public Health, University of Ghana, Legon. Other works referred to have been duly acknowledged by means of referencing. No part of this work has been presented elsewhere for any other degree of this University or elsewhere.

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DEDICATION

This project is dedicated to my loving family for the sacrifices and support in my pursuit of this degree.

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LIST OF DEFINITIONS

Anterior open bite	The condition where the upper and lower posterior teeth are touching when the patient bites down but the anterior teeth are not in occlusion.
Anterior teeth:	Consists of teeth at the front- the incisors and canines.
Buccal surfaces:	The side of the tooth adjacent to the inner part of the cheek
Dental arch	Consist of the curving structures formed by the crowns of the upper and lower teeth in their normal positions (or by the residual ridge after tooth loss)
Dental caries:	It is a result of a complex interaction of bacteria on the tooth surface covered by dental plaque or oral biofilm, fermentable carbohydrate to produce acids (lactic acid and acetic acid) which dissolve the protective hard tissues and acting on the teeth over time.
Dental plaque:	It is a soft adherent structured deposit which forms on the tooth surface. It consists of a mixed bacterial flora, sometimes epithelial cells and leukocytes
Exfoliated teeth:	Natural loss of the teeth more in children especially with the primary teeth.
Gingivitis:	It is an inflammatory response of the gingivae without destruction of the supporting tissues
Lingual surfaces:	The surface of the tooth towards the tongue.

- Periodontal pockets:** Describes a gap along the sides of the tooth as a result of destruction of the periodontal ligaments and bones which surround and support the tooth.
- Periodontitis:** A group of inflammatory diseases that affect all the periodontal structured. It results in destruction of the attachment apparatus.
- Periodontium:** It holds the teeth in the mouth. Consists of all the tissues which surround and support the teeth—cementum, alveolar bone, periodontal ligament and gingiva.
- Posterior open bite** The condition where the anterior teeth are touching when the patient bites down but the posterior teeth are not in occlusion.
- Posterior teeth:** Consist of the premolars and molars.

LIST OF ABBREVIATIONS

FDI	International Dental Federation
GHS-ERC	Ghana Health Service Ethics Review Committee
GIS	Ghana Immigration Service
GSS	Ghana Statistical Service
JHS	Junior High School
PI	Principal Investigator
PTA	Parent Teacher Association
RA	Research Assistant
SPH	School of Public Health
UG	University of Ghana
WHO	World Health Organization

ABSTRACT

Background

Dental malocclusion is the third most dominant dental condition behind dental caries and periodontitis. Unlike other disease conditions, dental malocclusion is a deviation in the arrangement of the teeth from the norm. It is not a life-threatening condition but can result in difficulty in mastication, speech and maintenance of good oral hygiene. Data on the prevalence of dental malocclusion based on acceptable classification of the condition remain scarce.

Objectives

The study therefore sought to determine the prevalence of dental malocclusion and occlusal traits among 12-16-year-old school children in the Shai-Osudoku District in the Greater Accra region of Ghana. This study also sought to determine the distribution of clinically relevant occlusal traits and the prevalence of occlusal anomalies in an orthodontically relevant period of dental development among the study population.

Methods:

The study was conducted using a descriptive school-based cross-sectional study design that involved interviewing and clinical examination of 340 school children between the ages of 12-16 years from randomly selected schools in the Shai-Osudoku district of Ghana. During the clinical examination, clinically relevant occlusal traits were recorded together with class of molar relationship based on Angle's classification of malocclusion using a modified WHO/FDI dentofacial anomalies assessment form. Data were recorded in excel and imported in STATA version 15 software for analysis. Descriptive and inferential statistical analysis was conducted which included Fisher's exact tests to

determine the factors influencing the development of the various classes of dental malocclusion.

Results:

Results showed the mean age of 13.5 ± 1.3 , majority (93.2%) of the respondents had various forms of occlusal anomalies. Prevalence of Class I, Class II and Class III malocclusion were found to be 69.2%, 5.6% and 19.1% respectively. Posterior crossbite, crowding and discrepancies in the midline were detected in 21%, 26% and 24.4% of the respondents respectively. Tooth malrotation ($\chi^2 = 31.221$, $p < 0.001$), increased overjet ($\chi^2 = 31.184$, $p < 0.001$) as well as increased overbite ($\chi^2 = 55.178$, $p < 0.001$) were found to be significantly associated with dental malocclusion.

Conclusion:

The study showed a high prevalence of dental malocclusion among the respondents. Tooth malrotation, increased overjet, increased overbite as well as age of the respondents were found to have a significant association with dental malocclusion. The high prevalence of dental malocclusion and clinically relevant occlusal traits therefore require behavioural, preventive and interceptive orthodontic procedures to halt the further progression into severe skeletal anomalies.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Oral health is defined as a state of a healthy mouth which is free from any form of extraoral and intraoral pain, oral malignancies, infections, ulcers, tooth decay, periodontal conditions and tooth loss as well as other conditions that decrease an individual's ability to chew, smile, bite, speak and general psychosocial well-being (WHO, 2019). As an integral aspect of general health, oral health encompasses both functional and psychosocial aspect of health as well.

Ranked among the most widespread non-communicable diseases, oral health related diseases constitute a fundamental element of the global disease burden (WHO, 2013). Dental conditions have a profound effect on the individual's well-being and quality of life. Conditions such as dental caries affects day-to-day activities of the affected person including chewing and talking due to pain associated with the condition. Even worse effects such as functional impairment and disfigurement are associated with cancrum oris and oral malignancies. The fact that poor oral health has profound effect on the individual's general health and quality of health cannot be overemphasized.

Dental malocclusions incidence is third only to dental caries and periodontal disease among worldwide public health dental priorities. As a key oral health condition, it is subject to regular epidemiological studies for the purposes of planning and institution of preventive and treatment modalities (Petersen, 2003). Data acquired through the surveys provide information about distributions of disease conditions and the training of specialists as well as allocation of resources required for the management of the conditions. Dental

malocclusion, though common in all societies, identification of the prevalent class of malocclusion and the occlusal anomalies help in determining the appropriate treatment plan and resources needed (E-Erum & Fida, 2008). However due to lack of data on its prevalence in Ghana, orthodontic treatment is not included in the Ghanaian public health service.

The aesthetics and functional defects associated with dental malocclusion negatively impacts the individual's social interactions and self-esteem. Thumb sucking, tongue thrusting, mouth breathing and incorrect swallowing patterns are bad. Oral habits are known to cause malocclusion and defects in facial growth. These habits which when allowed to progress may lead to conditions such as Class III malocclusion anterior open bites and posterior crossbites. Cessation of these habits using simple behavioural techniques employed by both parent and ward and/or functional and orthopedic appliances can be used to prevent the progression into severe skeletal anomaly which may require expensive orthodontic and surgical correction. The intention of the study is to determine the prevalence of malocclusion and clinically relevant occlusal trends that are present within the school children.

1.2 Problem Statement

Malocclusion has several unfavourable sequelae such as increased risk to dental caries and periodontal disease, trauma, abnormalities of function and temporomandibular joint problems. Malocclusion is also associated with aesthetic changes leading to psychosocial disturbances among the affected individuals. Malocclusion is not a life-threatening condition however their prevalence and tendency to militate against the ability of individuals to chew bite and speak in public as well as adversely affect their general well-being put them in focus of public healthcare. Global estimates of dental malocclusion

suggests a prevalence of 31%-96.6% and the highest prevalence among Africans to be 89.44% (Mtaya, Brudvik, & Astrom, 2009) A study conducted in the Ho municipality in the Volta Region of Ghana among school children from Primary one to JHS two, also found 27.9% of the sample population presenting with dental malocclusion (Beni, 2009). A study among patients in Rwanda of ages between 11-35 years showed 51% presenting with handicapping malocclusion and 23% presented with severe malocclusion (Goyal, Goyal, & Muhigana, 2013). With only a few numbers of specialist orthodontists available to grapple with the national burden of gross malocclusions, a lot of the cases are automatically left untreated. Epidemiological data informing the burden of malocclusion in Ghana which are necessary for planning for prevention and management of these conditions are either deficient or absent. This study therefore sought to determine the prevalence of occlusal anomalies and dental malocclusion in 12-16-year-old children.

1.3 Conceptual framework

As illustrated in figure 1 below genetic and environmental factors act synergistically at different times during human growth and development. These factors influence the growth of the jaw and masticatory system and in effect manifest as occlusal traits and the resulting occlusion. The occlusal defect with its psychosocial implications affects patients' appearance, function and self-esteem.

Dental malocclusion is multifactorial in origin. Genetic and environmental factors act synergistically to influence the development of the jaw and the masticatory system. Defects in the developmental processes manifest as occlusal irregularities based on which classification of malocclusion is done (Joshi, 2014). The genetic and hereditary components of malocclusion were given much credence in the Habsburg family inheritance of mandibular prognathism due to long decades of incest (Joshi, 2014).

Environmental factors including malnutrition and bad oral habits such as thumb sucking influence development of the teeth and the jaw leading to anterior openbite and enamel hypoplasia (Urzal, Braga, & Ferreira, 2013;Sheetal, Hiremath, Patil, Sajjansetty, & Sheetal Kumar, 2013). Some of the adverse effects are congenital and begin to manifest during development of the foetus when the teeth and jaws are developing and continues after birth. Whereas some of the effects are passed on from one generation to the other as hereditary, occlusal traits such as anterior open bite results from abnormal oral habits such as thumb sucking (Cakan, Ulkur, & Taner, 2012). Crowded dentition is common among those with small sized jaw with normal sized teeth or those with normal sized jaw with bigger than normal tooth size. When there is anterior crowding in the jaw the permanent canines are either rotated or erupt from an ectopic position resulting in malocclusion with associated esthetic problems. A study conducted among Tibetan adolescents found a high prevalence of Class I malocclusion (52.9%). Occlusal traits such as increased overbite, increased overjet, openbite, crossbite, displacement and hypodontia were found to be 5.79%, 10.8%, 10.86%, 9.42%, 50.72% and 4.34% respectively. The overbite, overjet, crossbite (anterior), hypodontia and displacement were found to significantly influence development of Angle's classification of dental malocclusion (Wangdu, Namgyal, Parajuli, Kunwar, & Karki, 2015). Occlusal traits such as anterior and posterior crossbite render the affected side of the jaw unusable resulting in further deterioration of the teeth if not corrected. Dental malocclusion results in difficulty in chewing, swallowing as well as speech difficulty. However, most people seek early treatment due to the esthetic problems associated.

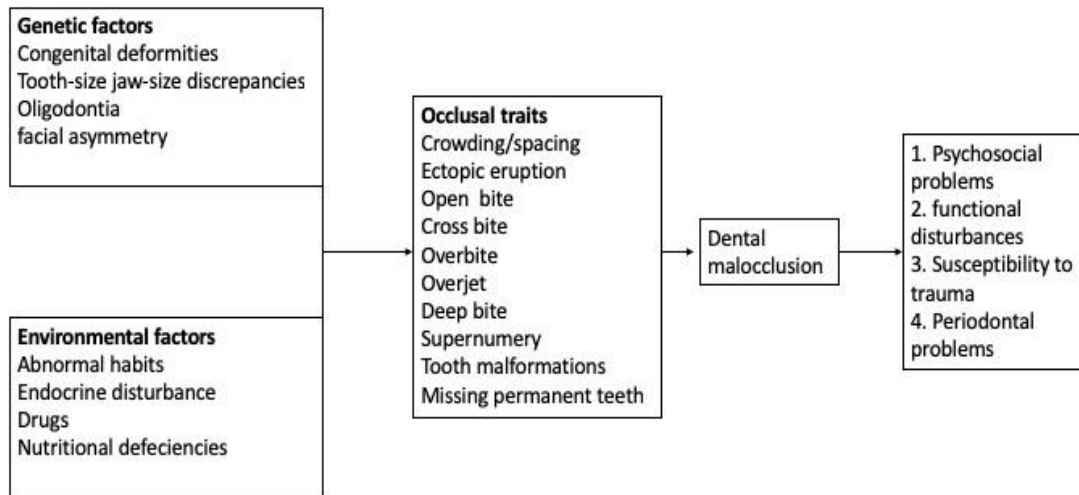


Figure 1.3.1: Conceptual framework of aetiology of dental malocclusion.
(Adapted from Moyers concept of the aetiology of malocclusion)

1.4 Justification of the Study

National data focusing on the prevalence and distribution of malocclusion to inform national policy on its management is absent. Coupled with the few numbers of trained orthodontist specialists available, only a few cases receive the necessary attention. Therefore, treatment of dental malocclusion has become the preserve of the rich and affluent. Most affected individuals are left to deal with the functional and psychosocial effects. This study will therefore provide the much-needed data on the prevalence of malocclusion and occlusal characteristics among children and serve as baseline data for further work in future. Findings from the study are also necessary for formulation of policy for prevention and management of the conditions among the affected. They are furthermore, necessary for training of specialists in the field of orthodontics. Finally, the data obtained from this study will guide the proper integration of orthodontic treatment and develop a country wide oral health plan to improve the quality of life and eliminate

disparities by facilitating collaborations amongst the citizenry, healthcare professionals, community leaders and policymakers in all levels of decision-making process.

