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Contextual and Individual Determinants of Anterior Open Bite in Adolescents

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Objective: Studying the broader determinants of anterior open bite (AOB) may guide more equitable policies.This study estimates the prevalence of AOB in Brazilian adolescents and its association with contextual and individual determinants.

Methodology: The data for dentofacial anomalies in 15- to 19-year-olds from the National Oral Health Survey SBBrasil 2010 were analysed (N = 4748). AOB was based on the Dental Aesthetic Index (AOB = 0; AOB > 0); the contextual variables were the Human Development Index (HDI) and the Gini Index (2010). The individual sociodemographic variables included sex (male, female), self-reported skin colour/race (white, black, brown, and indigenous + yellow), family income (≥4 minimum wage [MW]; 0–3 MW), and educational attainment (ideal, delayed). The individual clinical variables were decayed, missing, and filled teeth (DMFT) (0, ≥1), first permanent molar loss (0, ≤3, 4), and molar relationship (normal, half cusp, full cusp). Multilevel logistic regression models with random intercepts and fixed slopes were used to estimate odds ratios (ORs) and confidence intervals (95% CIs).

Results: AOB prevalence in Brazil was 8.78% (95% CI, 6.85–11.20) at 15 to 19 years of age. The lowest prevalence was in São Luis (2.63%; 95% CI, 0.58–11.03) and the highest was in João Pessoa (29.85%; 95% CI, 15.93–48.85), both capitals of the northeast Brazilian region. A higher prevalence of AOB (OR, 1.71; 95% CI, 1.04–2.80) was observed in municipalities with a lower HDI. Adolescents who declared their skin colour black, with lower family income, with delayed education, with DMFT ≥ 1, who lost 4 permanent first molars, and who had a complete molar cusp relationship were more likely to have AOB.

Conclusions: AOB varied amongst Brazilian municipalities. The HDI plays an important role in the prevalence of AOB; individual social determinants have also been associated with AOB malocclusion in adolescents.

Introduction

Anterior open bite (AOB) occurs in the absence of contact between the maxillary and mandibular incisors, whilst the posterior teeth are occluded.[1] Although AOB is not expected to have a large population prevalence, this malocclusion may be considered a public health problem due to its consequences on chewing, swallowing, and speech dysfunction.[2] Additionally, this condition may have several effects on daily life,[3] such as decreased quality of life,[4] self-esteem,[5] and psychological[6,7] and social[7] consequences. AOB requires challenging treatment[8]; therefore, preventive measures should avoid malocclusion.[3]

Malocclusion has been associated with individual characteristics for children whose mothers had fewer years of education and attended schools from less healthy and affluent districts.[9] AOB has a multifactorial aetiology, including hereditary factors in skeletal malocclusion such as the facial

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vertical growth pattern,[10] environmental factors, and behavioural habits,[11] such as digital thumb suction and oral respiration,[12] which influence alveolar bone stability.[13]

AOB cannot be explained only by genetic factors; otherwise, in Africa, distinct AOB prevalence could not be observed as 3.6% for Nigerian 6- to 12-year-olds (2019),[14] 6% for Zambians (2017),[15] and 15% for Tanzanian 12- to 14-year-olds (2009).[16] Social determinants may contribute to understanding the distinct prevalence of AOB and guiding equitable health policies towards its prevention.[17] Hence, it is reasonable to investigate the contextual determinants which might explain AOB prevalence in adolescents.

Although many epidemiologic studies have used the Dental Aesthetic Index (DAI),[4,6,9,14] no previous study has reported the contextual determinants of AOB. This research aimed to estimate the prevalence of AOB in 15- to 19-year-olds in a developing country in 2010 and evaluate its association with contextual and individual characteristics.

