

# Prevalence of Bimaxillary Protrusion: A Systematic Review

Trudee Hoyte<sup>1\*</sup>, Anil Ali<sup>1</sup>, David Bearn<sup>2</sup>

<sup>1</sup>School of Dentistry, Faculty of Medical Sciences, The University of The West Indies, Trinidad and Tobago

<sup>2</sup>School of Dentistry, University of Dundee, Scotland, UK

Email: \*Trudee.Hoyte@sta.uwi.edu

**How to cite this paper:** Hoyte, T., Ali, A. and Bearn, D. (2021) Prevalence of Bimaxillary Protrusion: A Systematic Review. *Open Journal of Epidemiology*, 11, 37-46.  
<https://doi.org/10.4236/ojepi.2021.111004>

**Received:** November 15, 2020

**Accepted:** December 21, 2020

**Published:** December 24, 2020

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## Abstract

**Objective:** This study aimed to systematically review current relevant literature on the prevalence of bimaxillary protrusion. **Materials and Methods:** The electronic databases PubMed, Medline, Scopus, Google Scholar and the Cochrane Library were searched using specific inclusion criteria to obtain applicable articles. References from included studies were also examined. **Results:** Three articles were identified that met the inclusion criteria. Prevalence of bimaxillary protrusion ranged from 3.7% to 68.8% in different populations reported in the literature examined. GRADE assessed overall confidence was deemed to be very low. **Conclusion:** These results show that the prevalence of bimaxillary protrusion varies greatly between races and geographic regions. The Trinidad and Tobago population has a high prevalence of bimaxillary protrusion.

## Keywords

Bimaxillary Protrusion, Prevalence, Systematic Review

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## 1. Introduction

In 1897 the term bimaxillary protrusion was coined by Calvin Case [1] describing “a condition in which the entire dentures of both jaws are protruded in relation to the mandible and other bones of the skull”, and that “this deformity is always aggravated by a receding chin” [2]. Another definition describes bimaxillary protrusion as “a condition characterized by protrusive and proclined upper and lower incisors and an increased procumbency of the lips” [3].

For the purpose of this systematic review bimaxillary protrusion will be defined as a form of malocclusion characterized by protrusion of both upper and lower jaws, and proclination of the incisors, usually without disharmony be-

tween the arches. Many articles have described this condition as being present in African-American [3] [4] [5], Asian [6], Trinidad and Tobago [7] and, in fact, almost every ethnic group to some extent [8]-[13].

The aetiology of bimaxillary protrusion has been described as multifactorial [14]. One author has suggested that an increased tongue volume was part of the multifactorial aetiology of bimaxillary protrusion [6]. Other authors reported key aetiological factors in bimaxillary protrusion to be increased tongue pressure and tongue volume [3] [15].

In most countries there is a negative aesthetic perception of a protrusive dentition and protrusive lips and this leads patients with bimaxillary protrusion to seek orthodontic treatment. Some of these societies have recorded a marked increase in orthodontic patients attending requesting a reduction in their protrusive profile [8]. While bimaxillary protrusion has been reported as occurring in many populations there appears to be a shortage of data on its actual prevalence and studies reporting prevalence have a wide variation in sample size. There is no previous attempt to consolidate this information and there is no attempt to undertake a systematic review of the prevalence of bimaxillary protrusion among different populations. Understanding of the prevalence of this condition in different populations is important for health policy making as the demand for orthodontic treatment of patients with bimaxillary protrusion is increasing in many countries and publicly funded healthcare systems will have to introduce methods to prioritize treatment based on appropriate measures of need.

## 2. Materials and Methods

This review was undertaken according to the Joanna Briggs Institute (JBI) reviewers' manual for systematic review of prevalence and incidence data [16]. The protocol for this systematic review on prevalence of bimaxillary protrusion was registered on the National

Institute of Health Research Database Registered with (<https://www.crd.york.ac.uk/prospero/> registration protocol: CRD 42020210364).

### Eligibility criteria

The following selection criteria were applied by two reviewers for initial identification and screening of potential published abstracts.

- 1) Type of Publication: Only published articles from scientific journals were selected. Excluded were thesis, letters, abstracts, editorials.
- 2) Type of Study: Only observational studies were included. Case control studies, case reports, clinical trials, and retrospective studies were excluded.
- 3) Population: No restrictions were placed on population.
- 4) Context: General population; no selection was made by context
- 5) Condition: Bimaxillary protrusion including the presence of prognathic upper and lower jaws, or proclined upper and lower incisors or both.
- 6) Exclusion criteria: Studies evaluating convenience samples were excluded. Studies not published in English language were excluded.