1.5 Research Questions

1. What is the prevalence of dental malocclusion among 12-16-year-old school children in the Shai-Osudoku district?
2. What is prevalence of clinically relevant occlusal traits among the 12-16-year old school children?
3. What are the occlusal irregularities that influence the development of dental malocclusion among the 12-16-year-old schoolchildren in the Shai-Osudoku district?

1.6 Objectives

1.6.1 General Objective

To determine the prevalence of malocclusion and occlusal traits among children between the ages of 12 -16 years in Shai-Osudoku district

1.6.2 Specific Objectives

1. To determine the prevalence of different forms of malocclusion among 12-16-year-old school children in the Shai Osudoku district.
2. To identify the various occlusal traits among 12-16-year old school children in the Shai-Osudoku district.
3. To determine the various occlusal traits that influence the development of the different classes of dental malocclusion among school children.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Occlusion

Occlusion refers to the functional interaction between the teeth and the rest of the masticatory system when the maxillary and mandibular arches are together. The jaw movements are as a result of neuromuscular control of structures of the masticatory system, namely teeth, maxilla & mandibular, periodontal structures, temporomandibular joints and their related muscles and ligaments. There are three main aspects of occlusion; the ideal, normal and malocclusion, based on the relationship between the maxillary and mandibular teeth, both arches and the relationship between the arches and the base of the skull (Hassan & Rahimah, 2007; Ash & Ramfjord, 1995). The ideal occlusion refers to a hypothetical state, which describes both the upper and lower jaw in proportional to each other and the base of the skull with the teeth positioned in their correct relationship to each other (McDonald & Ireland, 1998). It is rare to achieve an 'ideal' occlusion, therefore 'normal' occlusion is preferred when classifying malocclusion (Hassan et al, 2007). Edward H. Angle (Angle, 1899) described a normal occlusion as a condition where the mesiobuccal cusp of the maxillary first molar occludes in the buccal groove of the mandibular first molar. A normal occlusion, therefore, has a level of acceptable deviation from the ideal occlusion, defined by the cultural environment. It is esthetic and devoid of any functional or pathologic defects. The concept of normal occlusion has undergone several modifications as a result of the growing knowledge in the field of occlusion. Among them is the six keys of normal occlusion which constitute occlusal traits by Andrews (1972), following extensive data gathered from non-orthodontic normal models.

These include the molar relationship, crown angulation, crown inclination, rotations and tight contacts.

2.2 Dental malocclusion and occlusal traits

Malocclusion is therefore defined as a deviation from standards of normal occlusion rather a disease (Proffit, Fields, & Sarver, 2013). Dental malocclusion may be associated with other anomalies in the dental arch such as imperfect positioning of the teeth when the jaws are in occlusion such as crowding, spacing, tipping, displacement, malrotation, infra-occlusion, supra-occlusion and transposition of the teeth; asymmetry of the maxillary and mandibular arches (i.e. anteroposterior, vertical and transverse anomalies such that one may be placed too far forward or too far back than the other and vice versa) as well as skeletal discrepancies (the relationship of both arches to the skull) (Mtaya et al, 2009).

2.3 Aetiology of Malocclusion

Malocclusion is multifactorial in origin as such it is not caused by a single major cause (Pagonis & Viazis, 2018). Occlusal development is subject to many influences as the child grows. The interplay between genetic and environmental factors contribute significantly to the development of dental malocclusion (Cakan et al., 2012). In the absence of bad oral habits or environmental factors, mild and moderate degree of malalignment may be exhibited, however extremely severe crowding may have both genetic and environmental components (Mossey, 1999). There are several classifications of the etiology of malocclusion one of which is the Moyer's classification.

2.3.1 Moyer's classification of aetiology of dental malocclusion

This has been grouped into 7 different factors that influence the craniofacial growths. These factors include:

- Heredity which affects the neuromuscular system, bone, teeth and soft tissues.
- Developmental defects
- Trauma including prenatal trauma, birth injuries and postnatal trauma.
- Physical agents such as premature extraction of primary teeth.
- Habits such as finger sucking, tongue thrusting, lip sucking and lip biting, nail biting and other habits.
- Diseases including systemic, endocrine and local diseases such as periodontal diseases and caries.
- Malnutrition

2.4 Classification of malocclusion

Dental malocclusion has been classified in order to segregate them into smaller groups which are characterized by certain specific and basic variations of the normal occlusion of teeth. These variations play a significant role in determining the appropriate treatment plan.

There are various classification systems for dental malocclusion and these include Angle's, Simon's, Bennett's, Ballard, WHO, Canine, Ackermann-Proffit classification among others (Cangialosi, 1972).

2.5 Angle's classification

The Angle's classification of malocclusion (Angle, 1899) is based on molar relation, mesio-distal relation of the teeth and considers only the maxillary first molar as the key to occlusion. Angle classified malocclusion into 3 main classes designated by roman numerical class I, class II and class III. Shortcomings associated with the angles classification are notably evident in the class II molar relation which may result in two different forms, each requiring a different treatment strategy. This has resulted in a shift

from molar to skeletal relationship. Moreover, the hypothesis that the maxillary first permanent molar is invariably in a correct position has also been discarded in cephalometric studies (Anand, 2016). Despite the imperfections in the Angle's classification system, it is still the most conventional, most practicable, and hence the most acclaimed classification at present.

2.5.1 Normal occlusion

The state where the mesiobuccal cusp of the maxillary first molar occludes in the buccal groove of the mandibular first molar. In a normal occlusion the overjet and overbite are within the normal range and devoid of midline deviation (Angle, 1899).

2.5.2 Class I malocclusion

The presence of a normal molar relationships exists together with dental irregularities associated with the occlusal traits such as crowding, teeth malalignment, crossbite, rotation, and missing teeth. There may also be the presence of bimaxillary protrusion or retrusion (Angle, 1899).

2.5.3 Class II malocclusion

Class II malocclusion is when the mesio-buccal cusp of upper permanent first molar occludes mesial to the mesio-buccal groove of the lower first permanent molar during occlusion of the teeth. Class II molar relationship present with proclined upper central incisors, is called Class II Division 1 and same molar relation with retroclined upper central incisors is called Class II Division 2 malocclusion (Angle, 1899).

2.5.4 Class III. Malocclusion

When the molar relationship shows the mesiobuccal cusp of the maxillary first molar occluding distal to the buccal groove of the mandibular first molar during occlusion of the teeth is called Class III malocclusion (Angle, 1899).

2.6 Occlusal traits

2.6.1 Missing teeth

This refers to the situation when the tooth is clinically absent in the dental arch. It may be congenitally missing in the case of hypodontia, impacted or delayed eruption (Rakhshan, 2015). Missing teeth play a significant role in development of dentition. Congenitally missing teeth is the failure of the tooth to form and it is prevalent in 2% - 20% of the adult population (Kwon & Jiang, 2018). Apart from the third molars, the lateral incisors and premolars are the teeth often congenitally missing. They are often associated with malformed teeth such as a peg shaped lateral incisor. Missing teeth present with aesthetic, functional and prosthetic challenges which require multi-disciplinary approach to address. There may also be drifting of the adjacent teeth towards the space and this affects the ability to speak properly. Radiographic assessment is therefore required to determine whether it is congenitally missing, ectopic or impacted before removal of the existing primary tooth or commencing treatment.

2.6.2 Supernumerary teeth

Supernumerary tooth or hyperdontia refers to any tooth or odontogenic structure that serves as an addition to the regular number of the dental formula and can be located at any part of the dental arch. It may occur single or multiple, unilateral or bilateral and in either arch. Although more prevalent among males, supernumerary teeth are often associated with cleft lip and palate, cleidocranial dysplasia and Gardner syndromes (Subasioglu et al.,

2015). Problems associated with supernumerary teeth include tooth displacement, crowding and dentigerous cyst formation. Supernumerary teeth may also prevent a normal tooth from erupting. Occasionally they remain in the jaw without any adverse effect and radiographic finding may only be by chance.

2.6.3 Hypoplastic/ malformation

Dental anomalies such as enamel hypoplasia and hypocalcification, dentin dysplasia, fluorosis, tetracycline staining as well as dental discoloration of intrinsic origin such as hyperbilirubinemia and porphyria presents with situations that compromise the quality of the tooth tissue. Systemic factors associated in this defect include infections, medications, inherited diseases, metabolic disorders, malnutrition and birth related trauma. Anomalies involving the tooth size are common among lateral incisors. Malformations such as peg shaped lateral incisors are frequently associated with missing or peg shaped contralateral lateral incisor. Smaller than normal peg shaped lateral incisor makes extra space available in the arch resulting in adjacent teeth, midline shift and arch asymmetry (Shilbayih, Watted, & Abu-Hussein, 2016).

2.6.4 Ectopic eruption

The malposition of a permanent tooth as a result of the tooth erupting at the wrong position is termed ectopic eruption. This condition is common among the maxillary molars and canines resulting in palatally or buccally erupted canines (Juvvadi, Medapati Rama, Anche, Manne, & Gandikota, 2014).

2.6.5 Retained primary tooth

The persistence of primary tooth beyond its shelf life may be due to impaction of the permanent successor, transmigration of the permanent successor, existence of pathology but commonly due to congenital absence of the permanent successor (Aktan et al., 2012).

Exfoliation of the primary tooth in the mandibular arch occurs naturally by the time three quarters of the root of the permanent tooth is formed. However, in the maxillary anterior segment of the arch, failure to extract a retained primary tooth may result in the permanent tooth erupting in a crossbite with the mandibular incisor. This will require orthodontic intervention to align the tooth. A Study conducted by Richardson (1972), showed that premature loss of the primary tooth is the commonest cause of crowding of the teeth among the study sample. In cases like these space maintainers are provided to preserve the space for the successive tooth.

2.6.6 Open bite

It is a discrepancy of the jaw in the vertical plane characterized by failure of the maxillary and mandibular dental arches to occlude (Subtelny & Sakuda, 1964). Considered as one of the most difficult occlusal anomalies to treat successfully due to its multifactorial etiologies, open bites are characterized by localized absence of occlusion whereas other teeth remain in occlusion (Rohit, 2018). A cross sectional study conducted in Pelotas, Brazil using a birth cohort of 400, 6year-old children showed 46.3% prevalence of anterior open bite (Glazer Peres et al., 2007)

2.6.7 Crossbite

A discrepancy in the buccolingual relationship of the tooth is called crossbite. Anterior crossbite refers to the situation where the lower incisors overlap the upper incisors (Sockalingam, Khan, & Kuppusamy, 2018). Etiologic factors associated with anterior crossbite include the following: dental factor (anomalies of tooth size and shape, ectopic tooth eruption, retained deciduous tooth, tooth ankylosis and supernumerary), skeletal factor (asymmetric growth of the maxilla or mandible due to inherited growth pattern , trauma at birth or during growth and long standing functional problem), soft tissue factor (digit sucking and habit of biting upper lip) and functional factor (habitual forward

positioning of the mandible for maximum intercuspation) (Allen, Rebellato, Sheats, & Ceron, 2003). Posterior crossbite similarly is the state when there is a deviation from the ideal occlusion in the transverse plane. It appears as single tooth, single arch segment, unilateral or bilateral crossbite. Crossbites interfere with growth of the middle third of the face, causes abnormal speech patterns, loss of arch integrity, periodontal disease and undesirable esthetics and has a prevalence of 8-22% for posterior crossbite and 3.4% for anterior crossbite (Sultana et al., 2015).