Methods

The SBBrasil 2010 survey and study sampling

The SBBrasil 2010 was organised to register the national urban oral health condition of the Brazilian population aged 5, 12, 15 to 19, 35 to 44, and 65 to 74 years and obtain point estimates for 5 Brazilian macro-regions (north, northeast, midwest, southeast, and south), state capitals, and interior municipalities from each macro-region. The SBBrasil 2010[18] addressed 26 state capitals, the Federal District, and 30 interior municipalities of each macro-region, totalling 177 municipalities. The sampling process included 2 stages in the capital (30 census sectors and residence) and 3 stages in the interior (30 municipalities, 2 census sectors for each municipality and residence). The prevalence and severity of dental caries, periodontal disease, malocclusion, dental fluorosis, dental trauma, the use/need for dental prostheses, and dental pain were estimated. Socioeconomic profiles, dental service utilisation, self-perception, and oral health impact data were also obtained. For this study, we used public data for 15- to 19-year-olds from SBBrasil 2010 with complete information on AOB, sociodemographic characteristics, DAI, and dental caries (decayed, missing, and filled teeth [DMFT]).

Outcome

The outcome variable was AOB evaluated by a previously calibrated dentist considering the vertical AOB registered to obtain the DAI. The calibration included theoretical seminars concerning diagnosis criteria for DAI evaluation and practical seminars with adolescents from public schools in each city (κ (statistic) > 0.65).[19] The examinations and interviews were performed in the participants' homes using a Community Periodontal Index probe and a dental mirror. A vertical AOB was recorded if there was a lack of vertical overlap between the pair of incisors. The largest distance of the open bite was recorded to the nearest whole millimeter.[21] In this study, vertical overlap was categorised as 0, absence of vertical overlap (0 mm), or 1, presence of vertical overlap (>0 mm).

Contextual variables

The municipal Human Development Index (HDI) and Gini Index were used as municipal area socioeconomic status indicators.[20] The Brazilian HDI considers 3 dimensions: longevity, education (access to knowledge based on average years studied by the population), and income (living standards and purchasing power of the population according to the municipal gross income per capita). HDI ranges from 0 to 1, with higher values indicating better social conditions, and the groups are defined as very low (0–0.499), low (0.500–0.599), medium (0.600–0.699), high (0.700–0.799), and very high (0.800–1.00).[20] Municipalities were aggregated into low + medium (≤0.699) vs high (≥0.70).[20] Income inequality was assessed using the Gini Index, which ranged from 0 (total equality) to 1 (total inequality). The Gini Index was categorised into tertiles to differentiate municipalities according to levels of inequalities: <0.5809, 0.5909 to 0.6266, and >0.6266. The HDI and Gini Index were obtained from the 2013 Brazil Atlas of Human Development, which allows for selection based on data extracted from 2010 demographics.

Individual variables

Sociodemographic variables included sex (male, female), self-reported skin colour/race (white, black, yellow, brown, and indigenous), and family income by minimum wage (MW; ≥4 MW, 0–3 MW). Education attainment was based on age–grade level, then categorised as ideal/above-year or delayed years.[21]

The clinical variables accounted for dental caries, loss of first molars, and the anteroposterior relation of the first permanent molars. The DMFT was categorised as absent (0) or present (≥1). The number of first permanent molars lost was categorised as none missing (0), fewer than 4 missing (≤3), and all missing.[4] The molar relation was registered based on the upper/lower first molars and evaluated as 0 = normal, 1 = half cusp, and 2 = full cusp.

Statistical analysis

AOB prevalence and 95% confidence intervals (95% CIs) were estimated for Brazilian macro-regions, state capitals, and municipalities from the interior. Multilevel logistic regression was used to model the multilevel structure of an individual (level 1) nested within a municipality (level 2). These multilevel analytical techniques were used to evaluate the overall relationship between the individual variables and AOB (fixed effect) and the variation between areas that were not due to these factors (random-intercept parameter). A 4-step sequential modelling strategy was adopted where the empty model was a model without the inclusion of any covariates and in which the variance in AOB was evaluated amongst municipalities. A significant random-intercept variance indicates the presence of unexplained differences in AOB across municipalities. The median rate ratio (MRR) measures heterogeneity amongst municipalities; there is no variation between municipalities if the MRR is 1.0. The higher the MRR, the greater the area-level variation. Model 1 (random intercept, fixed effect) was a model including municipality-level

