

Epidemiology of Normative Orthodontic Anomalies among Adolescent Boys in Urban Nigeria: A Cross-Sectional School-Based Study

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Abstract Aim: To determine the prevalence and patterns of normative orthodontic anomalies among adolescent boys in public secondary schools in urban Ibadan, and to explore associations with sociodemographic variables. **Material & Method:** A school-based cross-sectional study was conducted among 706 male students aged 10–19 years using multistage sampling across three urban local government areas in Ibadan. Clinical examination was carried out assessing orthodontic anomalies including spacing, crowding, tooth rotation, and Angles malocclusion class. Demographic data was collected via structured questionnaires. Bivariate and multivariable analyses evaluated associations between anomalies and age, school class level, parental education, and socioeconomic status (SES). **Results:** Orthodontic anomalies were highly prevalent, with upper arch spacing (37.3%), tooth rotation (28.9%), lower arch spacing (25.9%), and lower arch crowding (25.5%) most common. Class I malocclusion was predominant. Anomalies varied significantly by age group and school class level ($p < 0.05$). Lower arch crowding and spacing were significantly more frequent among low and middle SES groups. Logistic regression identified school class level, but not age or SES, as an independent predictor of lower crowding (AOR = 2.36, $p = 0.038$). **Conclusion:** Normative orthodontic anomalies are widespread among adolescent boys in urban Ibadan, with sociodemographic disparities evident. School-based screening and preventive orthodontic programs targeting underserved populations are needed.

Keywords: Malocclusion, Orthodontic anomalies, Adolescents boys, Socioeconomic status, School-based survey

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1. Introduction

Adolescent oral health constitutes a pivotal aspect of overall well-being, with malocclusion and related anomalies, such as crowding, spacing, and tooth rotation, carrying both functional and psychosocial consequences. The World Health Organization ranks malocclusion as the third most prevalent oral health problem worldwide, after dental caries and periodontal disease, due to its considerable impact on mastication, speech, aesthetics, and psychosocial health [1,2,3]. Prevalence estimates among children and adolescents vary broadly, from 39% to 93%, highlighting disparities attributable to ethnicity, age, and regional factors [1,4,5].

In sub-Saharan Africa, particularly in Nigeria, several epidemiological surveys have delineated the distribution of occlusal traits among school-aged youths. A survey of 1,028 children aged 11–18 years in Kaduna reported that 84.0% exhibited Angle’s Class I malocclusion, normal occlusion was present in only 12.2%, and the prevalence of anterior spacing and crowding were 45.9% and 21.6%,

respectively [6]. In Rivers State, among adolescents aged 13–20 years, approximately 80.3% had Class I malocclusion, 14.4% exhibited crowding, and 60% had spacing in the maxillary arch [7]. A pan-regional study encompassing Lagos, Kano, and Imo reported normative orthodontic treatment need varying across ethnic groups, highest among Yoruba adolescents (42.8%) with an overall normative need of 35% [8].

Despite these insights, urban centres in Western Nigeria, and in Ibadan specifically, remain under studied. Onyeaso and Sanu evaluated self-perception of dental aesthetics among secondary school adolescents in Ibadan, revealing poor correlation between perceived appearance and clinical malocclusion severity [9]. Although this underscores the psychosocial dimension, normative clinical data on occlusal anomalies among male adolescents in Ibadan are scarce. Existing studies are often gender inclusive, geographically broad, or lack fine stratification by age and school class.

The dearth of urban, gender specific, and class stratified data represents a critical research gap. In Ibadan’s densely populated urban school environment, quantifying the prevalence and sociodemographic distribution of

normative orthodontic anomalies among adolescent boys is essential. Robust data of this nature are fundamental to inform community health planning, optimize allocation of orthodontic resources, tailored school based preventive interventions, and improve equity in access to care.

Accordingly, this study aims to determine the prevalence and patterns of normative orthodontic anomalies, including crowding, spacing, malocclusion classification, and tooth rotation, among male adolescents in secondary schools across urban Ibadan. Additionally, it assesses associations between these anomalies and sociodemographic variables such as age, school class level, parental education and occupation, and socioeconomic status. We hypothesize that malocclusion prevalence will vary significantly across socioeconomic strata and age cohorts, reflecting trends documented in other Nigerian populations.