2.6.8 Diastema and midline deviation

A diastema is the space between the maxillary central incisors. Whereas it is common and somewhat desirable in the primary dentition, its absence in the permanent dentition is indicative of potential crowding (Gupta, 2018). It is common in situations of orofacial imbalances such as tongue thrust, macroglossia and flaccid lip muscles; pernicious habits such as digit sucking and abnormal lip habits; physical impediments such as high labial frenum, supernumerary teeth and periodontal inflammation; deep bite and abnormal maxillary arch structure such as tooth size-arch size discrepancy as well. Countries like Ghana, Nigeria and Namibia regard diastema as being attractive and as an ethnic norm among blacks and Mediterranean whites (Gupta, 2018). There are racial and gender differences for diastema with greater prevalence in Africans (West Africans) than in Caucasians or Mongoloids. Midline diastema has a prevalence of 98% in 6-year-olds, 49% in 11-year-olds and 7% in 12-18-year-olds (Hussain, Ayub, & Farhan, 2013).

2.6.9 Overjet and overbite

The human skull naturally has a wider maxilla compared to the mandible creating a natural overjet and overbite. The overjet represents the horizontal overlap of the maxillary central incisors over the mandibular central incisors. It shows how far forward the upper front tooth is from the lower front tooth. The overbite represents the vertical overlap of the

maxillary central incisors over the mandibular central incisors. Overbite shows how much the upper front teeth cover the lower front teeth in a vertical dimension. A study conducted in Karela among 10-12-year old school children had 35.6% of the participants with increased overbite and 23.2% increased overjet (Narayanan, Jeseem, & Kumar, 2016).

Both overbite and overjet can be measured using a probe and normal overjet and overbite is between 2-3mm.

2.6.10 Rotation, Crowding and spacing

The objective of having well aligned teeth is for esthetics, stability of dental arch and ideal conditions for maintaining good oral health and optimal care of the teeth. Crowding and spacing in the arch result from differences in the tooth and arch size. Local causes of crowding include the premature removal of primary teeth. Occlusal traits such as these compromise dental health and function, smile esthetics as well as lower the persons self-esteem. A study conducted among adolescents showed crowding and rotation as the commonest dental irregularity in 42% and 59% of cases respectively (Vrazalica, Ilic, Laganin, Dzemic, & Tiro, 2017).

2.7 Prevalence of malocclusion and occlusal traits

At an early point, it was realized that, due to the complexity of malocclusion epidemiologic studies had to be based on some kind of classification. Angle's classification is the only one among several typologic classifications which has gained wide ground in the epidemiology of malocclusion. However, there is some level of defect in intra- and inter-examiner reliability of recording Angle's classes. The current public health problem in this field is to bridge the gap between recognition of the occurrence of the defined single traits or combination of traits and determination of the need for

treatment of these conditions. The main purpose of the indices is to interpret malocclusion severity objectively in priority. Fundamentally, the index scores are from clinical examination of the severity of various traits. The scores are assigned according to clinical concepts of the adverse effects of the traits on facial appearance, function, and oral health. Thus, the objectivity involved in such interpretations would be questionable.

Different age groups, ethnic groups as well as different populations exhibit varying prevalence of dental malocclusion (Masood, Masood, Newton, & Lahti, 2015). The indices used and criteria for measuring malocclusion also determines its measure among populations (Agarwal & Mathur, 2012).

Global estimates of dental malocclusion remain higher than 70% (Yu et al., 2019). In a systematic review of 2,977 retrieved studies, 53 of which were based on Angle's classification and satisfied the inclusion criteria showed that in the permanent dentition, the global distributions of Class I, Class II, and Class III malocclusion were 74.7% (31 – 97%), 19.56% [2 – 63%] and 5.93% [1 – 20%], respectively. It was also observed that overbite and open bite were 21.98% and 4.93%, respectively whereas posterior crossbite affected 9.39% of the sample. The highest prevalence of Class I (89%) and open bite (8%) in permanent dentition were observed among Africans while Caucasians showed the highest prevalence of Class II (23%) (Alhammadi, Halboub, Fayed, Labib, & El-Saaidi, 2018).

Studies conducted among Indian children reported 39% of cases of malocclusion (Dhar, Jain, Dyke, 2007) compared to 98% in Tanzanian children (Mtaya et al., 2009). Child Dental Health Survey among 12-year-olds in the United Kingdom also estimated that approximately 66% required orthodontic treatment (Klages, Bruckner, & Zentner, 2004). According to the study conducted by Vrazalica et al. (2017), in both primary dentition in

preschool children and school-aged children, posterior crossed bite was seen in 30.0% of them and midlines deviation in 46.0% of children. Angle's Class II intercuspitation was seen in 28% of school-age children while 7.0% exhibited Class III intercuspitation. From this study, there was an increase in the prevalence of the dental malocclusion with age suggesting the role of environmental factors such as bad oral habits play in the in the etiology of malocclusion.

A study conducted by Ajayi (2008), in Benin City, Nigeria, consisting of 229 males and 212 females with mean age 13.52 years \pm 1.83, 15.9% of the study subjects had normal occlusion, 80.7% had Angle's class I malocclusion, 1.1% Class II div 1, 0.5% class II div 2 and 1.8% Angle's class III malocclusion. According to the study, increased overjet and overbite were observed in 24.7% and 9.8% respectively and 4.1% of the study subjects presented with anterior open bite. Lower anterior crowding was found to be 12% and spacing was more prevalent in the upper arch (29.9%) than the lower anterior segment (10.7%) with midline diastema present in 19.5%. The study concluded that the occlusal traits were not influenced by gender difference ($P>0.05$) and revealed predominance of Angles Class I malocclusion among Nigerian children in Benin City (Ajayi, 2008).

A study on 919 teenagers in Kenya, aged 13-15 years, reported that the prevalence of malocclusion was as high as 72%. In this study crowding, increased overjet, and open bite were found in 19%, 10%, and 8% of the cases respectively (Ng'ang'a, Ohito, Ogaard, & Valderhaug, 1996).

On extensive search of literature, only few studies were found to depict the pattern of occlusal irregularities among Ghanaian children. A study in the former Brong Ahafo region in 1967 among 5-18-year olds reported 38.6% malocclusion among the subjects (Haupt, Adu-Aryee, & Grainger, 1967) . Studies by Richardson, (1972b) on dental

diseases among 5-14-year-old school children in Mampong, Ghana, recorded a malocclusion prevalence of 4.3%. An unpublished study in 2005 found malocclusion to be moderately high in 15-24-year-olds in the Wa municipality of Ghana (Abu-Sakyi, 2005). Recent study by Beni (2009), on the oral health status among school children in the Ho municipality showed malocclusion prevalence of 27.9%.

2.8 Effects of Malocclusion

Any deviation from the normal arrangement of teeth is referred to as malocclusion. Malocclusion is a disorder of multiple traits which may be present singly or in combinations. Patients visiting the dental clinics chiefly complain of the irregular arrangement of teeth, presence of spaces between teeth, teeth are placed outward or forward, teeth not closing properly, teeth not erupting in line among other complaints. Some patients also complain of problems during smiling, talking, biting the food, and teasing by peers. Thus, malocclusion not only affects the smile, aesthetics and function, but also the social and psychological status of the patient. Orthodontic treatment is aimed at improving physical function, preventing tissue damage, improving aesthetics and psychosocial well-being. Malocclusion results in disturbances of oral function, such as mastication, swallowing and speech. It also increases the susceptibility to dental trauma and periodontal disease. Among the serious implications of malocclusion in everyday life are psychosocial problems caused by disturbed dentofacial aesthetics, which demonstrates a sizable problem considering today's trends of imposed standards of beauty. Societies of today define norms of acceptable, normal and physical attractiveness. Today's society dictates standards of what is acceptable, normal and appealing look. Therefore, various forms of malocclusions can generate a sense of marginalization and social rejection that could have adverse effects on individual social integrity.

2.9 Conclusion

Traditionally the responsibility for initiating orthodontic measures and the economic burden of the treatment have rested mainly with the patients or rather with the parents. How we provide orthodontic treatment has often been determined by the incidental educational and socio-economic level of the family, instead of the severity of the patient's malocclusion.

In Rwanda, state agencies pay for the cost of orthodontic treatment, basically for functional correction and not the aesthetic component (Goyal et al., 2013). Due to the high cost of treatment and time involved in treatment, only the rich can afford, therefore, assessment is done such that treatment is based on need. The aim of epidemiologic studies of malocclusion is to describe and analyse the prevalence and distribution of malocclusion and occlusal traits in various populations with the goal being to identify etiologic factors. A further aim is to add to the solution of the public health problems concerning the need assessment for orthodontic treatment as well as organization of orthodontic services.

CHAPTER THREE

METHODOLOGY

3.1 Study Area

The study was conducted in the Shai-Osudoku District in the Greater Accra region. The district is in the south eastern part of Ghana between latitudes $5^{\circ}54'$ and $6^{\circ}05'$ and longitudes $0^{\circ}05'$ E and $0^{\circ}20'$ W. Shai-Osudoku district has a total land area of about 968,361 square kilometers (Ghana Statistical Services, 2015) and a population size of 51,903 people. Data from the 2010 National Population and Housing Census suggests that 76.4 percent of the district population resides in the rural communities and 23.6% lives in semi-urban and urban areas. The most densely populated communities include Asutuare and Dodowa, both of which have less than 25,000 inhabitants, the rest of the communities have less than 1,000 in population size and widely spread. The predominant economic activity is crop farming. The entire district has 51 Preschools, 52 Primary Schools, 37 Junior High Schools and 6 Senior High Schools with high prevalence of oral health problems including dental malocclusion among the school children. There are ten health facilities strategically located to improve health service delivery system in the district.

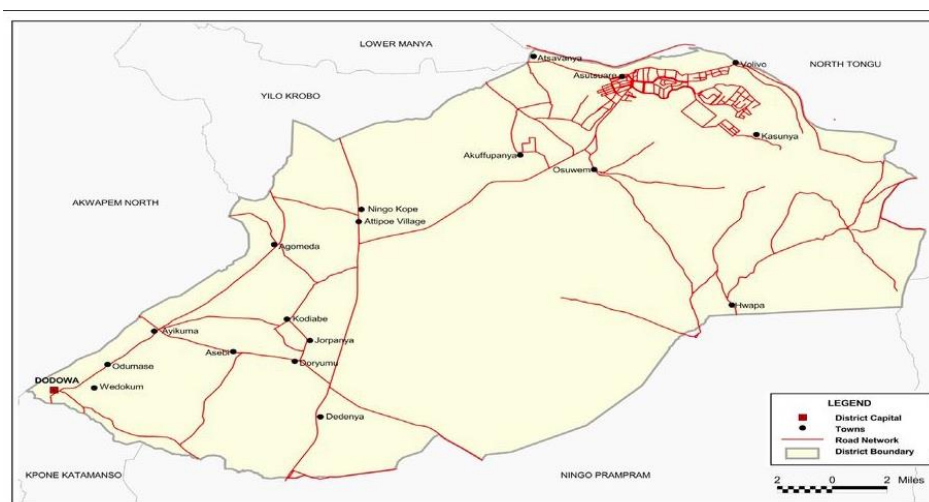


Fig 3.1: Map of Shai-Osudoku District.

Credit: Ghana Statistical Service (GSS), GIS

3.2 Study Design

Descriptive cross-sectional quantitative design was used to execute the study.

3.2 Study population

The participants comprised students attending the four selected schools namely Shai International School, Roman Catholic School, Kordiabe, Methodist Junior High School, Doryumu and Roman Catholic School, Dodowa.

3.2.1 Inclusion Criteria

Participants were between the ages of 12-16 years old and had all the first permanent molars fully erupted.