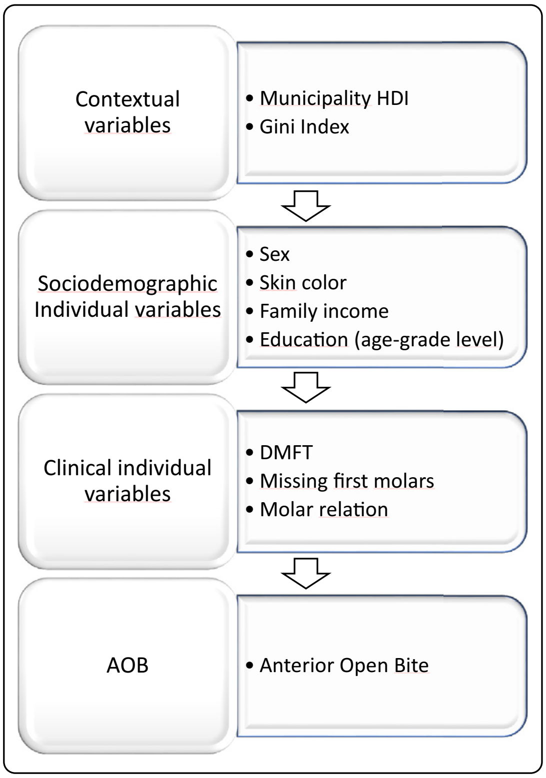

Fig. 1 – Theoretical model of social determinants of anterior open bite in adolescents.

variables (HDI and Gini Index); model 2 was model 1 with the addition of individual sociodemographic variables; and model 3 was model 2 with the addition of clinical variables (Figure 1).

The proportional change in variance (PCV) was calculated using the following formula: PCV = (variance model 1 – variance model 2) / variance model 1. The deviance statistic was used to test the hypothesis that additional model variables improved the model's fit. It was obtained by multiplying the difference between the log-likelihood (LL) of the adjusted model and the LL of the initial model by 2 (–2 * (LL of the initial model – LL of the adjusted model)). For the model-building process, we started with the empty model. After adding additional covariates to the model, the reduction in deviance must have been greater than the corresponding chi-square value ($P < .05$), with the number of degrees of freedom equal to the number of included variables. Intraclass correlation was employed to quantify the proportion of observed variation in AOB attributable to clustering (ie, living in different municipalities). The goodness-of-fit for model 2 and model 4 was compared using the likelihood-ratio test (LRT). The prevalence of AOB for the total sample and according to the investigated variables were estimated using procedures for the complex sample design (command svy) and weight sample. Multilevel analyses address data with a hierarchical structure and can account for the dependence amongst observations; that is, the participants are grouped into different groups (or clusters), which is the municipality in this study.[22] For multilevel analysis, the municipalities with few observations were excluded (<10 adolescents). Descriptive analyses and the crude and adjusted multilevel logistic regressions were conducted using Stata version 16.1 (StataCorp LLC).

Ethics

The SBBrasil 2010 project was registered with the National Ethics Research Council (15,498; 2010.01.07) and conducted in accordance with the Helsinki Declaration.

Results

A total of 5445 15- to 19-year-olds from 176 municipalities were included in SBBrasil 2010. Of the 5445 adolescents aged 15 to 19 years, malocclusion was reported in 5129 (94.2%), of whom 8.78% had AOB (95% CI, 6.85%–11.20%). Figure 2 shows the distribution of AOB in Brazil in 2010. Prevalence was highest in the northern region (11.06%) and lowest in the southern region (3.86%). The higher and lowest AOB prevalence amongst the state capitals was João Pessoa (29.85%; 95% CI, 15.93–48.85) and São Luis (2.63%; 95% CI, 0.58–11.03), both from the northeast region. The highest prevalence amongst the macro-regions was in the north (11.06%; 95% CI, 7.25 –16.51) reducing towards the south of Brazil, with the lowest prevalence in the southern region (3.86%; 95% CI, 1.60–9.02).