### Search Strategy

To identify all the studies on prevalence of bimaxillary protrusion a literature search was performed in the following electronic databases: PubMed, Medline, Scopus, Google Scholar and the Cochrane Library up to 5th October 2020. The MeSH headings Bimaxillary Proclination or Bimaxillary Protrusion or Bimaxillary dentoalveolar protrusion or Bidental or Bialveolar Protrusion or Biprotrusion or Bimaxillary Prognathism or Bimax\* or Bimaxillary\* AND Prevalence were used in conjunction with keywords.

### Selection and Assessment of Relevance

Selection of articles was determined independently by two authors using the criteria above and any discrepancy between the authors was resolved through discussion. All article abstracts that met the selection criteria were selected and full articles retrieved, extraction of data was performed independently and in duplicate by two investigators (T. H and D. B) who were not blinded to the authors or the results of the research.

### Assessment of Methodological Quality

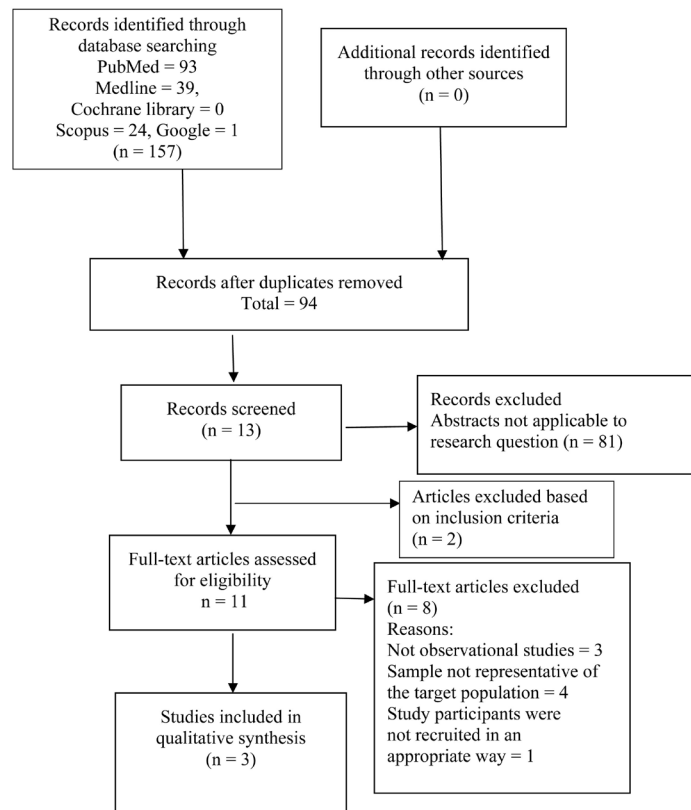
The methodologic soundness of each article was assessed using the critical appraisal tool for studies reporting prevalence from the Joanna Briggs Institute (JBI) [16]. The following ten questions were asked to critically appraise the study:

- 1) Was the sample representative of the target population?
- 2) Were study participants recruited in an appropriate way?
- 3) Was the sample size adequate?
- 4) Were the study subjects and setting described in detail?
- 5) Was the data analysis conducted with sufficient coverage of the identified sample?
- 6) Were objective standard criteria used for the measurement of the condition?
- 7) Was the condition measured reliably?
- 8) Was there appropriate statistical analysis?
- 9) Are all important confounding factors/ subgroups/ differences identified and accounted for?
- 10) Were subpopulations identified using objective criteria?

The outcome from the overall assessment of quality (include, exclude or seek further information) was made for each study using the JBI critical appraisal tool. Studies with at least one criterion obtaining a “no” in the first five questions from the critical appraisal checklist were regarded as having a high risk of bias and excluded from the narrative synthesis. The quality of the body of retrieved evidence was assessed following the guidance in the GRADE handbook [17].

## 3. Results

The outcome of the search and selection are shown in the PRISMA flow diagram (Figure 1). PubMed identified 93 articles, Medline identified 39, Scopus 24,



**Figure 1.** Prisma flow diagram of article retrieval.

Google Scholar 1 and Cochrane Library identified 0. After removal of duplicates, 94 articles were initially deemed potentially relevant to the review.

After initial screening, 13 were deemed applicable to the research question. Two were subsequently excluded because they did not satisfy the inclusion criteria. Of the final 11 full text articles assessed for eligibility eight were excluded, three of these were not observational studies but were interventional. Of the observational studies the sample was deemed not representative of the target population in four articles and because of this risk of bias these four were excluded from the systematic review (**Table 1**).

One of the remaining articles was excluded as the study participants were not recruited in an appropriate way with the sampling being from patients assessed as requiring orthognathic surgery. Of the three articles assessed as eligible for inclusion, all were cross sectional studies.