3.2.2 Exclusion criteria

The study excluded students who had undergone any kind of orthodontic treatment. Those without their consent forms were also excluded.

3.3 Sampling and Sample Size Calculation

3.3.1 Sample Size Calculation

A sample size of 340 participants was derived using the Cochran's formula (Israel, 1992) as shown below

$$N = \frac{z^2 p q}{d^2}$$

where Z= reliability coefficient for 95% confidence level (Z= 1.96), P= prevalence of dental malocclusion from previous studies (P=27.9%) (Beni, 2009).

$$q = (1-p)$$

N is the population size

D is the acceptable difference which is the precision at 5% ($d=0.05$)

The sample size was calculated as:

$$N = \frac{1.96^2 (0.279 \times 0.721)}{0.05^2}$$

$$= 309$$

$$= 309$$

Adding 10% of the calculated sample size as security for non-responsive participants

$$N = 309 + (0.1 \times 309) = 340$$

3.4 Sampling procedure/ Technique

The list of all primary and junior high schools as well as total enrolment was obtained from the District Educational Directorate and stratified into rural and urban localities based on the classification by the GSS. According to this classification, a locality is considered as urban if it has human population of 5,000 or more and rural if less than 5,000 people. Four schools from the Shai-Osudoku District were randomly selected by paper balloting. This was to select 3 schools in the rural areas and one in the urban area based on the rural-urban population ratio of 3:1. The lists of students from the selected schools who were within the ages of 12 to 16 years and satisfied the inclusion criteria was obtained from the attendance book of each of the schools. The participants were selected using simple random sampling which was applied proportionately to the various schools based on the population of students who satisfied the inclusion criteria to obtain the 340 participants from all the schools that were recruited in the study.

3.5 Study Variables

3.5.1 Independent variables

The variables recorded as independent variables include dental status (missing teeth), overbite, overjet, crowding, midline diastema, midline deviation, malrotation of tooth, crossbite (anterior and posterior), open bite (anterior and posterior) and presence of congenital defects such as hypoplasia/malformation.

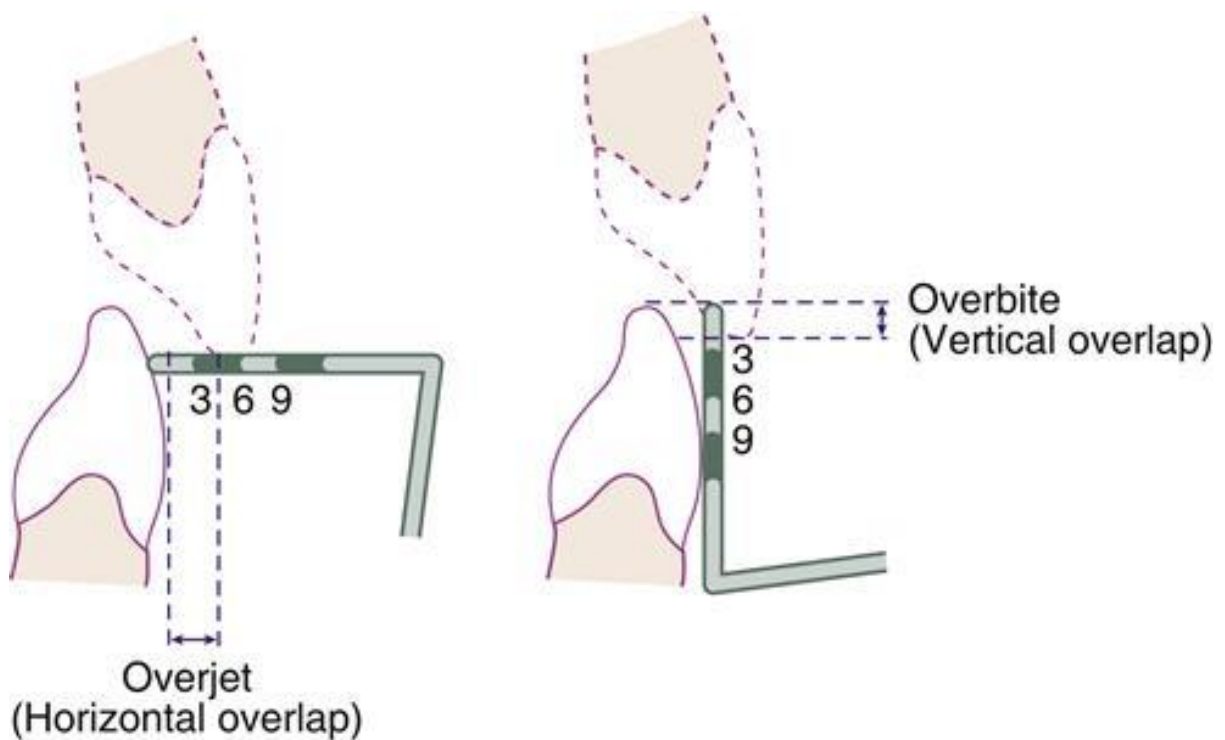


Figure 3.2: diagram of overbite and overjet

3.5.2 Dependent variables

- Dental malocclusion (Angle's classification)

3.6 Instruments for Data Collection

3.6.1 Questionnaire design

Data were collected by way of interview and clinical examination of participants using a modified WHO/FDI dentofacial assessment form. The modified WHO/FDI dentofacial assessment form comprising five aspects namely sociodemographic data, dentition,

anomalies of tooth development, intra-and inter-arch findings as well as state of occlusion were used in data collection. The WHO/FDI dentofacial assessment form was used in previous studies by Bezroukov et al., (1979).

3.6.2. Questionnaire administration

All the students in the school gathered for oral health education which was translated in the local dialect (Dangme). The purpose of the study and the contents of the participant information sheet were also explained and translated. All questions bothering the minds of the students and staff were addressed before the exercise began. The clinical assessment was conducted on the participants who satisfied the inclusion criteria after all parties were satisfied with the process

3.7 Data Collection Procedure

3.7.1 Clinical assessment

Clinical examination was carried out in the classroom by experienced dental surgeons using disposable wooden spatula, metal ruler in the presence of natural and artificial illumination. Disposable gloves, facemasks, sanitizers, perasafe, soap, water and paper towels were provided to aid in standard cross-infection control practices through cold sterilization of instruments using perasafe. For precise measurement, the orthodontic caliper was used in taking measurements. Clinical findings from the occlusal traits and state of the sagittal occlusion at the time of clinical examination were recorded for each participant in the dentofacial assessment form.

3.7.2. Assessment of dentition

This section recorded missing permanent teeth. Any tooth from the regular set of teeth that is not present in the mouth is recorded as missing. There was however no attempt to identify the reasons for the absence of the teeth.

3.7.3. Anomalies of tooth development

This section recorded the number of permanent teeth that erupted at ectopic positions in the jaw, number of malformed teeth such as peg-shaped lateral incisor or hypoplastic teeth such as fluorosed tooth, the number of supernumerary teeth present as well as retained deciduous teeth. The position and shape of the tooth were not specified.

3.7.4 Inter-and intra-arch findings

The presence and absence of the following occlusal characteristics were recorded in this section. The presence of the occlusal trait was recorded as “1” whereas absence of which was recorded as “0”.

The presence of 2mm or more space mesial to the maxillary central incisors was recorded as a diastema. The presence or absence of crowding and spacing were also recorded. The affected segment was however not specified.

Crowding was recorded when the amount of space in the affected segment is insufficient to accommodate the full set of teeth for the segment. When the space available exceeded that required to accommodate the set of teeth for that segment spacing was recorded. However, situations where there was the presence of supernumerary tooth and missing normal teeth were excluded.

Midline deviation was recorded where the midlines of the maxillary and the mandibular arch are displaced by more than 2mm. There was no attempt to specify whether the displacement was from the upper or lower arch. Situations where the upper or lower central incisors were missing were excluded.

Anterior openbite was recorded when all the maxillary incisors fail to overlap or contact the mandibular teeth.

Posterior openbite was recorded when there is lack of contact between the posterior teeth with a minimum of at least 2mm between opposing teeth.

Anterior crossbite was recorded when the maxillary incisors bite lingually to the mandibular incisors.

Posterior crossbite was recorded when the buccal cusp of the maxillary tooth lies lingual to the buccal cusp of the lower tooth or lingual cusp of the upper tooth lies buccally to the buccal cusp of the lower tooth

3.7.5 Assessment of Occlusion

Overbite is the extent of vertical overlap between the maxillary incisors and the mandibular incisors. The overbite was recorded as normal or “0” for overlap that measured between 0 to 3mm. More than 3.5mm without gingival contact was coded “1”, complete overbite without palatal trauma was coded “2”, whereas complete overbite with palatal trauma was coded “3”

Overjet is the extent of horizontal overlap between the maxillary incisors and the mandibular incisors. Values between 0 to 3 mm were considered normal and coded “0”. Increased overjet greater than 3.5mm to 6mm with competent lips was coded as “1”. Increased overjet of 3.5mm to 6mm with incompetent lips was coded as “2”. Increased overjet of more than 6mm to 9mm was coded “3”, and more than 9mm was coded “4”. The method of assessment is summarized in table 3.7.1.

Malocclusion (Angle’s classification)

The classification of malocclusion was based on Angle’s classification system. Class I molar relationship with no dental irregularities was considered normal and coded as “0”. Figure 3.3 illustrates a Class I molar relationship. Class I molar relationship associated

with any of the occlusal irregularities is termed Class I malocclusion and was coded “1”. Class II division 1 molar relationship was coded “2”, Class II division 2 was coded “3”. Figure 3.4 illustrates Class II molar relationship. Whereas Class III malocclusion was coded “4”. Class III molar relationship is illustrated in figure 3.5. Table 3.7.1 below summarises the assessment of occlusion and their designated codes.

Table 3.7.1 assessment of occlusion with assigned codes

Malocclusion	Overjet	Overbite	code
Normal occlusion	0-3mm (normal)	0-3mm (normal)	0
Class I malocclusion	>3.5mm- 6mm with competent lips	>3.5mm without gingival contact	1
Class II div 1	>3.5mm- 6mm with incompetent lips	Complete overbite without gingival or palatal trauma	2
Class II div 2	>6mm-9mm	Complete overbite with gingival or palatal trauma	3
Class III	>9mm		4

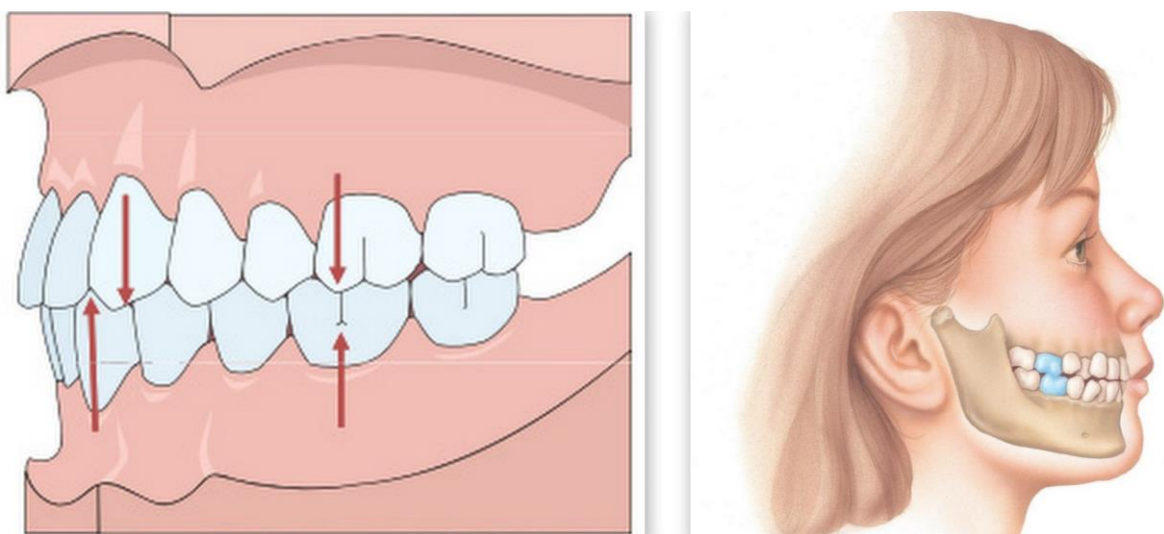


Fig 3.3: Diagram depicting Class I molar relationship
(Credit: <https://dentodontics.com/2015/09/09/>)