The total sample comprised 4178 adolescents (76.73%) from 69 Brazilian municipalities, including those without missing data for all study variables. A total of 107 municipalities with a sample size ranging from 1 to 9 adolescents were excluded from the regression model, totalling 638 adolescents. The prevalence of AOB did not differ between the included (n = 4807) and excluded (n = 638) municipalities ($P = .101$). There was no difference in HDI levels between the excluded (n = 107) and included (n = 69) municipalities ($P > .05$). The frequency of excluded municipalities was higher amongst those with a Gini Index of >0.5809 ($P < .05$). Of the 4807 adolescents considered for this analysis, 5.65% had no records for AOB, 5.24% had no records for income, 1.45% had no records for DMFT, and 3.60% had no records for molar relation.

Table 1 shows the sample distribution and prevalence of AOB according to contextual and individual studied variables. The comparison of AOB prevalence amongst groups was performed by observing the 95% CIs. The AOB prevalence was similar in males and females, amongst those with a delayed education level compared to an ideal level/above, and amongst those who were missing 1 or more first molars compared to those without teeth loss. There were no differences in AOB prevalence amongst municipalities with different Gini Index levels. Municipalities with higher HDI (>0.700) presented lower AOB prevalence than municipalities with HDI < 0.699. The AOB prevalence was higher amongst those who self-declared brown skin compared to those who self-declared white skin colour. Adolescents from a family with higher income (≥4 MW) presented lower AOB prevalence than those from families with incomes of 0 to 3 MW. Amongst the clinical variables, the prevalence of AOB was higher amongst those with DMFT higher than zero and with the full