Guided by a conceptual framework that posits sociodemographic variables as upstream determinants of orthodontic anomalies through behavioural and functional mediators, this study aimed to examine the prevalence and distribution of normative orthodontic anomalies among adolescent boys in urban Nigeria. The framework (Figure 1) informed both the selection of variables and the analytical strategy, particularly the multivariable modelling of predictors such as age, socioeconomic status, and school class level.

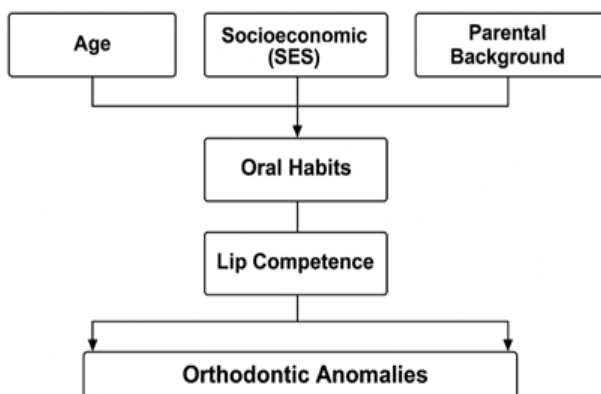


Figure 1. Conceptual Framework Linking Sociodemographic Factors to Orthodontic Anomalies

2. Materials and Methods

2.1. Study Design and Setting

This study utilized a school based cross sectional design to assess the prevalence and patterns of normative orthodontic anomalies among adolescent males in Ibadan, the capital of Oyo State, Nigeria. Ibadan is a densely populated urban metropolis comprising a diversity of socioeconomic strata and educational institutions, both public and private. Data collection took place from May to July 2024 in selected public boys' secondary schools across various urban zones.

2.2. Study Population and Sampling

The target population included male students aged 10 to 19 years in junior and senior secondary classes (JSS1–

SSS3). A multistage sampling technique was employed. First, three of the five urban Local Government Areas (LGAs) in Ibadan were randomly selected. From each LGA, two public all boys secondary schools were randomly chosen. Within each school, systematic random sampling based on class registers ensured proportional representation from each class level (JSS1–SSS3).

Students who were 10–19 years at the time of study, registered in the selected schools, and with both verbal assent and parental or guardian consent formed the inclusion group. Exclusion criteria comprised a history of prior orthodontic treatment, presence of craniofacial anomalies, or systemic conditions known to affect dentofacial development.

2.3. Sample Size Determination

Sample size calculation followed Cochran's formula for prevalence studies. Due to the absence of existing prevalence data for orthodontic anomalies among adolescent boys in Ibadan, a conservative prevalence estimate of 50% was assumed to maximize sample size (with absolute precision = 5% and $z = 1.96$ for 95% confidence). This yielded a minimum of 384 participants. Factoring in a design effect of 1.5 (due to cluster sampling) and a projected non-response rate of 10%, the final estimated sample size was 706.

2.4. Data Collection Instruments and Procedures

Data were obtained using a structured questionnaire and clinical dental examination performed by calibrated examiners. The questionnaire, available in English and Yoruba, captured demographic data including age, class, parental educational level, occupation, and socioeconomic status (SES). SES was classified according to the method described by Oyedele, which combines parental education and occupation into a five-tier scale [10,11].

Clinical assessments were conducted under natural daylight in temporary examination stations within classrooms to evaluate anterior spacing, crowding, tooth rotation, overjet, overbite, and other malocclusion. Intra arch characteristics (spacing/crowding) and Angles molar relationships were documented. Functional parameter such as lip competence was also recorded.

To ensure diagnostic reliability, a calibration exercise was conducted on 10% of the sample prior to the main survey. Inter and intra examiner consistency were assessed using Cohen's Kappa statistic, with values ≥ 0.80 indicating strong agreement.

2.5. Data Management and Statistical Analysis

Questionnaire responses and clinical data were entered into Microsoft Excel for cleaning and management. Statistical analyses were performed using IBM SPSS Statistics version 28. Continuous variables were summarized using means and standard deviations, while categorical data were reported as frequencies and percentages.