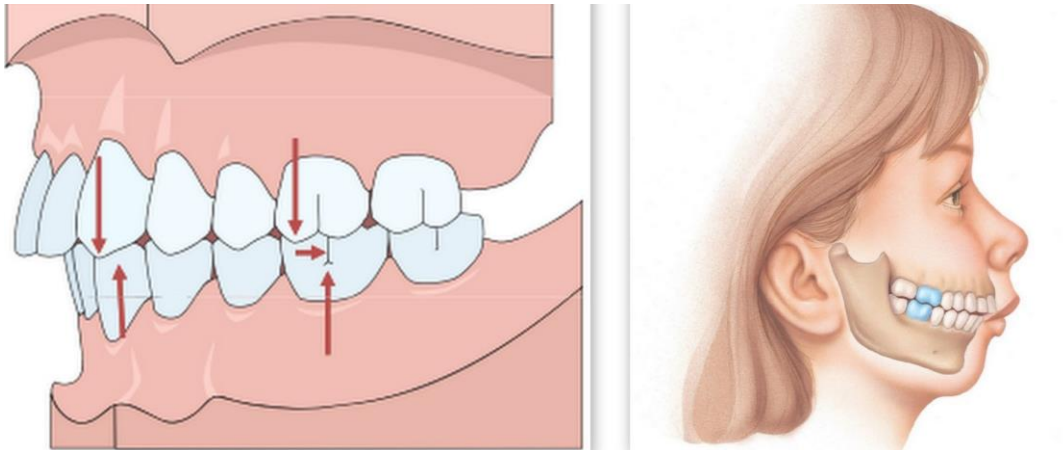


Fig 3.4: Diagram depicting Class II molar relationship
(Credit: <https://dentodontics.com/2015/09/09/>)

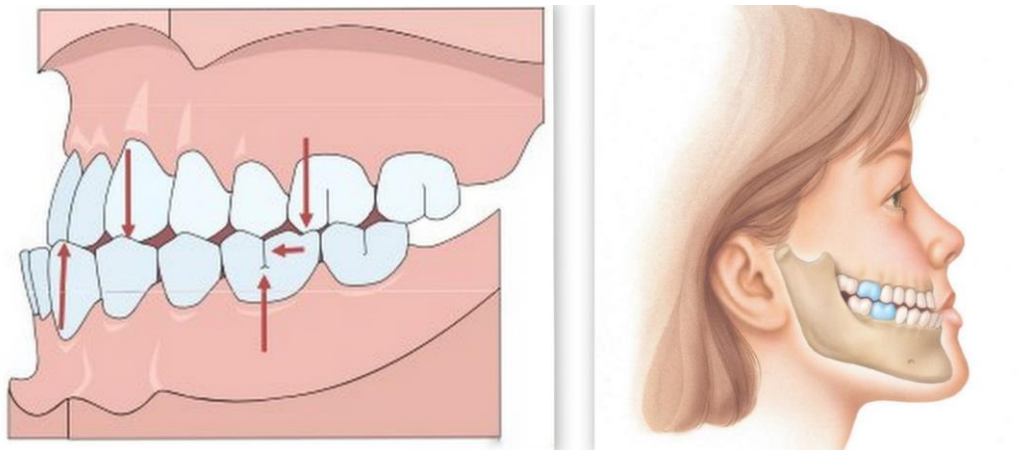


Fig 3.5: Diagram depicting Class III molar relationship
(Credit: <https://dentodontics.com/2015/09/09/>)



Fig 3.6: A photograph of anterior open bite among the respondents



Fig 3.7: A photograph of bilateral buccally erupting ectopic maxillary canines



Fig 3.8: A photograph of anterior crowding and rotated maxillary central incisors among respondents

3.8 Quality control

The need for accurate data throughout the study required that measures be put in place to minimize errors at every stage of the study.

3.8.1 Training of the research assistants

The study required the help of individuals with clinical skills in dentistry and orthodontics subspecialty. Therefore, three experienced dentists undertook the clinical examination aspect of the study. During the training session the dentists were calibrated in the assessment of all the variables to reduce the level of ambiguity in measurement. Each dentist was assisted by a research assistant who recorded the findings. Each assistant was taken through training session on every section of the assessment form, how to administer each questionnaire and the rights of the participants as spelt out in the participant information sheet.

3.8.2 Pretesting

Pre-testing was done involving 34 participants making up 10% of the actual sample size from Doryumu D/A school to check for any flaws in the questionnaire design and administration phase as well as ambiguities in the clinical findings. The difficulties encountered in the pre-testing phase were addressed accordingly to prevent any interviewer bias. This was done by the principal investigator and the trained research assistants.

3.9 Data collection

The study participants were proportionally and randomly selected to avoid bias. The principal investigator and the research assistants met each day after data collection to discuss and address difficulties encountered to ensure uniformity in data collection stage.

3.10 Data entry, processing and analysis

Data were coded and entry controls put in place to prevent any wrong entry into Excel statistical package. All the errors in the data were cleaned and imported to Stata Version 15 software for analysis.

3.10.1 Data analysis

Analysis was done using Stata V15. The various classes of malocclusion based on Angle's system of classification as observed clinically were entered using their assigned codes as shown in Table 3.7.1. The total score for each class of malocclusion is used to determine the prevalence of each class of malocclusion... The other occlusal irregularities such as overbite and overjet were measured and scored according to the findings. The proportion with normal overjet and overbite as well as the severity of each were determined from the clinical findings.

The number of missing teeth, supernumerary, malrotated, malformed/hypoplastic, ectopic teeth and retained primary teeth were recorded and categorised. The result was used to determine the prevalence as well as severity of the condition. The presence or absence of occlusal traits such as openbite, crossbite, crowding, spacing, and diastema and midline deviation were recorded and scored. The prevalence of each was determined from the results.

Fisher's exact test was used to determine the association each of the occlusal traits and each class of dental malocclusion. The association of sex, age and malocclusion was also determined using Fisher's exact test.

3.11 Ethical considerations

The following steps were taken during the study to ensure the rights of the respondents were not violated and to prevent any harm from occurring to them.

3.11.1 Ethical clearance

Ethical clearance was sought from the Ghana Health Service Ethical Review Committee before the study was conducted.

3.11.2 Permission to conduct the study at the study sites

Permission was sought from the headteachers of the four selected schools, the District Health Directorate and the District Directorate of the Ghana Education Service before the study was conducted.

3.11.3 Informed consent

The purpose of the study was read and explained to the study participants as well as the head of the institutions and in some cases with the help of an interpreter. All follow up questions were addressed. The headteachers and PTA chairpersons signed on behalf of the PTA. They were made aware that participation by their children was entirely voluntary and that they could willingly decline to participate without any adverse consequence at any point. The participants as well as the headteachers gave their informed consent by either signing or thumb printing the consent form.

3.11.4 Privacy/confidentiality /anonymity

The study was conducted in a way that ensured that privacy of the participants was protected. No names were used throughout the study.

3.11.5 Potential risks and benefits

The study was conducted in a classroom, a familiar setting, to reduce any form of anxiety or shyness among the participants especially those who have not visited the dental clinic before. The participants also had the opportunity to know their oral health status. Those who required attention were given referral note to the nearest dental clinic. The study

finding is essential in policy formulation which would eventually benefit the participants and the general public.

3.11.6 Data storage and usage

The questionnaires were coded and kept under lock and key in a safe with the principal investigator. Additionally, the data collected were coded, entered within 24 hours of collection, saved under password protection and a copy kept on CD-ROM. The data collected would be kept by the principal investigator for 3-4years to allow for publishing of the research after which the questionnaire be destroyed.

3.11.7 Conflict of interest

I declare no competing interest.

3.11.8 Funding of the study

The entire cost of the study was borne solely by the principal investigator.

CHAPTER FOUR

4.0 RESULTS

4.1 Sociodemographic characteristics

Table 4.1 shows the socio-demographic characteristics of respondents. The mean age of respondents was 13.5 years \pm 1.3 SD with most of them being females (62.6%). Nearly 30% of the school children were in year one of Junior High School. More than half (63.8%) of the participant had history of dental visit.

Table 4.1 socio-demographic characteristics of respondents

Variables	Frequency N=340	Percent (%)
Mean age in years (M \pm SD)	13.5 \pm 1.3	
Sex		
male	127	37.4
female	213	62.6
History of dental visit	217	63.8
Educational level		
primary 6	76	22.4
JHS 1	104	30.6
JHS 2	72	21.2
JHS 3	88	25.8

*SD standard deviation

4.2 Malocclusion amongst respondents

Figure 4.2.1 below summarizes the prevalence of malocclusion among the participants. As shown, about 6.2% of respondents had normal dentition while 69.2% of them had Class I

malocclusion. Class II division 1 and Class II division 2 malocclusion were detected in 3.2% and 2.4% of the respondents respectively. Class III Malocclusion was found in 19.1% of respondents. In total, 93.8% of the respondents had various classes of dental malocclusion.

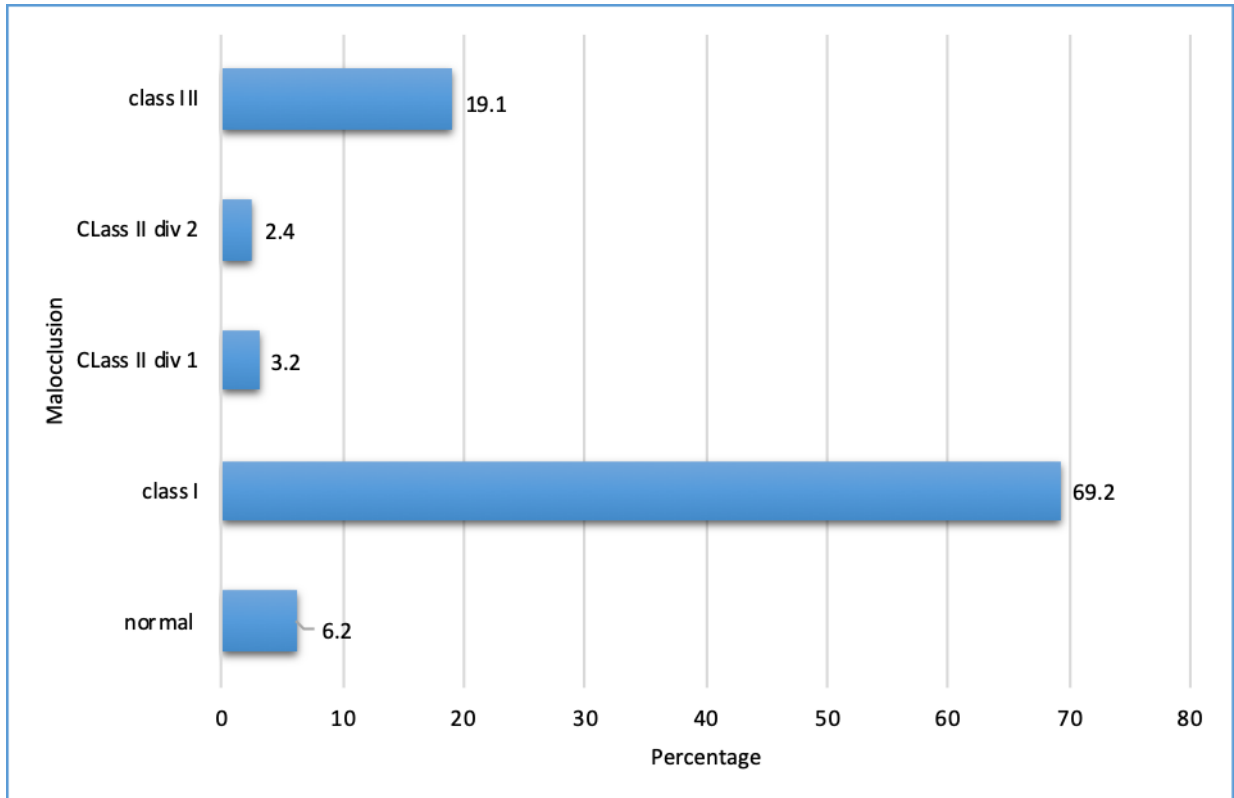


Figure 4.2.1 Frequency of Malocclusion amongst respondents.