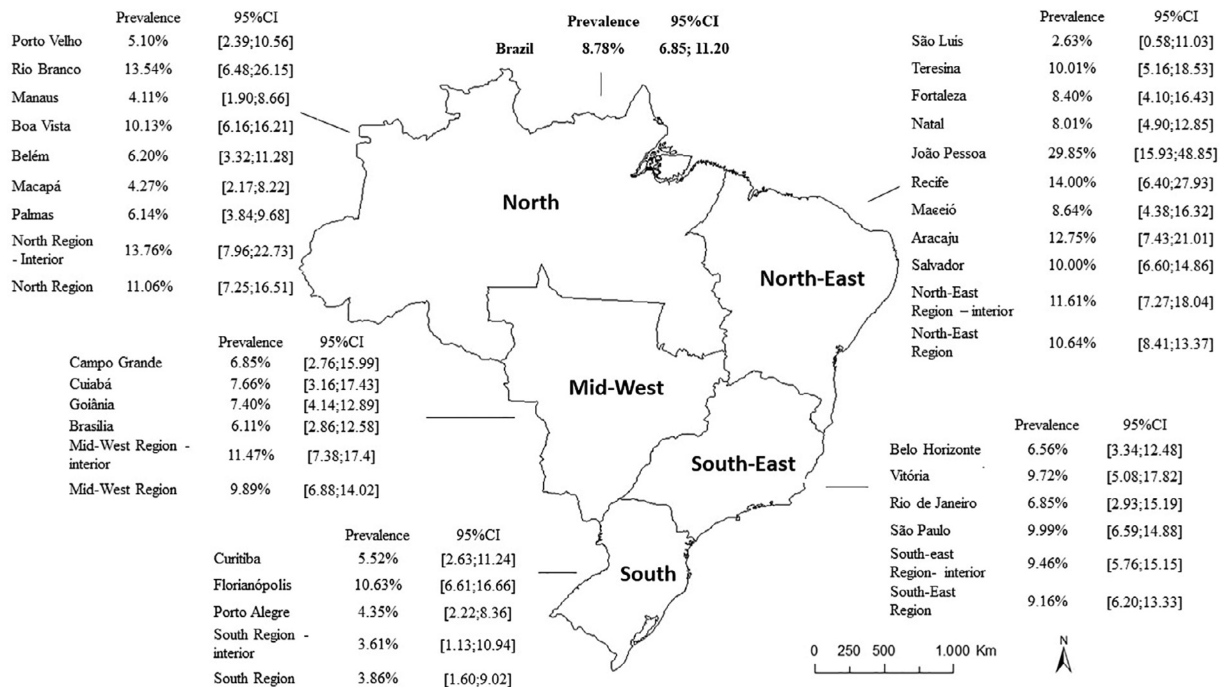

Fig. 2 – Distribution of the adolescents AOB prevalence in Brazil, 2010.

cusp molar relation compared to participants with DMFT = 0 and with normal molar relation, respectively.

Crude logistic regression analysis showed an association between the HDI and AOB. A significant association of AOB was also observed with individual sociodemographic variables (skin colour, family income, and delayed education) and clinical variables (DMFT, missing first molar, molar relation). Gini Index and sex were not associated with AOB prevalence (Table 2).

The null model demonstrated that the contextual-level variation was significant, suggesting differences in AOB amongst municipalities (LRT: $\chi^2 = 17.88$; $P < .0001$). Moreover, the MRR (1.55) varied amongst municipalities (model 1). In model 1, HDI was associated with AOB; adolescents from municipalities with lower HDI showed a higher likelihood of AOB than those from municipalities with higher HDI. This association was significant after adjusting for individual sociodemographic and clinical variables (models 2 and 3). The MRR, as well as the between-municipality variance, was reduced from 21.03 (null model) to 12.42 (−40.94%) after the inclusion of the contextual variables (model 1). The LRT showed model 1 a better fit than the null model (LRT: 12.24; $P < .0066$). The inclusion of sociodemographic variables in the model resulted in a further decrease in the between municipality variance (compositional differences = −3.86%) and MRR, and the decrease in deviance and LRT (LRT = 34.54; $P < .0001$) indicated an improvement in the goodness-of-fit of the model (model 2). The inclusion of clinical variables resulted in deviance reduction and improved model adjustment (model 3) but did not contribute to explaining variation amongst municipalities (Table 3).

The final multiple model (model 3) showed, for the individual variables, a higher chance of AOB amongst adolescents who declared having black skin compared to those who declared their skin colour as white. Adolescents from a family with lower income (0–3 MW) showed higher AOB prevalence than those from a family with income >4 MW. Delayed education compared to ideal/above education level was associated with a lower prevalence of AOB. Adolescents with DMFT ≥1, those who lost 4 permanent first molars, and those who had a full molar cusp relationship were more likely to have AOB than those with DMFT = 0, those who did not lose any first molar and those who showed normal molar relation (Table 3).

Discussion

The estimated AOB prevalence for Brazilian 15- to 19-year-olds in 2010 was 8.78% (95% CI, 6.85%–11.20%). Adolescents living in Brazilian cities with lower municipal HDI (<0.699) showed a higher chance of AOB malocclusion than those living in municipalities with higher HDI (≥0.70). The results indicate that social disadvantage related to family income and education level were associated with higher AOB prevalence amongst Brazilian adolescents. The previous caries experience, the loss of first molars, and molar relation were clinical variables associated with AOB prevalence. Therefore, the AOB prevention and education actions should be included in the oral health public policies for adolescents, contributing to decreasing the observed inequalities.

Skeletal AOB is genetics-related.[10,23] Nevertheless, AOB might also occur by alveolar bone shaping due to deleterious oral habits.[24] Over the years of facial growth, this oral behaviour might be a disabling AOB in need of costly orthodontic treatment and minimally associated with oral functional therapy.[13] Pacifier, lip, lingual, and thumb sucking, lip and nail biting, and tongue thrust, amongst other dysfunctional

Table 1 – Prevalence of anterior open bite in adolescents, according to contextual and individual variables, in Brazil (2010) (N = 5129).