Chi square tests (or Fisher's exact test when appropriate) were used to evaluate bivariate associations between

orthodontic anomalies and demographic variables. Multivariable logistic regression models identified independent predictors of anomalies, adjusting for potential confounders such as age, school class level, SES, and parental education. A *p* value of <0.05 was considered statistically significant. Cases with missing data were excluded via listwise deletion, as these constituted less than 5% of total records.

2.6. Ethical Considerations

Ethical clearance was obtained from the Oyo State Ministry of Education (EDU.215T7/133). Written informed consent was obtained from parents or guardians, while verbal assent was secured from each participating student. All collected data were anonymized to maintain confidentiality.

3. Results

3.1. Characteristics of Study Participants

A total of 706 male students participated in the study. The mean age of participants was 13.7 years (SD = 1.9), with the largest proportion falling within the 13–15 years range. Representation spanned all secondary school levels (JSS1 through SSS3), providing a comprehensive age and class distribution across early to late adolescence.

Socioeconomic background varied, with over half of the participants classified as middle class, and the remainder nearly equally distributed between low and high socioeconomic categories. The ethnic composition was predominantly Yoruba, reflecting the demographic profile of the study area.

Parental education levels showed notable variation. While a majority of parents had attained at least secondary education, a considerable number reported only primary schooling or no formal education. Employment patterns similarly varied: most parents were engaged in skilled or professional occupations, although a significant proportion were employed in unskilled roles or were unemployed. [Table 1](#) presents a detailed breakdown of these sociodemographic characteristics.

Table 1. Socio-Demographic Characteristics of Study Participants

Participants' Characteristics	N (706)	%
Age (years)		
10-12	83	11.7
13-15	427	60.5
16-19	196	27.8
Tribes		
Hausa	8	1.1
Igbo	77	10.9
Yoruba	621	88.0
Social class		
Low	308	43.6
Middle	308	43.6
High	90	12.8
Mother's education level		
No formal education	37	5.2
Post-Secondary certificate, not University	58	8.2
Primary 6 certificates	161	22.8
Secondary School or grade II certificate	289	41.0
University graduate and equivalents	161	22.8
Father's education level		
No formal education	32	4.5
Post-Secondary certificate, not University	49	6.9
Primary 6 certificates	131	18.6
Secondary School or grade II certificate	305	43.2
University graduate and equivalents	189	26.8
Mother's Occupations		
Intermediate grade, public servant, senior schoolteachers	140	19.8
Junior schoolteacher, driver, artisan	184	26.1
Petty trader, labourer, messenger, similar grades	353	50.0
Senior public servant, professional, manager, contractor, large scale trader	21	3.0
Unemployed, fulltime housewife, student, subsistence farmer	8	1.1
Father's Occupations		
Intermediate grade, public servant, senior schoolteachers	175	24.8
Junior schoolteacher, driver, artisan	164	23.2
Petty trader, labourer, messenger, similar grades	334	47.3
Senior public servant, professional, manager, contractor, large scale trader	27	3.8
Unemployed, fulltime housewife, student, subsistence farmer	6	0.9

3.2. Prevalence of Normative Orthodontic Anomalies

A variety of orthodontic anomalies were identified among the study participants, underscoring the burden of normative treatment needs in this adolescent male population. The most frequently observed condition was upper arch spacing, present in approximately 37.3% of respondents. This was followed by rotated teeth, which affected 28.9% of participants, and lower arch spacing, observed in 25.9% of the sample. Lower arch crowding was also prevalent, affecting 25.5% of participants (Table 2).

These anomalies were not mutually exclusive, as many participants exhibited more than one clinical finding. For instance, cases of spacing were occasionally accompanied by rotation or crowding in the opposing arch, suggesting complex occlusal presentations. Figure 2 visually summarizes these findings, demonstrating the relative prominence of each anomaly. The bar chart highlights upper arch spacing as the most common single anomaly in the cohort, followed by rotated teeth and lower arch spacing.

The overall pattern of anomalies suggests a high demand for orthodontic evaluation and potentially interceptive treatment among this urban adolescent male population. These findings form the basis for further analysis of their distribution across sociodemographic subgroups and exploration of associated risk factors.