4.3 Prevalence of overjet among respondents

Figure 4.3.1 below summarizes the various degrees of overjet in the dentition of the participants. As shown about 13.5% of the respondents had increased overjet, out of which 2.7% and 1.5% had overbite more than 9mm and more than 6mm-9mm respectively. The respondents with competent lips and overjet more than 3.5mm-6mm were 6.2% while those with same degree of overjet but associated with incompetent lips were 1.2%.

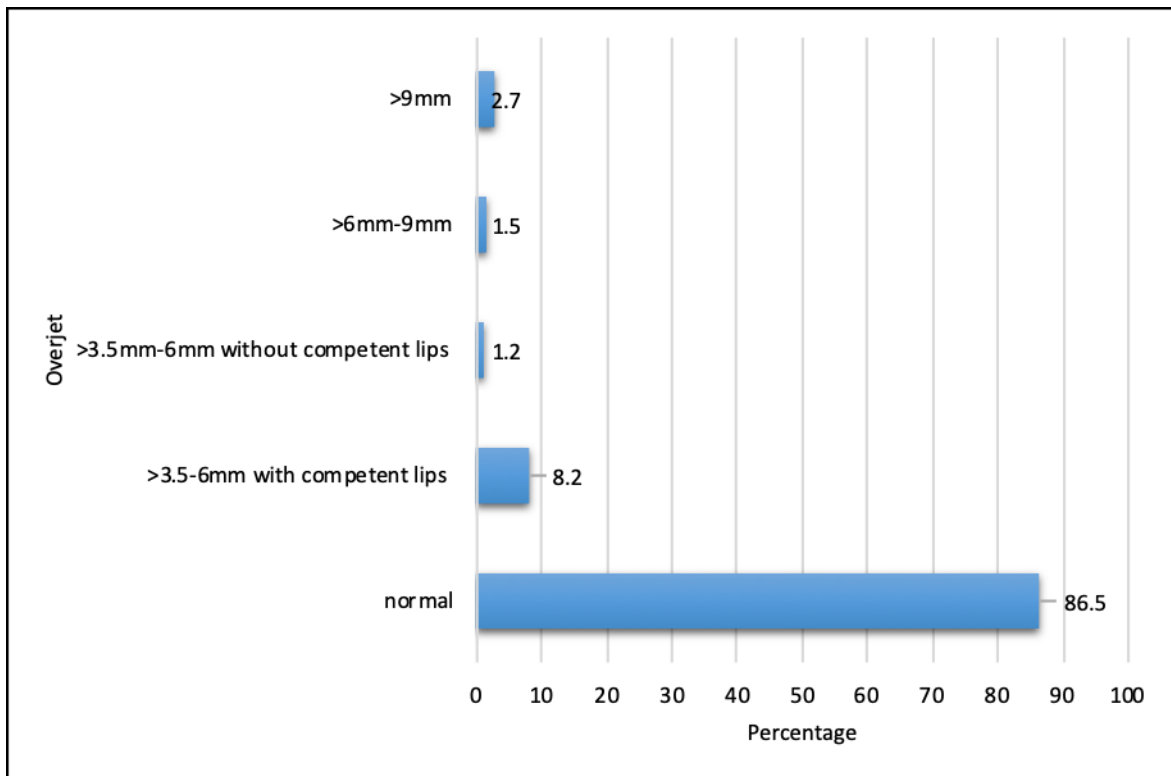


Fig 4.3.1: Frequency of overjet among respondents

4.4 Prevalence of overbite among respondents

Figure 4.4.1 below is a summary of the various degrees of overbite in the dentition among the participants. As shown, 88.5% of the participants had normal overbite. About 3% presented with complete overbite with palatal trauma. About 11.5% of the respondents had increased overbite.

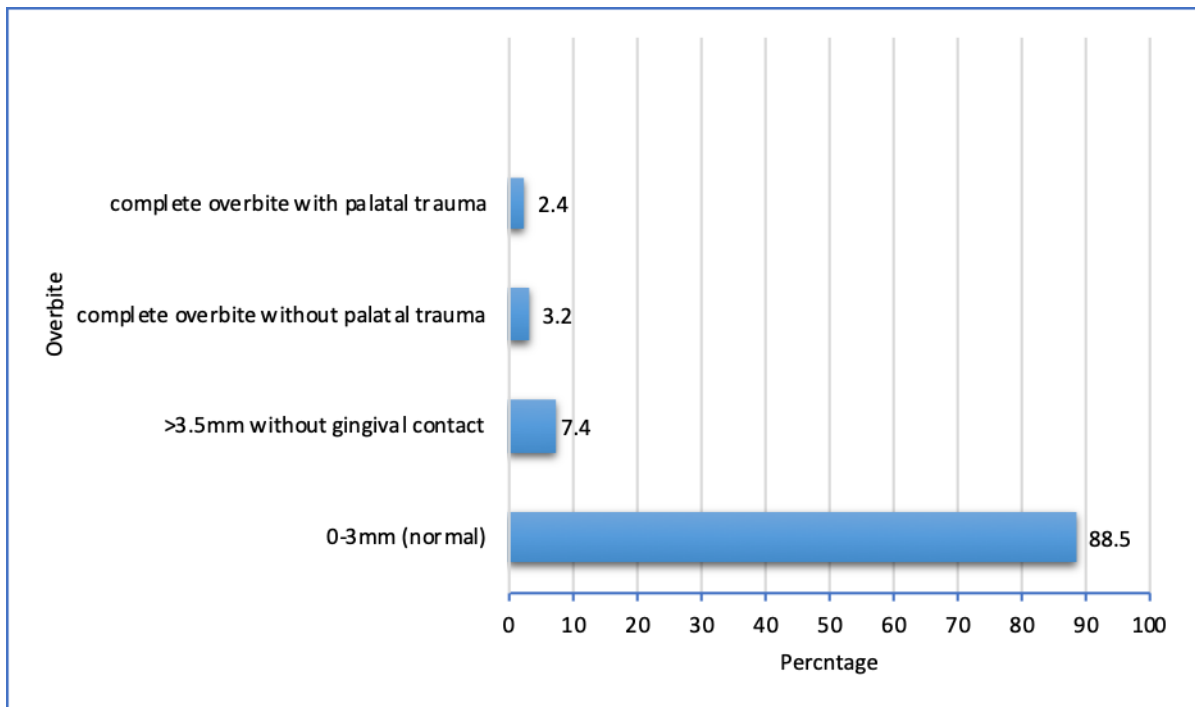


Fig 4.4.1 Frequency of overbite among respondents

4.5 Prevalence of occlusal irregularities

Table 4.5.1 below summarizes the prevalence of occlusal traits among 340 respondents of the study. As shown 23 (6.8%) of them had anterior openbite, 14 (4.1%) had anterior crossbite and 24 (7.1%) had posterior openbite. Spacing was the most recorded dental anomaly amongst respondents (33.2%) while crowding was detected among 26.2% of the participant. About 53.5% of respondents had malrotation of the tooth, out of which half (50%) had 1-5 teeth rotated. About 11.2% of respondents presented with retained deciduous teeth, more than half (28/40) of the affected have between 1-5 deciduous teeth retained. About 24.4% had deviated midline of the upper and lower arch. Only 1.2% of respondents had supernumerary teeth present whereas 16.7% had malformed/hypoplastic teeth. Midline diastema and midline deviation were detected among 26.5% and 24.4% respectively. Table 4.5.1 shows the frequency and percentage of dental anomalies among respondents.

Table 4.5.1 Frequency of occlusal traits among respondents

Variables	percentage	Total
Supernumerary	1.2	4
Malformation/hypoplastic	16.7	56
1-5 teeth	16.2	55
>5 teeth	0.3	1
Ectopic tooth	2.4	8
Retained teeth	11.2	40
1-5 teeth	8.2	28
>5 teeth	3.2	11
Anterior openbite	6.8	23
Anterior crossbite	4.1	14
Posterior openbite	7.1	24
Posterior crossbite	21.	71
Midline deviation	24.4	83
diastema	26.5	90
Crowding	26.2	89
Spacing	33.2	113
Malrotation	53.5	182
1-5 teeth	50	170
>5 teeth	3.5	12
Increased overjet	13.5	46
Increased overbite	11.5	39
Missing teeth	93.5	31
1-5 teeth	82.7	281
6-10 teeth	8.2	28
11-15 teeth	0.6	2
16-20 teeth	2.2	7

4.6 Association between Malocclusion and Dental Anomalies

Table 4.6.1 below summarizes the test of association between malocclusion and the various occlusal traits among the participants. As shown, most of the occlusal traits were significantly associated with malocclusion. Posterior open bite was significantly associated with malocclusion ($\chi^2=29.787$, $p<0.001$), 11 of the respondents with Class I malocclusion had posterior open bite while 6 of the respondents with Class III malocclusion had posterior open bite.

Posterior cross bite was also significantly associated with malocclusion ($\chi^2=12.024$, $p=0.017$), 45 of the respondents with Class I malocclusion had anterior cross bite while 20 of the respondents with Class III malocclusion had posterior cross bite.

Midline deviation was significantly associated with malocclusion ($\chi^2=11.203$, $p=0.024$), 55 of the respondents with Class I malocclusion had midline deviation while 23 of the respondents with Class III malocclusion had midline deviation.

Midline diastema was significantly associated with malocclusion ($\chi^2=12.806$, $p=0.012$), 58 of the respondents with Class I malocclusion had midline diastema while 21 of the respondents with Class III malocclusion had midline diastema.

Crowding was significantly associated with malocclusion ($\chi^2=18.445$, $p=0.001$), 66 of the respondents with Class I malocclusion had crowding while 16 of the respondents with Class III malocclusion had crowding.

Spacing was significantly associated with malocclusion ($\chi^2=16.808$, $p=0.002$), 82 of the respondents with Class I malocclusion had spacing while 26 of the respondents with Class III malocclusion had spacing. There was a significant association between tooth malrotation ($\chi^2=31.221$, $p<0.001$), increased overjet ($\chi^2=31.184$, $p<0.001$) and increased

overbite ($\chi^2 = 55.178$, $p < 0.001$) and dental malocclusion. Out of the 182 respondents who had tooth malrotation, 138 had class I malocclusion, while 182 of the respondents had class III malocclusion.

Table 4.6.1 Association between Malocclusion and Dental Anomalies

Variables	Malocclusion					N=340		
		class I	class II	class II	class III	total	χ^2	p-value#
	Normal	I	div 1	div 2	III			
Anterior open bite	0	13	2	1	7	23	6.433	0.169
Anterior cross bite	0	8	0	0	6	14	6.325	0.176
Posterior open bite	0	11	4	3	6	24	29.787	0.000*
Posterior cross bite	0	45	3	3	20	71	12.024	0.017*
Midline deviation	0	55	3	2	23	83	11.203	0.024*
Malformation/hypoplasia	1	41	2	1	11	56	2.380	0.666
Midline diastema	4	58	7	0	21	90	12.806	0.012*
Crowding	0	66	2	6	15	89	18.445	0.001*
Missing teeth	21	220	11	6	60	318	6.916	0.140
Spacing	0	82	5	0	26	113	16.808	0.002*
malrotation	0	138	5	7	32	182	31.221	0.000*
Supernumerary	0	0	2	0	0	2	2.710	0.608
Ectopic teeth	0	7	0	0	1	8	1.552	0.817
Increased Overbite	0	23	7	5	4	39	55.178	0.000*
Increased overjet	0	31	5	5	5	46	31.184	0.000*

*statistically significant ($p < 0.05$).
P-value# - Fisher's exact p-value

4.7 Association between sex, age and dental malocclusion

Table 4.7.1 summarizes the assessment of association between sex and age of the participants and dental malocclusion. As shown, there was no significant association between sex of the respondents and dental malocclusion. However, there was a significant relationship between age and dental malocclusion. The number of respondents with dental malocclusion decreases with age.