Variable	n	Prevalence	95% CI
Contextual variables			
Municipal HDI (2010)			
≥0.70	4501	6.84	5.28–8.80
<0.699	628	16.95	11.16–24.89
Gini Index (2010)			
<0.5809	1829	8.98	6.28–12.67
0.5909–0.6266	1696	7.69	5.40–10.84
>0.6266	1604	8.78	6.73–11.37
Sociodemographic individual variables			
Sex			
Male	2342	8.77	6.31–12.06
Female	2787	8.80	6.52–11.76
Skin colour/race			
White	2081	5.09	3.46–7.43
Black	558	8.24	0.05–13.27
Brown	2350	12.83	9.29–17.45
Indigenous + yellow	140	10.88	2.71–34.89
Family income (missing = 290)			
≥4 MW	1506	3.97	2.17–7.17
0–3 MW	3333	11.17	8.36–14.76
Education (age–grade level)			
Ideal level/above	2762	6.79	4.95–9.23
Delayed	2367	11.38	7.81–16.29
Clinical individual variables			
DMFT			
0	1204	4.49	2.58–7.68
≥1	3925	10.18	7.77–13.24
Missing first molars			
0	4310	8.58	6.59–11.12
≤3	791	9.91	6.80–14.21
4	28	16.78	4.56–46.01
Molar relation (missing = 96)			
Normal	2796	5.65	3.95–8.02
Half cusp	1608	10.65	7.03–15.82
Full cusp	629	21.12	13.77–30.99

DMFT, decayed, missing, and filled teeth HDI, Human Development Index; MW, minimum wage.

Table 2 – Nonadjusted association between contextual and individual variables with an anterior open bite in 15- to 19-year-old Brazilians in 2010 (N = 4178; 69 Brazilian municipalities).

Variable	OR (95% CI)
Contextual variables	
Municipality HDI (2010)	
≥0.70	1.00
≤0.699	**1.74 (1.14–2.68)***
Gini Index (2010)	
<0.5809	1.00
0.5909–0.6266	1.01 (0.66–1.55)
>0.6266	1.31 (0.86–2.01)
Sociodemographic individual variables	
Sex	
Male	1.00
Female	1.03 (0.83–1.29)
Skin colour	
White	1.00
Black	**1.85 (1.30–2.63)*****
Brown	**1.36 (1.05–1.78)***
Yellow + indigenous	1.02 (0.46–2.29)
Family income	
≥4 MW	1.00
0–3 MW	**1.83 (1.39–2.43)*****
Education (age–grade level)	
Ideal level/above	1.00
Delayed	**1.61 (1.28–2.03)*****
Clinical individual variables	
DMFT	
0	1.00
≥1	**2.19 (1.59–3.02)*****
Missing first molars	
0	1.00
≤3	**1.51 (1.13–2.02)****
4	**4.49 (1.51–13.30)****
Molar relation	
Normal	1.00
Half cusp	**1.91 (1.47–2.48)*****
Full cusp	**3.86 (2.86–5.21)*****

DMFT, decayed, missing, and filled teeth HDI, Human Development Index; MW, minimum wage.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

oral habits,[25] might be interrupted earlier, preventing AOB and its severity. The lower AOB prevalence amongst individuals with mixed dentition than amongst those with deciduous dentition suggests the importance of orofacial dysfunction over the dentoalveolar complex for AOB genesis. The effects of skeletal, dental, alveolar bone, and soft tissue combined with deleterious oral habits are considered part of the multifactorial causes of AOB.[25] Therefore, it is reasonable to assume that social determinants are indirectly linked to AOB amongst adolescents.