Table 2. Prevalence of Normative Orthodontic Anomalies Among Participants

Orthodontic Trait	N (706)	%
Upper arch Crowding		
No	604	85.6
Yes	102	14.4
Lower arch Crowding		
No	526	74.5
Yes	180	25.5
Upper arch Spacing		
No	443	62.7
Yes	263	37.3
Lower arch Spacing		
No	524	74.2
Yes	182	25.8
Rotated Teeth		
No	502	71.1
Yes	204	28.9
Malocclusion Class		
Class I	654	92.6
Class II	29	4.1
Class III	23	3.3
Overjet		
Normal	531	74.6
Increased or decreased	179	25.4
Overbite		
Increased	56	7.9
Normal	431	61.1
Reduced	219	31.0
Lip competence		
Competent	591	83.7
Incompetent	58	8.2
Potentially Competent	57	8.1

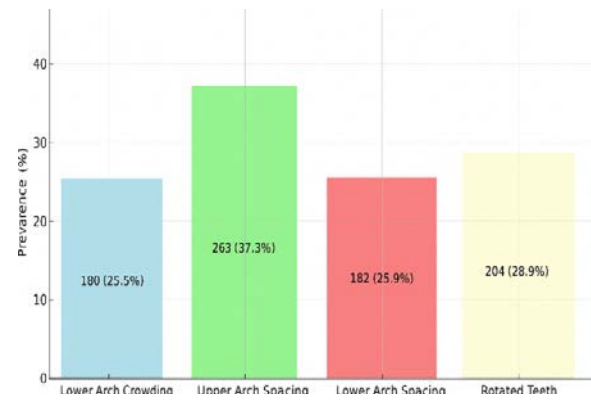


Figure 2. Bar Chart of the Most Common Orthodontic Anomalies

3.3. Malocclusion Class Distribution

The distribution of malocclusion according to Angle's classification revealed that the majority of participants fell into Class I, which is generally considered the physiologically normal occlusion type, albeit potentially with minor dental and arch anomalies. A smaller proportion of participants were classified under Class II, indicating a tendency toward distal occlusion, while Class III malocclusion, suggestive of mesial occlusion, was the least common presentation.

As depicted in Figure 3, the dominance of Class I malocclusion among the sample was evident, although the presence of Class II and Class III cases confirms the spectrum of occlusal deviations within the population. These classifications provide a structural framework for understanding the nature and severity of orthodontic needs and allow for differentiation in subsequent analyses examining age, socioeconomic status, and other predictive factors.

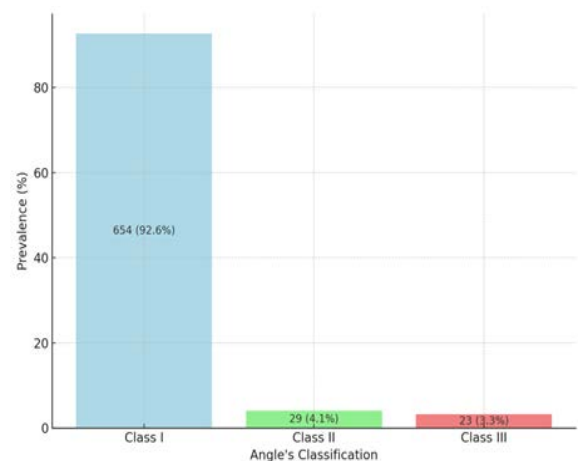


Figure 3. Distribution of Angle's Classification among Participants

3.4. Stratified Prevalence of Orthodontic Anomalies by Age and School Class Level

The prevalence of orthodontic anomalies varied notably across different age groups and school class levels, indicating age-related and developmental influences on occlusal patterns. As shown in Table 3a and 3b, the distribution of certain anomalies such as crowding, spacing, and rotated teeth differed significantly by age

group. For example, lower arch crowding showed a modest increase in frequency among older adolescents (16–19 years), while rotated teeth appeared relatively evenly distributed across all age bands.