Table 4.7.1 Association between age, sex and Dental malocclusion

Variables	Malocclusion					Total No. 340	χ^2	p-value#
	Normal	class I	class II div 1	class II div 2	class III	total		
Sex							3.486	0.480
Male	6	85	4	5	27	127		
Female	15	150	7	3	38	213		
Age (years)							26.5619	0.047*
12	4	62	5	2	13	86		
13	9	53	1	0	18	81		
14	2	59	5	3	13	82		
15	6	50	0	1	16	73		
16	0	11	0	2	5	18		

*statistically significant (p<0.05)

p-value- Fisher's exact p-value

CHAPTER FIVE

5.0 DISCUSSION

5.1 Prevalence of dental malocclusion

Dental malocclusion adversely affects a large number of individuals particularly of school going age, leading to adverse consequences including difficulty in chewing and swallowing and lack of confidence to talk in public. However, it can be prevented or treated in the rudimentary stages during childhood to prevent complications.

In view of this, this study was conducted to determine the prevalence of dental malocclusion in 12 to 16-year-old school children in the Shai-Osudoku district in the Greater Accra Region of Ghana. The following presents a discussion of the findings of the study.

The high prevalence (93.8%) of malocclusion was observed in the respondents of this study which suggests the need for regular screening at each stage of development in order to reduce or avoid complications and expensive orthodontic treatment by employing measures of preventive and interceptive orthodontics (Karaiskos, Wiltshire, Odlum, & Hassard, 2005). There are many indices for assessing dental malocclusion (Agarwal & Mathur, 2012). The modified Angle's classification was used in the study due to the ease with which it can be deployed and ease of communication among professionals and scientific community. A study by Alhammadi et al. (2018), showed the global estimates of Class I, Class II and Class III malocclusion in the permanent dentition stage as 74.7% (31-97%), 19.56% (2-63%), 5.93% (1-20%) respectively. The study emphasized the roles of racial differences in the aetiology of malocclusion and reported a prevalence of 89.44% as Class I, 6.76% Class II and 3.8% Class III malocclusion among Africans (Alhammadi et al., 2018). In this study prevalence of dental malocclusion among the respondents who

were all in the permanent dentition stage was found to be 69.2% as Class I, 3.2% Class II division 1, 2.4% Class II division 2 and 19.1% Class III Angle's malocclusion. The results of the present study, though slightly lower, it is consistent with the findings in the global and African trend. Studies on dental malocclusion in Ghana dates back to 1967 by Houpt et al. who studied among 5-18year olds in the Brong Ahafo region and reported a prevalence rate of 38.6% with anterior crossbite being the most common occlusal irregularity (Houpt et al, 1967). Richardson (1968), in a study among 5-14-year olds in Mampong also reported of 4.3% prevalence of malocclusion. An unpublished work by Abu-Sakyi (2005), cited in the work of Beni (2009), reported a 9.6% prevalence of severe forms of malocclusion in the Wa municipality among 15-24-year-olds. These studies did not use any specific orthodontic indices but rather considered orthodontic conditions as a criterion (Onuoha, 2002). This could have accounted for the large differences in the prevalence. Other studies by Beni (2009), and Onuoha (2002), which sought to use orthodontic treatment needs index found the prevalence of dental malocclusion to be 27.9% and 7.8% respectively. It is interesting to note that all of these studies focused on participants in their mixed, permanent and primary dentition stage rather than on adolescents in their permanent dentition stage only, as a result were not able to present a good comparison of the molar relationship. Also detailed literature on malocclusion among school children in their permanent dentition stage in Ghana is limited. The difference in prevalence of malocclusion is partly due to differences in the indices used in classification (Thilander, Pena, Infante, Parada, & De Mayorga, 2001), ethnic differences and the age group of the study population (Atashi, 2007; Joshia & Hamdanb, 2014). Studies done among populations in the primary and mixed dentition stage usually show strikingly different results from those in the permanent dentition stage. For example, prevalence of malocclusion in permanent dentition range from 39% (Dhar et al., 2007) to

98% (Mtaya et al., 2009) whereas that of the primary and mixed dentition stage range from 57% (Stahl & Grabowski, 2003) to 94.1% (Goís et al., 2012) Therefore, since the present study was conducted among children in the permanent dentition stage it was not surprising that a relatively lower prevalence of malocclusion (93.8%) was obtained compared to 94.1% (Goís et al., 2012) among children in the primary and early mixed dentition stage.

5.2 Prevalence of occlusal traits among respondents

The study showed a prevalence of 13.5% increased overjet and 11.5% increased overbite among respondents. These results are consistent with those of a study conducted by (Onyeaso, 2004) among 12-17 years olds in Ibadan which showed a prevalence 16% increased overjet while 14% had increased overbite. Findings from the study conducted by Onyeaso also showed crowding in 20% of the subjects and midline diastema was observed in 37% of the respondents. These results are consistent with findings from this study which found 26.2% and 26.5% of respondents with crowding and midline diastema respectively. The higher prevalence of crowding in this study is partly due to premature extraction of the primary tooth which is further enforced in studies by Richardson (1972a). Studies by Goyal & Goyal, 2012 in Rwanda and Drummond (2005), in South Africa however showed markedly higher prevalence of 71.2% and 40% respectively. Furthermore, in this study spacing was found in 33.2% of the respondents in sharp contrast to the 9.9% found by Goyal and Goyal (2012). The higher prevalence of spacing and crowding therefore need to be investigated in further studies and appropriate preventive actions prescribed. The differences could partly be due to differences in the sample size as well as ethnic differences. Ethnic and racial difference as well genetic differences controlling jaw growth are known to play an important role in the prevalence of crowding and spacing (Onyeaso, 2004). In this study more than half (53%) of the respondents had

one or more teeth rotated and 40% of the respondents had retained primary teeth. The retention of the primary tooth in the presence of the permanent successor may result in crowding of the segment as well as malrotation of the erupting secondary tooth due to inadequate space in the dental arch. The high prevalence of malrotated teeth therefore need to be studied further in order to ascertain the causative factors for the appropriate preventive measure to be taken.

The prevalence of anterior openbite, posterior openbite, anterior crossbite and posterior crossbite were found to be 6.8%, 7.1%, 4.1% and 21% respectively. Compared to the results of the global and racial trends from the study by Alhammedi et al., 2018 which showed a global prevalence of 9.39% for posterior crossbite and 7.9% among Africans, the prevalence of posterior crossbite in this study was higher than the global trend however it was consistent with that found in the study by Tiro et al., 2017 which found 30% of the respondents having posterior crossbite. The underlying causes therefore need to be thoroughly investigated in further studies since cases of posterior crossbites require early intervention. Occlusal anomalies such as the crossbites require early treatment in order to avoid severe skeletal outcomes later which will require surgical correction.

Discrepancies in the dental midlines was found in 24.4% of the respondents. This is consistent with that found in the study by Tiro et al. (2017) in which 30% of the respondents had midline deviation. There are several underlying causes including tooth loss, supernumerary tooth as well as retention of primary tooth. Midline deviation has aesthetic implications and thus require orthodontic correction.

5.3 Association between occlusal traits and dental malocclusion

Malrotation was recorded in 182 respondents. Rotated teeth affect dental aesthetics and function. Correction of the rotated tooth improve intercuspation of the opposing teeth as

well as mastication. The findings of the study showed significant association between malrotation (p value < 0.001), posterior openbite (p value < 0.001), posterior crossbite (p value = 0.017), midline deviation (p value = 0.024), midline diastema (p value = 0.012), crowding (p value = 0.001), spacing (p value = 0.002), increased overbite (p value < 0.000), increased overjet (p value < 0.001) and the development of Angles dental malocclusion.

Although there was a high prevalence (93.5%) of missing teeth among the respondents there was no association between having a missing tooth and the development of dental malocclusion according to the study. The high prevalence is partly because most of the respondents did not have the full set of 32 normal teeth at the time of the study. Thus, absence of third molar which may not have erupted before age 16 years (Renton & Wilson, 2016) was categorised same as that of a central incisor.

5.4 Association between age, sex and dental malocclusion

According to the study there was no association between the sex of the respondents and the development of malocclusion as reported in other studies (Ajayi, 2008). However significant association exist between age (p value = 0.0470) of the respondents and development of dental malocclusion was found as reported by other studies (Luzzi et al., 2018). A lot of studies on malocclusion are carried out among young children because of the importance of age in determination of success of treatment (Atashi, 2007). Most malocclusions may worsen or improve with age depending on factors such as premature shedding of the deciduous tooth and trauma. Therefore prevalence of some particular malocclusions may decrease or increase with time (Atashi, 2007). This calls for further studies to determine the differing prevalence of different types of malocclusion for different age groups in the same population

5.5 Study limitations

1. But for financial constraints, a larger sample size would have been appropriate to improve the outcome of the study.
2. The study also failed to explore the implications of other causative factors of malocclusion such as socio-economic status of respondents and knowledge about malocclusion which would have provided a better insight as to why the results followed this trend.
3. Examiner subjectivity may also account for some differences in the results.
4. The Angles systems of classification of malocclusion has inherent errors associated with the position of the first permanent molars which could lead to misclassification.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

Dental malocclusion affects a significant number of people with various degrees and associated consequences. This descriptive cross-sectional study was conducted to quantify the problem of malocclusion and occlusal anomalies that influence the development of malocclusion using a standard orthodontic index that is easy to use and compare with findings in previous studies among different populations.

The study showed a high prevalence of dental malocclusion among the respondents. According to the study only 6.2% of the respondents had no occlusal irregularities. Angle's Class I, Class II and Class III malocclusion were detected in 69.2%, 5.6% and 19.1% respectively. The results show a higher prevalence of dental malocclusion compared to previous studies. There were significant association between age of participants and the prevalence of malocclusion

Early intervention using preventive and interceptive orthodontics is required to prevent the development of severe skeletal anomalies which require surgical and expensive orthodontic correction.

6.2 Recommendation

6.2.1 Public health recommendation

Since lack of oral health education, lack of regular dental visits and poor oral hygiene practices are some of the preventable causes of malocclusion, the reintroduction of oral health education into the schools' curriculum will go a great length in reducing the prevalence of dental malocclusion among the populace. The oral health education coupled

with regular screening at every stage of the development to identify occlusal irregularities at the early stages of development and addressed. Bad oral habits such as digit sucking which causes anterior openbite and posterior crossbites can be controlled by behavioral techniques which both parents and wards can employ. Failure of which interceptive orthodontics can be used rather than allowing it to progress from dental anomalies to severe skeletal anomalies which will require surgical correction.

6.2.2 Policy recommendation

The cost of dental treatment remains high despite efforts by government to absorb some services under the National Health Insurance Scheme. Preventive and interceptive orthodontic services should be included among services covered under the National Health Insurance Scheme to lessen the financial burden and improve equity among the citizenry.

6.2.3 Research recommendation

There is the need for further studies with much larger sample size and a broader scope and coverage aimed at identifying the environmental determinants underlying the etiology of dental malocclusion. This will better serve in addressing the burden of dental malocclusion.

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APPENDICES

Appendix A: Participant Information Sheet

Title of study: Prevalence of Dental Malocclusion among 12-16-year-old School Children in the Shai-Osudoku District of Ghana.

Introduction: I am Richard Nii Armah from School of Public Health, University of Ghana, Legon. I work at St Andrews Hospital, Kordiabe as a dental surgeon.

Background and purpose of the research: We are conducting a study to find out about the arrangement of your teeth. The arrangement of the teeth in the mouth is known in science as dental occlusion. If the teeth are poorly arranged, it is known as dental malocclusion. If the malocclusion is not identified and corrected early in childhood, it can lead to bad effects such inability to chew properly, difficulty to pronounce certain alphabets and words correctly as well as lack of confidence to smile and answer questions in class. It is because of this that we have come to do this study to check the arrangement of the teeth in your mouth as well as your oral hygiene status so that if they are not good enough advice will be given for them to be corrected. We are hoping you will take part in the study because it will help us to recommend for planning of oral health programs for you and members of your community.