Other studies have already shown the association between malocclusion and social determinants,[6,9,13,26] but not with a contextual variable such as the municipal HDI associated with AOB. The lower municipal HDI results indicate that adolescents living in less affluent cities have a higher chance of being found with AOB. Several studies linked health to "upstream" (social structure) together with "downstream" individual choice,[17,27] but what would be the quality of this choice if there are considerably fewer opportunities to access public service as in lower-HDI cities regarding oral health habit prevention and education?[28] AOB is treatable[2,8] and preventable[25]; thus, early professional counselling may eliminate or attenuate the AOB in adolescence. However, the majority of the dentistry courses in Brazil are in the south and southeast regions, where the majority of municipalities with higher HDI are located and also where the majority of Brazilian dentists work. It is reasonable to assume that the poor quality or the lack of orthodontic treatment access in lower-HDI municipalities negatively impacts the AOB prevalence and might have influenced its disparities over Brazilian state capitals and macro-regions, similar to the asymmetries in the dentistry courses and dentists' distribution.[29] In addition, individual understanding, constraints,

Table 3 – Adjusted association between contextual and individual variables with the anterior open bite in 15- to 19-year-old Brazilians in 2010 (N = 4178; 69 Brazilian municipalities).

Variable	Empty model	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Contextual variables				
Municipality HDI (2010)				
≥0.70		1.00	1.00	1.00
≤0.699		**2.23 (1.41–3.53)###**	**1.87 (1.77–3.00)##**	**1.71 (1.04–2.80)#**
Gini Index (2010)				
<0.5809		1.00	1.00	1.00
0.5909–0.6266		1.28 (0.84–1.93)	1.23 (0.81–1.88)	1.28 (0.81–2.00)
>0.6266		**1.74 (1.14–2.66)#**	**1.55 (0.99–2.38)#**	1.56 (0.98–2.48)
Sociodemographic individual variables				
Sex				
Male			1.00	1.00
Female			1.02 (0.82–1.28)	1.05 (0.83–1.32)
Skin colour				
White			1.00	1.00
Black			**1.58 (1.11–2.25)#**	**1.59 (1.11–2.29)#**
Brown			1.18 (0.90–1.54)	1.15 (0.87–1.51)
Yellow + indigenous			0.92 (0.41–2.07)	0.82 (0.36–1.85)
Family income				
≥4 MW			1.00	1.00
0–3 MW			**1.58 (1.19–2.10)##**	**1.43 (1.07-1.91)#**
Education (age–grade level)				
Ideal level/above			1.00	1.00
Delayed			**1.43 (1.13–1.80)##**	**1.30 (1.02–1.65)#**
Clinical individual variables				
DMFT				
0				1.00
≥1				**1.81 (1.30–2.53)###**
Missing first molars				
0				1.00
≤3				1.07 (0.79–1.46)
4				**3.29 (1.06-10.22)#**
Molar relation				
Normal				1.00
Half cusp				**1.79 (1.37–2.33)###**
Full cusp				**3.48 (2.57–4.72)###**
−2 log likelihood (deviance)	2363.70	2351.47	2316.92	2229.96
Difference in deviance		−12.23*	−34.55*	−86.96*
Residual intraclass correlation	0.06 (0.03–0.13)	0.03 (0.01–0.09)	0.03 (0.01–0.10)	0.05 (0.02–0.11)
Area level variance (random intercept)	21.03 (9.12–12.85)	12.42 (4.52–34.13)	12.90 (4.79–34.76)	16.96 (6.98–41.19)
PCV		−40.94%	−3.86%	+31.47%
Median rate ratio	1.55	1.40	1.40	1.48

Results of multilevel logistic regression model assuming a random intercept and fixed effect. # $p < 0.05$, ## $p < 0.01$, ### $p < 0.001$.