Table 3a. Distribution of Orthodontic Anomalies by Age Group

Orthodontic Trait	Age (years)			P
	10-12 (83)	13-15 (427)	16-19 (196)	
Upper arch Crowding				0.229
No	75 (90.4)	367 (85.9)	162 (82.7)	
Yes	8 (9.6)	60 (14.1)	34 (17.3)	
Lower arch Crowding				0.024
No	72 (86.7)	311 (72.8)	143 (73.0)	
Yes	11 (13.3)	116 (27.2)	53 (27.0)	
Upper arch Spacing				0.081
No	63 (75.9)	265 (62.0)	115 (58.7)	
Yes	20 (24.1)	162 (37.9)	81 (41.3)	
Lower arch Spacing				0.001
No	72 (86.7)	321 (75.4)	129 (66.2)	
Yes	11 (13.3)	105 (24.6)	66 (33.8)	
Rotated Tooth				0.048
No	68 (81.9)	293 (68.6)	141 (71.9)	
Yes	15 (18.1)	134 (31.4)	55 (28.1)	
Overjet				0.389
Normal	69 (83.1)	315 (73.8)	143 (72.9)	
Increased or decreased	14 (16.9)	112 (26.2)	53 (27.1)	
Overbite				<0.001
Increased	10 (12.1)	37 (8.7)	9 (4.6)	
Normal	67 (80.7)	251 (58.8)	113 (57.6)	
Reduced	6 (7.2)	139 (32.5)	74 (37.8)	
Lip competence				0.831
Competent	70 (84.3)	355 (83.1)	166 (84.7)	
Incompetent	8 (9.6)	37 (8.7)	13 (6.6)	
Potentially Competent	5 (6.1)	35 (8.2)	17 (8.7)	

Table 3b. Distribution of Orthodontic Anomalies by School Class Level

Orthodontic Trait	School Class Level						P
	Junior			Senior			
	1 (50)	2 (60)	3 (43)	1 (260)	2 (179)	3 (114)	
Upper arch Crowding							0.239
No	43 (86.0)	57 (95.0)	36 (83.7)	222 (85.4)	149 (83.2)	94 (82.5)	
Yes	7 (14.0)	3 (5.0)	7 (16.3)	38 (14.6)	30 (16.8)	20 (17.5)	
Lower arch Crowding							0.001
No	40 (80.0)	55 (91.7)	37 (86.0)	189 (72.7)	134 (74.9)	71 (62.3)	
Yes	10 (20.0)	5 (8.3)	6 (14.0)	71 (27.3)	45 (25.1)	43 (37.7)	
Upper arch Spacing							0.001
No	41 (82.0)	46 (76.7)	34 (79.1)	162 (62.3)	103 (57.5)	57 (50.0)	
Yes	9 (18.0)	14 (23.3)	9 (20.9)	98 (37.7)	76 (42.5)	57 (50.0)	
Lower arch Spacing							0.001
No	44 (88.0)	50 (83.3)	36 (83.7)	199 (76.8)	119 (66.9)	74 (64.9)	
Yes	6 (12.0)	10 (16.7)	7 (16.3)	60 (23.2)	59 (33.1)	40 (35.1)	
Rotated Tooth							
No	41 (82.0)	55 (91.7)	31 (72.1)	163 (62.7)	143 (79.9)	69 (60.5)	<0.001
Yes	9 (18.0)	5 (8.3)	12 (27.9)	97 (37.3)	36 (20.1)	45 (39.5)	
Overjet							<0.001
Normal	42 (84.0)	53 (88.3)	40 (93.0)	200 (76.9)	126 (70.4)	66 (57.9)	
Increased or decreased	8 (16.0)	7 (11.7)	3 (7.0)	60 (23.1)	53 (29.6)	48 (42.1)	
Overbite							
Increased	7 (14.0)	4 (6.7)	3 (7.0)	26 (10.0)	12 (6.7)	4 (3.5)	<0.001
Normal	41 (82.0)	43 (71.6)	28 (65.1)	156 (60.0)	105 (58.7)	58 (50.9)	
Reduced	2 (4.0)	13 (21.7)	12 (27.9)	78 (30.0)	62 (34.6)	52 (45.6)	
Lip competence							0.307
Competent	44 (88.0)	51 (85.0)	35 (81.4)	215 (82.7)	152 (84.9)	94 (82.5)	
Incompetent	3 (6.0)	7 (11.7)	7 (16.3)	23 (8.8)	10 (5.6)	8 (7.0)	
Potentially Competent	3 (6.0)	2 (3.3)	1 (2.3)	22 (8.5)	17 (9.5)	12 (10.5)	

When stratified by school class, several anomalies displayed discernible trends. Students in senior secondary classes (SS1–SS3) were more likely to present with lower arch crowding and spacing anomalies compared to those in junior classes (JSS1–JSS3). These patterns may reflect cumulative effects of nutrition and growth, delayed treatment, or other contextual influences as students advance through adolescence.