Nature of the research: This is a cross-sectional study in which two experienced dental surgeons and two registered dental surgery assistants will examine participants who satisfy the inclusion criteria and all data will be collected in a day.

Duration: The entire study will span a period of four months. However, the data collection will be done in a day for all participants and requires less than ten (10) minutes for each.

Participants' involvement: The study involves clinical examination of 340 students aged 12-16 years in the classrooms under natural light on the school premises.

What is involved: We will ask you questions about what you know about your teeth and gums and how to keep them in good health. We will also check your mouth to see the arrangement of your teeth and if you need any care for your gums and teeth problems in your mouth. Your answers will be kept private and it will not be shown to your teachers, your parents or your friends. Only people from the University working on the study will see them.

Potential risks: The participants may feel shy opening the mouth and in some cases experience jaw fatigue if the mouth is kept open much longer than can be tolerated. The time you will spend in answering questions, opening your mouths for check-up may also inconvenience you in a way.

Benefits: Taking part in the research will help you know whether you are doing well with care for your mouth. We will also be able to give you some guidelines for future practice of good oral care. Taking part in the study will also help to plan for oral health programs for other children in other schools.

Costs: The estimated cost of the study is being borne by the principal investigator. No cost will be incurred by the participants.

Compensation: The participants will not be compensated for taking part in the study however, some refreshments will be served in a form of soft drinks and pastries.

Confidentiality: The identity and clinical findings will be kept confidential. No names will be recorded in course of the study. Instead, codes will be used and the findings will

not be divulged and any other person. Only the team conducting the study will know.

Voluntary participation/withdrawal: Kindly note that participation is voluntary and that participants have the right to refuse to participate at any stage of the process without penalty.

Outcome and feedback: After the investigation, report of the findings will be sent to the Ethics Review Committee, Ghana Health Service. The PI will return to study participants, PTA, opinion leaders and the elders of the communities that house the study sites to have an oral health awareness education on the condition of dental malocclusion and its effect based on the study findings as well as measures to correct it. The findings from the study will be used for policy formulation to enhance dental care in the country. It will also help create awareness of the dental malocclusion and its effects as well as measures that need to be taken to correct it nationwide.

Appropriate alternative procedures and treatment: Those who were not or refused to take part in the study participants but want to have the oral health checked will be referred to St Andrews Hospital for dental examination and management. The participants who require urgent dental treatment will be referred to St Andrews Catholic Hospital, Kordiabe and the Shai-Osudoku hospital for treatment. Those found to present with gingivitis and caries will be required to seek periodontal therapy and dental restorations whereas those with oral habits and simple anterior crossbites may be referred for correction using removable appliances and fixed orthodontic treatment as its deemed fit.

Funding information: This research is entirely self-sponsored. The entire cost is borne by the principal investigator.

Sharing of participants information/Data: All data generated from the study will be stored safely in a locked cabinet and not shared with any institution. Should the need arise

for the data to be used for any new studies approval will be sought from the Ethics Review Committee of the Ghana Health Service.

Provision of information and consent for participants: A copy of the information sheet and consent form will be given to you after it has been signed to keep.

Kindly contact any of the below listed at the University of Ghana School of Public Health and the Ghana Health Service Ethics Review Committee should you need further clarification

CONTACT

For further information

Dr Richard Nii Armah 0242111643 rnarmah001@st.ug.edu.gh

School of Public Health

University of Ghana -Legon

Dr Uri Markakpo 0246373898 umarkakpo@gmail.com

Lecturer, Research Fellow

School of Public Health

University of Ghana -Legon

Your rights as a Participant

If you have any questions about your rights as a research participant, you can contact the

Administrator of the GHS Ethics Review Committee at the following address:

Hannah Frimpong 0507041223 hannahfrimpong@ghsmail.org

Administrator

Ghana Health Service Ethics Review Committee

P.O. Box 190

Adabraka Polyclinic Hospital (now Ridge Hospital OPD)

Accra Ghana

Appendix B: Assent Form for Children Aged 12-16 Years

Study Title: Prevalence of Dental Malocclusion among 12-16-year-old School Children in the Shai-Osudoku District of Ghana.

I acknowledge that I have read/ have had the purpose and contents of the Participants' Information Sheet (read) and all my questions have been satisfactorily addressed in a language I understand (English/Dangme/Twi). I fully understand the contents and any potential implications as well as my right to change my mind (i.e withdraw from the research) even after I have signed this form.

I voluntarily agree to be part of this research.

Name or Initials of Participant..... ID Code.....

Participants' SignatureOR Mark (please specify)

Date.....

INTERPRETER'S STATEMENT

I interpreted the purpose and contents of the participants' information sheet to the aforementioned participant to the best of my ability in the (Dangme/Twi) language to his/her proper understanding. All questions, appropriate clarifications sort by the participant and answers were also duly interpreted to his /her satisfaction.

Name of interpreter.....

Signature of interpreter.....

Date.....

Contact details.....

STATEMENT OF WITNESS

I was present when the purpose and contents of the participant information sheet was read and explained satisfactorily to the participant in the language, he/she understood (Dangme /Twi).

I confirm that he/she was given the opportunity to ask questions/ seek clarifications and same were duly answered to his/ her satisfaction before voluntarily agreeing to be part of the research.

Name.....

Signature.....

Date.....

INVESTIGATOR STATEMENT AND SIGNATURE

I certify that the participant has been given ample time to read and learn about the study.

All questions and clarifications raised by the participant have been addressed.

Researcher's name.....

Signature

Date.....

Appendix C: Consent Form for PTA Chairperson /Teacher

Study Title: Prevalence of Dental Malocclusion among 12-16-year-old School Children in the Shai-Osudoku District of Ghana.

I acknowledge that I have read the purpose and contents of the Participants' Information Sheet and all questions have been satisfactorily addressed in a language I understand (English). I fully understand the contents and any potential implications as well as my right to change my mind (i.e withdraw from the research) even after I have signed this form.

I voluntarily agree to be part of this research.

Name or initials of PTA Chairperson/ Teacher

Signature

Date.....

INVESTIGATOR STATEMENT AND SIGNATURE

I certify that the PTA Chairperson/Teacher has been given ample time to read and learn about the study. All questions and clarifications raised have been addressed.

Researcher's name.....

Signature

Date.....

Appendix D: Study Questionnaire

Prevalence of dental malocclusion among 12-16year old school children in the Shai-Osudoku district of Ghana.

Sociodemographic data

ID CODE..... Date.....
 Age Examiner
 Sex.....
 Class.....
 Name of school History of dental visit.....

Clinical findings

a. dentition

8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8

Missing permanent teeth (mark tooth missing with X)

Anomalies of tooth development	Enter count
Supernumery	
Malformation/hypoplastic	
Ectopic eruption	
Retained deciduous teeth	

b. Inter- and intra-arch examination:

Anomaly	Present	Absent
anterior open bite		
posterior open bite		
posterior crossbite		
Anterior crossbite		
midline deviation		
Crowding		
Spacing		
upper midline diastema		

c. occlusion

Malocclusion		
Class I malocclusion		
Class II div 1		
Class II div 2		
Class III		
Overjet		
0-3mm (normal)		
>3.5mm- 6mm with competent lips		
>3.5mm- 6mm with incompetent lips		
>6mm-9mm		
>9mm		
Overbite		
0-3mm (normal)		
>3.5mm without gingival contact		
Complete overbite without gingival or palatal trauma		
Complete overbite with gingival or palatal trauma		

Referral note

The bearerreceived dental screening and was found to need some dental treatment/consultation. We would be most grateful if you can assist with the management of the above stated condition.

Thank you

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this Letter should be quoted.



Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
GPS Address: GA-050-3303
Tel: +233-302-681109
Fax + 233-302-685424
Email: ghserc@gmail.com
14th June, 2019

MyRef: GHS/RDD/ERC/Admin/App 119/2019
Your Ref. No.

Richard Nii Armah
University of Ghana
School of Public Health
Ghana-Legon

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	GHS-ERC 038/04/19
Project Title	Prevalence of Dental Malocclusion and Occlusal Traits among 12-16-Years – Old Children in Children in Shai-Osudoku District
Approval Date	14 th June, 2019
Expiry Date	13 th June, 2020
GHS-ERC Decision	Approved

This approval requires the following from the Principal Investigator

- Submission of yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report after completion of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.
- Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED.....

DR. CYNTHIA BANNERMAN
(GHS-ERC CHAIRPERSON)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra



UNIVERSITY OF GHANA
DEPARTMENT OF BIOLOGICAL, ENVIRONMENTAL
AND OCCUPATIONAL HEALTH
SCHOOL OF PUBLIC HEALTH

Ref. No.:

March 18, 2019

The Regional Director
Ghana Health Service
Dodowa

Dear Sir/Madam,

LETTER OF INTRODUCTION
RICHARD NII ARMAH (10105776)

I am pleased to introduce to you the above-named Master of Public Health (MPH) student in the Department of Biological, Occupational and Environmental Health Sciences in the School of Public Health, University of Ghana, Legon.

As part of the requirement for the award of Master of Public Health Degree, he is conducting a research on **"Prevalence of Dental Malocclusion among School Children at Kordiabe in the Shai Osudoku District of Ghana."**

The general objective of this study is to estimate the prevalence of malocclusion and occlusal traits in 12-16-year-old school children at Kordiabe in the Shai Osudoku District of Ghana.

It is my hope that you will give him the necessary assistance to enable his carry out the research work.

I count on your support and assistance.

Yours faithfully,

Prof. Julius Fobil
(Head of Department)

COLLEGE OF HEALTH SCIENCES

• Telephone: +233 (0) 289 109 002 P. O. Box LG 13, Legon, Accra, Ghana.
• Email: sph-beohs@ug.edu.gh • Website: www.publichealth.ug.edu.gh



UNIVERSITY OF GHANA
DEPARTMENT OF BIOLOGICAL, ENVIRONMENTAL
AND OCCUPATIONAL HEALTH
SCHOOL OF PUBLIC HEALTH

Ref. No.:

March 18, 2019

The District Director
Ghana Education Service
Dodowa

Dear Sir/Madam,

LETTER OF INTRODUCTION
RICHARD NII ARMAH (10105776)

I am pleased to introduce to you the above-named Master of Public Health (MPH) student in the Department of Biological, Occupational and Environmental Health Sciences in the School of Public Health, University of Ghana, Legon.

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UNIVERSITY OF GHANA
DEPARTMENT OF BIOLOGICAL, ENVIRONMENTAL
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SCHOOL OF PUBLIC HEALTH

Ref. No.:

March 18, 2019

The District Director
Ghana Health Service
Accra

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RICHARD NII ARMAH (10105776)

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I count on your support and assistance.

Yours faithfully,

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• Email: sph-beohs@ug.edu.gh

• Website: www.publichealth.ug.edu.gh

The Headteacher
Roman Catholic Junior High School
Dodowa

Dear Richard,

RE: PERMISSION TO CONDUCT RESEARCH STUDY IN YOUR SCHOOL

Your request to conduct a study as part of your thesis on the topic: Prevalence of dental malocclusion and occlusal traits among 12-16-year-old children in the shai osudoku district, has been approved.

An appropriate date will be communicated to you to conduct the study. be assured that all the necessary support will be accorded to you to carry out the study at the chosen date.

I have attached a signed copy of the participant information sheet on behalf of the Parents' Teacher Association and parents of the students.

Best regards.

.....
HEADTEACHER
ST. AGNES R/C PRIMARY SCHOOL
(Headteacher)
DODOWA
DATE: 2/7/2019
.....

(Signature)

The Headteacher
Roman Catholic Primary and Junior High School
Kordiabe

Dear Richard,

RE: PERMISSION TO CONDUCT REASEARCH STUDY IN YOUR SCHOOL

Your request to conduct a study as part of your thesis on the topic: prevalence of dental malocclusion and occlusal traits among 12-16-year-old children in the shai osudoku district, has been approved.

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I have attached a signed copy of the participant information sheet on behalf of the Parents' Teacher Association and parents of the students.

Best regards.

MR. MATEY NICKOLAS

.....
(Headteacher)



.....
(Signature)