* Deviance model 1 – deviance empty model (χ^2 for 2 df = 4606); deviance model 2 – deviance model 1 (χ^2 for 6 df = 10.645); deviance model 3 – model 2 (χ^2 for 9 df = 14.684). The covariables contributed to model fit.DMFT, decayed, missing, and filled teeth; HDI, Human Development Index; MW, minimum wage; PCV, proportional change in variance.

behaviour, and lifestyles are constructed from the social structure where adolescents live upon their life conditions, local economics, education, and dental services opportunities,[30,31] which might have influenced the unequal distribution of AOB in adolescents over Brazilian state capital and macro-regions in 2010.

Those who self-declared having black skin showed a higher prevalence of AOB than those who declared themselves as having white skin.[32] This result also demonstrates ethnic inequality in the AOB distribution. Ethnic inequality in oral health has already been discussed with Brazilian data[33]; for severe malocclusion,[32] AOB and ethnicity might be indicators of Brazilian socioeconomic inequities. No differences were found in AOB between men and women.[32]

Social determinants of health include how people grow, live, work, and age[27]; therefore, they are strongly related to behaviours that may compromise health conditions. Social position, assessed by family income and educational attainment, was associated with AOB. These individual factors may be related to low access to knowledge of good health habits and few opportunities for preventive measures and orthodontic treatment.[29,32]

Dental caries affects occlusion when the interproximal teeth are cavitated, possibly affecting the first molar position by reducing mesiodistal distances.[34] Nevertheless, our results should be considered an indirect association with AOB because dental caries is associated with disadvantaged social positions.[21] The relation of the half and full cusps between the first permanent molars is associated with a more severe overjet, thus making it easier to establish an AOB. AOB prevalence was associated with missing all the first permanent molars. Anterior and posterior tooth loss is associated with malocclusion in adolescents,[32] as it induces tooth migration and interferes with the molar relation, contributing to AOB. Tooth loss is an important marker of social exclusion associated with severe malocclusions such as AOB in adolescents, which leads to reductions in life opportunities.[26]

This study was limited by the characteristics of the SBBrasil 2010. We could not address other potential determinants of AOB, mainly regarding behavioural aspects. It should be noted that sample planning was not carried out with the objective of this multilevel research; therefore, the sample size in many municipalities was very low, and it is necessary to exclude some of them for this reason. Although biased estimates are more due to the number of clusters (ie, municipalities), we chose to remove municipalities with cluster sizes of <10 from the analysis. Even after removing these individuals, 69 municipalities were included in the analysis. A study on the effect of a small sample size on 2-level model estimates reviewed the results from several sample simulation studies.[35] According to these studies, 10 to 50 clusters are needed to obtain the effects of interest (level 1, fixed-effect point estimates; level 2, fixed-effect point estimates and fixed-effect standard errors; level 2, variance estimates; and level 2, standard errors). These authors affirmed that a cluster size greater than 5 is recommended for binary outcomes. However, municipalities with 10 or more adolescents were maintained to reduce the risk of biased estimates, mainly because the prevalence of the response variable, AOB, was <10%. Simulation studies have shown that the degree of bias of estimates in a multilevel model is affected by the prevalence rate of the outcome.[35] Larger sample sizes are required to produce unbiased estimates as the frequency between the 2 levels of the outcome becomes more disparate.[35] This cross-sectional observational study allowed estimates of the AOB prevalence with satisfactory precision. However, this study cannot support any conclusion on the risk of this condition or a causal relationship.

Nonetheless, sociodemographic characteristics highlighted the importance of social determinants of AOB in adolescents. The epidemiology of AOB has rarely been investigated at the population level, and this subject should be explored further, especially concerning contextual effects. Policymakers should implement educational and preventive actions for AOB, focusing on socially disadvantaged children and adolescents and considering the multidimensional characteristics of this condition.

Conclusions

The prevalence of AOB in 15- to 19-year-old Brazilians varies amongst Brazilian municipalities. Living in disadvantaged municipalities is associated with a higher chance of AOB. AOB was more frequent amongst adolescents in disadvantaged social positions (lower-income families and those with delayed education) than amongst those who were better positioned socially.

Conflict of interest

None disclosed.

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Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.identj.2022.07.001.

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