Statistical analysis using the chi-square test revealed significant associations between certain anomalies and both age group and class level. For instance, lower arch spacing and rotated teeth showed statistically significant differences across class levels ($p < 0.05$), suggesting that the educational stage may be a proxy for age-related changes or behavioural exposures affecting occlusion.

These stratified distributions provide a clearer understanding of how orthodontic anomalies manifest in relation to biological and social progression through adolescence and form the basis for subsequent examination of socioeconomic disparities and multivariable predictors.

3.5. Socioeconomic Inequalities in Orthodontic Health

The analysis of orthodontic anomalies across socioeconomic strata revealed noticeable disparities in the distribution of specific conditions. As summarised in

Table 4, lower arch crowding was more frequently reported among participants from the low and middle socioeconomic classes compared to those from the high socioeconomic group. A similar pattern was observed for lower arch spacing, with a higher prevalence among students in the lower socioeconomic tier.

Rotated teeth, another common anomaly, exhibited a slightly more uniform distribution across the three socioeconomic classes, though the prevalence remained marginally higher among participants from middle-income households. For lip incompetence, although present in all classes, the difference in occurrence did not reach statistical significance.

Chi-square tests were conducted to determine the significance of these associations. Statistically significant associations were found between socioeconomic status and lower arch crowding ($\chi^2 = 7.94$, $p = 0.019$) as well as lower arch spacing ($\chi^2 = 6.43$, $p = 0.040$), indicating that these conditions may be more strongly influenced by socioeconomic factors than others. In contrast, other anomalies such as rotated teeth and upper arch spacing did not exhibit significant variation by socioeconomic class.

These findings suggest that adolescents from lower socioeconomic backgrounds may be more vulnerable to certain orthodontic conditions, reinforcing the need to consider social determinants in the planning of school-based oral health interventions.

Table 4. Association Between Socioeconomic Status and Normative Orthodontic Anomalies

Anomaly	Low (308)	Middle (308)	High (90)	p
Upper arch Crowding				0.690
No	265 (86.0)	260 (84.4)	79 (87.8)	
Yes	43 (14.0)	48 (15.6)	11 (12.2)	
Lower arch Crowding				0.556
No	235 (76.3)	227 (73.7)	64 (71.1)	
Yes	73 (23.7)	81 (26.3)	26 (28.9)	
Upper arch Spacing				0.076
No	199 (64.6)	192 (62.3)	51 (56.7)	
Yes	109 (35.4)	116 (37.7)	38 (42.3)	
Lower arch Spacing				0.515
No	221 (72.2)	231 (75.0)	70 (77.8)	
Yes	85 (27.8)	77 (25.0)	20 (22.2)	
Rotated Tooth				0.936
No	218 (70.8)	221 (71.8)	63 (70.0)	
Yes	90 (29.2)	87 (28.2)	27 (30.0)	
Overjet				0.282
Normal	235 (76.3)	228 (74.0)	64 (71.1)	
Increased or decreased	73 (23.7)	80 (26.0)	26 (28.9)	
Overbite				0.952
Increased	22 (7.1)	26 (8.4)	8 (8.9)	
Normal	190 (61.7)	185 (60.1)	56 (62.2)	
Reduced	96 (31.2)	97 (31.5)	26 (28.9)	
Lip competence				0.493
Competent	249 (80.8)	265 (86.1)	77 (85.5)	
Incompetent	30 (9.8)	21 (6.8)	7 (7.8)	
Potentially Competent	29 (9.4)	22 (7.1)	6 (6.7)	

3.6. Multivariable Predictors of Orthodontic Anomalies

To identify the socio-demographic factors independently associated with orthodontic anomalies, logistic regression analysis was performed using the presence of lower arch crowding as the outcome variable. The predictors included age group, school class level, and socioeconomic status. Results of the adjusted multivariable analysis are presented in Table 5a, while the unadjusted estimates are shown in Table 5b.