### Included Studies

Only three articles qualified for the final analysis, as they fulfilled the selection criteria and finally were included in this systematic review. The study design of the three articles and the results are summarized in **Table 2**. The first included study was of 1028 subjects aged 11 - 18 years from four educational institutions in an urban city in northern Nigeria [22]. The second included study was of 1024 randomly selected subjects aged 13 - 15 years residing in Jeddah City attending middle schools from different socioeconomic background [23]. The

**Table 1.** Observational studies excluded from the narrative synthesis.

| Author                        | Year | Population   | Sample Size | Prevalence      | Condition                | Reason for exclusion  |
|-------------------------------|------|--|-------------|-----------------|--------------------------|---|
| Isiekwe, M. [18]              | 2003 | Medical, dental students and armed forces of Nigeria | 110         | 20%             | Bimaxillary protrusion   | Unclear if sample is representative of population   |
| Jones Byran [19]              | 1986 | Saudi Arabia   | 132         | No figure given | Bimaxillary Proclination | The sample was not representative of the population, the participants were not recruited in an appropriate way. The study subjects and settings were not described in detail        |
| Boeck, E., <i>et al.</i> [20] | 2011 | Brazil   | 381         | 4.09%           | Biprotrusion             | Used patient with dentofacial deformities and required orthognathic surgery   |
| Baeshen, Hosamn [21]          | 2017 | Saudi Arabia   | 300         | 8.3%            | Bimaxillary Protrusion   | Did not sample from population but people seeking treatment. Sample was not representative of the target population and study participants were not recruited in an appropriate way |

**Table 2.** Studies included in the narrative synthesis.

| Study                         | Dacosta 1999 [22]   | Murshid <i>et al.</i> [23]   | Hoyte <i>et al.</i> [7]  |
|-------------------------------|---|--|--|
| Study Design                  | Epidemiological survey  | Cross-Sectional study  | Epidemiological survey   |
| Setting                       | Kaduna, Urban city in northern Nigeria<br>4 educational institutions  | Jeddah city, Saudi Arabia, an urban city. Middle school students from government and private schools                             | High schools across Trinidad and Tobago (entire country)   |
| Participants                  | 11 - 18 years old<br>Both genders<br>Fulani ethnic tribe<br>Excluded was anyone with previous orthodontic treatment | 13 - 15 years old<br>Both genders<br>No exclusion criteria reported  | 11 - 12 years old<br>Both genders<br>All ethnic groups<br>Excluded were participants with craniofacial anomaly and current or previous orthodontic treatment |
| Variables/Diagnostic criteria | Bimaxillary proclination  | Bimaxillary protrusion   | Bimaxillary proclination   |
| Data sources/measurement      | Clinical examination for proclined incisors   | Clinical examination for protruded teeth and lip strain  | Measured using a tooth inclination protractor  |
| Study size                    | 1028 Volunteers From 4 educational institutions of Fulani ethnic tribe  | 1024 Participants randomly selected. From participants referred for dental examination at screening clinics in the dental school | 972 Sample size calculation was tabulated and volunteers from 41 high schools across the country   |
| Statistical methods           | Statistical methods described. No information on how missing data was addressed                                     | Statistical methods described. No information on how missing data was addressed  | Statistical methods described. Information on how missing data was addressed was given   |
| Participants                  | Numbers at each stage were not reported   | Numbers at each stage were not reported  | Numbers at each stage reported   |
| Descriptive data              | Fulani ethnic tribe (predominant tribe) of varied socioeconomic background  | Different socioeconomic background.  | Rural and urban populations  |
| Prevalence                    | 3.7%  | 8%   | 68.8%  |

third included study was of 972 subjects aged 11 - 12 years old from high schools across Trinidad and Tobago [7]. In all three studies the sample size was representative of the target population, the participants were recruited in an appropriate way, the sample size was adequate and the study subjects and settings were described in detail. For two studies [22] [23] objective, standard criteria were not used for the measurement of the condition and the condition was not measured reliably. The study by Da Costa [22], reported a prevalence of 3.7%, Murshid *et al.* [23] reported 8% and Hoyte *et al.* [7] reported a 68.8% prevalence.

#### **Grade**

Overall confidence was deemed to be very low as per GRADE handbook for the included observational studies. Any overall estimates of prevalence are therefore regarded as weak and unreliable.