In the adjusted model, age group was not significantly associated with lower arch crowding, although adolescents aged 13–15 years had slightly higher odds of presenting with the anomaly compared to those aged 10–12 years (AOR: 1.24; 95% CI: 0.61–2.51; $p = 0.553$). Similarly, participants aged 16–19 years did not show a statistically significant difference in risk (AOR: 1.31; 95% CI: 0.57–3.00; $p = 0.528$).

School class level, however, demonstrated a stronger relationship. Students in SS1 had higher odds of lower arch crowding compared to JSS1, with an adjusted odds ratio of 2.36 (95% CI: 1.05–5.33; $p = 0.038$), indicating a statistically significant association. Other senior classes also showed increased odds, but these did not reach statistical significance.

Regarding socioeconomic status, no significant associations were observed in the adjusted model. Participants from middle and low socioeconomic backgrounds had slightly elevated odds of lower arch crowding relative to their high socioeconomic counterparts, but the differences were not statistically significant (Middle SES AOR: 1.37, 95% CI: 0.65–2.89, $p = 0.407$; Low SES AOR: 1.32, 95% CI: 0.60–2.92, $p = 0.486$).

The unadjusted analysis (Table 5b) reflected similar patterns, with school class showing a stronger univariable association with lower arch crowding compared to age or SES. While some crude odds ratios appeared larger in magnitude, their confidence intervals overlapped with unity, suggesting limited precision and reinforcing the need for multivariable adjustment.

Table 5. Multivariable Logistic Regression of Predictors of Orthodontic Anomalies

Predictor	OR	95% CI	P	AOR	95% CI	p
Intercept	-	-	-	0.26	0.11, 0.64	0.003
Age						
10-12	1	-	-	1	-	-
13-15	2.44	1.25, 4.77	0.009	1.69	0.68, 4.22	0.262
16-19	2.43	1.19, 4.93	0.014	1.24	0.46, 3.38	0.674
School Class Level						
JSS1	1	-	-	1	-	-
JSS2	0.36	0.12, 1.15	0.084	0.3	0.09, 0.99	0.049
JSS3	0.65	0.21, 1.96	0.443	0.5	0.15, 1.69	0.262
SSS1	1.50	0.71, 3.16	0.284	1.05	0.40, 2.77	0.926
SSS2	1.34	0.62, 2.90	0.453	0.97	0.35, 2.67	0.956
SSS2	2.42	1.10, 5.34	0.028	2.01	0.70, 5.77	0.193
Socioeconomic class						
High	1	-	-	1	-	-
Low	0.76	0.45, 1.29	0.317	0.77	0.44, 1.32	0.336
Middle	0.88	0.52, 1.48	0.626	0.89	0.52, 1.52	0.671

4. Discussion

4.1. Summary of Main Findings

This study of 706 adolescent boys in urban Ibadan revealed a considerable burden of normative orthodontic anomalies, with upper arch spacing, tooth rotation, and lower arch spacing emerging as the most prevalent conditions. Angle's Class I malocclusion constituted the predominant occlusal pattern. Stratified analyses showed variation in anomaly prevalence across age groups and school class levels, older adolescents and those in senior classes exhibited higher frequencies of certain anomalies. Socioeconomic disparities were evident, particularly in the distribution of lower arch crowding and spacing. Multivariable logistic regression identified school class level as a significant independent predictor of lower arch crowding, while age group and socioeconomic status did not remain significant after adjustment.

4.2. Contribution to Orthodontic Epidemiology

This study offers a comprehensive assessment of the prevalence and sociodemographic distribution of orthodontic anomalies among male adolescents in public secondary schools in urban Ibadan. These findings contribute important data in a context that has been underrepresented in sub-Saharan African orthodontic research.

The observed high prevalence of spacing, crowding, and tooth rotation mirrors patterns reported in previous Nigerian studies. Otuyemi and colleagues found greater rates of crowding in urban areas compared to rural 12-year-olds in Ile Ife, with spacing also commonly observed [12]. Similarly, Aikins and Onyiaso reported spacing and rotation as predominant features among adolescents in Rivers State [7]. However, the prevalence estimates in our cohort appear higher than those documented in some rural or mixed-gender Nigerian populations, potentially reflecting urbanization effects, male specific growth patterns, or dietary and oral hygiene factors. The predominance of Angle's Class I malocclusion aligns with global trends and prior local findings by Onyiaso [13] and Etim et al. [8], where Class I represented most cases. Although Class I malocclusion often does not require intervention except if malocclusion is beyond acceptable limits, its frequent co-occurrence with spacing, crowding, and rotation underscores its clinical relevance.

Age- and class-stratified patterns demonstrated that older students and those in senior secondary levels exhibited higher frequencies of crowding and spacing. This trend supports established knowledge that dental arch development and craniofacial growth influence malocclusion progression over time and is consistent with reports from Nigeria and beyond [14,15]. It suggests that untreated minor malocclusions may become more pronounced with age, particularly in the absence of early orthodontic screening.

Socioeconomic disparities were evident, as participants from lower SES backgrounds exhibited significantly

higher rates of lower arch crowding and spacing in bivariate analysis. These findings reinforce the well-documented social gradient in oral health and access to orthodontic care, as noted by Onyeaso and Sanu in their discussion of aesthetic self-perception [9]. Factors such as financial limitations, limited awareness, and differential oral hygiene practices are likely to have contributed to this inequality, underscoring the need for school-based preventive programmes tailored to underserved communities.

The multivariable logistic regression analysis highlighted school class level as an independent predictor of lower arch crowding, while age and SES lost significance, possibly due to overlap with educational stage and oral health behaviours. The persistent significance of class level may reflect its function as a marker for developmental maturity and cumulative exposure to etiologic factors. The lack of adjusted association with SES may be attributable to confounding by maternal education, oral hygiene, and other unmeasured behaviours.

4.3. Validation of the Conceptual Framework

Our conceptual framework, positing that sociodemographic factors influence orthodontic status through behavioural and functional pathways, was largely validated. Educational level (school class) was significantly associated with anomaly prevalence, and functional traits such as lip incompetence were descriptively linked to occlusal outcomes. The significant association between class level and lower arch crowding supports the temporal component of the framework, consistent with developmental influences. While SES did not retain significance in the multivariable model, bivariate analyses supported its theoretical role as a determinant of exposure to risk factors. Although functional mediators such as lip competence could not be included in regression models due to data limitations, their descriptive inclusion remains justified, given their role in the causal pathway as described in prior orthodontic literature [15,16,17,18,19].

4.4. Study Limitations

Despite methodological rigour and adequate sample size, the study has limitations. It was confined to public boys' schools in a single urban setting, limiting generalisability to girls, private school students, or rural residents. Its cross-sectional nature precludes assessment of temporal progression and causal inference. The use of visual clinical assessment, though pragmatic for fieldwork, lacks the precision of radiographic or model-based measurements common in orthodontic diagnostics. Furthermore, behavioural mediators such as oral habits and prior dental interventions were not assessed, limiting etiologic insight. Self-reported parental education and occupation may suffer from classification bias. Sparse data on some variables also constrained multivariable modelling, leading to focus on a single outcome (lower arch crowding) for reliable estimation.

4.5. Implications and Future Directions

This study enriches understanding of adolescent orthodontic needs in West Africa, highlighting the importance of early detection and equitable resource allocation. It underscores the value of integrating orthodontic surveillance within school health programmes and national oral health strategies, particularly targeting junior and senior secondary students from lower socioeconomic backgrounds.

Future research should include female adolescents, employ longitudinal designs to track malocclusion progression, and incorporate behavioural, clinical, and radiographic data for comprehensive assessment. Mixed-methods studies exploring attitudes and barriers to orthodontic care among adolescents and their parents could also elucidate factors influencing treatment uptake.

4.6. Conclusion

This study demonstrates a high prevalence of normative orthodontic anomalies among adolescent boys in urban Ibadan, with significant variation by school level and socioeconomic background. These findings reinforce the relevance of early orthodontic screening, particularly in school-based settings, to identify and address orthodontic needs before they escalate. Moreover, the empirical support for the study's conceptual framework offers a valuable template for future research that integrates developmental, behavioural, and socioeconomic dimensions of adolescent oral health. The study highlights the urgent need for policy interventions to improve access to preventive orthodontic services among Nigerian adolescents, especially in underserved urban communities. Future studies should adopt longitudinal and mixed-methods approaches to deepen understanding of the dynamics, perceptions, and health-seeking behaviours surrounding orthodontic care.

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