## **4. Discussion**

This systematic review only identified a small number of studies that met the initial inclusion criteria, and only three studies were included for narrative synthesis. It had been hoped to conduct a random effects meta-analysis but the number of studies included was inadequate for this purpose and the wide variation in populations studied meant that it may not have been valid. It is disappointing that so many of the studies originally identified had to be excluded, but there were clear reasons for the exclusion. Studies were excluded mainly because the sample was not representative of the population [18] [19], or were not observational studies and the study participants were not recruited in an appropriate way, but were selected from populations seeking treatment [20] [21]. For inclusion in this review, selection criterion had to be independent of specific context to minimize the number of confounding variables. This was because it is likely that the prevalence of bimaxillary protrusion in those seeking treatment does not represent the prevalence in the general population. Therefore, more studies with better representative samples and appropriate recruitment are needed to produce more robust data on prevalence of bimaxillary protrusion.

Analysis of reported prevalence data requires scrutiny of the sample and collection of data. Reliability of the prevalence data is affected by the quality of the diagnostic criteria for identifying the condition of bimaxillary protrusion which varied between the studies. Also defining bimaxillary protrusion in the included studies was generally subjective based on the clinician's opinion. Different rates would have been reported because different methods were used to measure bimaxillary protrusion.

There is a need for an agreed definition and diagnostic criteria for bimaxillary protrusion and bimaxillary prognathism. For example, the diagnostic tools used in the three included studies varied from extra oral clinical examination to intra oral clinical examination to use of the tooth inclination protractor (TIP). Common diagnostic criteria for bimaxillary protrusion have been suggested [7]. In bimaxillary protrusion there is a combined extraoral assessment of bimaxillary prognathism (prognathic jaws and an increase in vertical proportions) and an

intraoral assessment of bimaxillary proclination (proclined upper and lower incisors) [7].

The large variation in prevalence rates in the included studies are likely due to these and other methodological issues as well as a high level of variability across geographic areas and ethnicities. Trinidad and Tobago's population showed a very high prevalence rate which alludes to previous suggestions of high rates in Afro-Caribbean populations [24]. Prevalence in this ethnic group is significantly higher than that amongst other ethnic groups.

Assessing prevalence in a population is a difficult task. Two studies [22] [23] in this review analysed a region or a city. This method of sampling may not be representative of the entire country. Genetics of bimaxillary protrusion in certain countries may be present in certain groups which may not be localized to one area of the country. Nigeria, one of the countries included in this review has numerous local ethnic groups that are divided and there is minimum contact between groups.

The differences in prevalence therefore ranged from 3.7% to 68.8%, and with only three included studies a meta-analysis was not conducted. This wide range may be due to geography, ethnicity or methodology for conducting research. The impact that methodology, geography and ethnicity have on reported prevalence may have caused prevalence to be over or underestimated. A random effects meta-analysis had been initially planned to identify both the average prevalence and also the variations in prevalence between different populations. The 3 included studies were considered to be too few to achieve this latter goal, particularly in light of the high observed heterogeneity [25]. The prevalence reported by each study was discussed, but no attempt at synthesis through meta-analysis was attempted out of a desire to avoid providing misleading results. There is simply too little data available to ascertain how prevalence varies across different populations. This indicates that further research in this field is needed, in particular to assess how prevalence varies between different populations.

Overall confidence was deemed to be very low, as qualified by GRADE. Thus, further research is highly likely to have an impact on the estimate of effect and is likely to change the estimate [26]. A more robust protocol for reporting prevalence data is required to obtain meaningful rates and comparisons an example of such a protocol that can be used is the STROBE guidelines for reporting cross-sectional studies.

The clinical significance of this research is for the orthodontic treatment needs to provide treatment for any patient with functional or aesthetic problems. Bimaxillary Protrusion patients can have functional problems such as speech, adaptive tongue thrust, anterior open bite and spacing. Aesthetically, these patients can have psychosocial problems and they are also entitled to treatment just the same as anyone with a functional problem. Excessive bimaxillary protrusion has been attributed to gingival recession as the unbalanced tooth arch relationship results in buccally prominent teeth enclosed by a thin or non-existent labial plate of bone and inadequate keratinized gingival [27].

However, given these limitations it is important to remember the need for prevalence data since more people with bimaxillary protrusion are seeking orthodontic treatment to improve facial aesthetics. Bimaxillary Protrusion has now been identified in almost all ethnicities. Because it is realistically impossible to sample every population for a prevalence rate, it becomes very difficult to make generalized decisions on all populations. We can only make decisions on the available data until more information on sex, ethnicity and geographical variation in prevalence through further research is made available and it is likely that this would change our conclusions.

## 5. Conclusions

- 1) Prevalence of bimaxillary protrusion varies greatly among populations;
- 2) The Trinidad and Tobago population showed a high prevalence;
- 3) Methodology, geography and ethnicity had a major impact on reported prevalence;
- 4) Further studies are required to better assess impact of factors affecting reported prevalence.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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