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Socioeconomic inequalities and temporomandibular joint disorders in adolescents: contributions from a Maranhão cohort

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Aim: To assess the prevalence of temporomandibular disorder (TMD) in adolescents and estimate possible associations with poverty. ***Basic research design***: A cross-sectional study nested within a prospective birth cohort study conducted in São Luís, Maranhão, Brazil. ***Participants***: 2,412 adolescents aged 18-19 years. ***Material and Methods***: The presence of TMD, classified according to the Fonseca Anamnestic Index, was used as the outcome. The following explanatory variables were assessed: gender, household head, paved/asphalted street, piped water, and socioeconomic background, based on the Brazilian Association of Market Research criteria and the poverty income ratio (PIR). Logistic regression analysis was performed with the estimation of odds ratios (OR) and 95% confidence intervals. ***Results***: TMD was common (51.4%) and was associated with poverty, as it was more frequent among adolescents from social classes D-E (OR=2.60; 95% CI: 1.48-4.55) and C (OR=1.82; 95% CI: 1.12-2.99) compared to A/B, and among poor adolescents using the PIR (OR=1.50; 95% CI: 1.02-2.33). ***Conclusions***: The prevalence of TMD in socioeconomically disadvantaged adolescents in São Luís is high, and these data allow the early identification of at-risk groups. We recommend carrying out other population-based studies, using diagnostic strategies with greater accuracy.

Keywords*: adolescent, temporomandibular joint disorders, poverty, economic inequality*

Introduction

Temporomandibular disorders (TMD) consist of a group of signs and symptoms observed in the temporomandibular joints and associated structures (Manfredini *et al*., 2011). The aetiology of TMD remains unclear, although psychosocial, anatomical and systemic factors have been implicated. The effect of socioeconomic factors is uncertain (Magalhães *et al*., 2014; Visscher *et al*., 2015).

The association between poverty and oral morbidities has been investigated in Brazilian (Da Silva *et al*., 2016; Magalhães *et al*., 2014) and international studies (Graue *et al*., 2016; Visscher *et al*., 2015). Different theories underpin the possible roles of deprivation. Health status may reflect the whole life trajectory, moulded by social determinants, such as biopsychosocial and demographic factors in a complex, dynamic, and multidimensional process (Natu *et al*., 2018; Visscher *et al*., 2015).

An assumption of these studies is that socioeconomic vulnerability can result in stressful lifestyles, due to a more hectic routine owing to the lack of amenities, including finance, information, poor access to services and other health resources to prevent disease (Fonseca *et al*., 2015; Slade *et al*., 2015). Such neurobiological, financial and intellectual pathways can affect the prevalence of TMD. However, some data contradict this thesis (Graue *et al*., 2016; Tecco *et al*., 2017).

Therefore, this study aimed to determine the prevalence of TMD in adolescents in a cross-sectional study nested within a cohort and to estimate possible associations between the presence of disease and poverty. This is the first large population-based study in the Brazilian Northeast to investigate TMD among adolescents.

Material and Methods

This is a cross-sectional study nested within a prospective birth cohort study (RPS) conducted in São Luís, the state capital of Maranhão, Brazil. The investigation began in 1997/98. One in every seven live newborns in public and private hospitals born to mothers living in the municipality of São Luís was selected by systematic sampling with stratification proportional to the number of births (n=2,443). The children were reassessed in 2005 (school age: 7-9 years); and again in 2016, during adolescence (age 18-19 years). Only data from the second follow-up are included in this study.

From January to December 2016, we reassessed the participants (aged 18-19). To locate them, we searched enrollment at schools and universities, addresses and contacts on social media, as well as military enrollment records (for men). A total of 654 adolescents were identified from the original cohort and agreed to participate in this follow-up. Due to the difficulty in locating individuals, we included participants in two ways: by lot in the database of the "Sistema de Informação sobre Nascidos Vivos" (National Live Births Registry, SINASC) (n=1,716), and by the inclusion of volunteers identified in schools, universities and social networks born in maternity hospitals in São Luís in 1997 (n=145). These new participants were submitted to the same tests and questionnaires as the original cohort. A total of 2,515

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adolescents were enrolled, of whom 103 were excluded (either for wearing an orthodontic appliance or declining an examination). Therefore, the final sample comprised 2,412 adolescents (Figure 1) (Sousa *et al*., 2020). This number was estimated to have a 93% power to identify an odds ratio (OR) from 1.5, at a 50% disease prevalence among unexposed individuals in a sample of equal numbers of exposed and unexposed participants, with a 95% confidence interval, and an effect of design of 2.0.

The dependent variable was the presence of TMD, based on the Fonseca Anamnestic Index (FAI) (da Fonseca *et al*., 1994), validated by Berni et al. (2014). This index consists of ten questions, all of which have three possible answers (no=0, sometimes=5, or yes=10). The information was collected via face-to-face interviews. The total score of answers may range from 0 to 100. TMJ disorder is classified as absent (0 to 15 points), mild (20 to 45 points), moderate (50 to 65 points), or severe (70 to 100 points). We reclassified TMD as absent/mild (up to 47.5) or moderate/severe. This threshold was found to have a high degree of diagnostic validity against the Research Diagnostic Criteria for Temporomandibular Disorders with an area under the receiver operating characteristic (ROC) curve of 0.940, sensitivity of 86.3%, specificity of 91.9%, positive predictive value of 94.35%, and negative predictive value of 84.31% (Berni *et al*., 2014).

The primary independent variable was poverty, assessed in two ways. First, the Brazilian Association of Market Research (ABEP) criteria were used to categorise participants into five socioeconomic strata. A 15-item structured interview determined possession of specified material goods (clothes dryer, wash clothes, dishwasher, fridge, freezer, dvd, microwave, personal computer, motorcycle and automobiles), certain amenities (such as having a housemaid), number of bathrooms in the house, the educational level of the household and access to public services (piped water and paved street). A score per residence was calculated as the sum of the item scores (range 0 to 100. The classes were categorized as A/B (the wealthiest, 29 to 100 points), C (17 to 28 points), and D/E (0 to 16 points) (ABEP, 2014). Secondly, using the poverty income ratio (PIR), which is the relationship between household income and the number of household members, divided by R$140.00 (a value that refers to the level of poverty, according to the World Bank and to the Brazilian federal government, 2006) (Capurro *et al*., 2015).

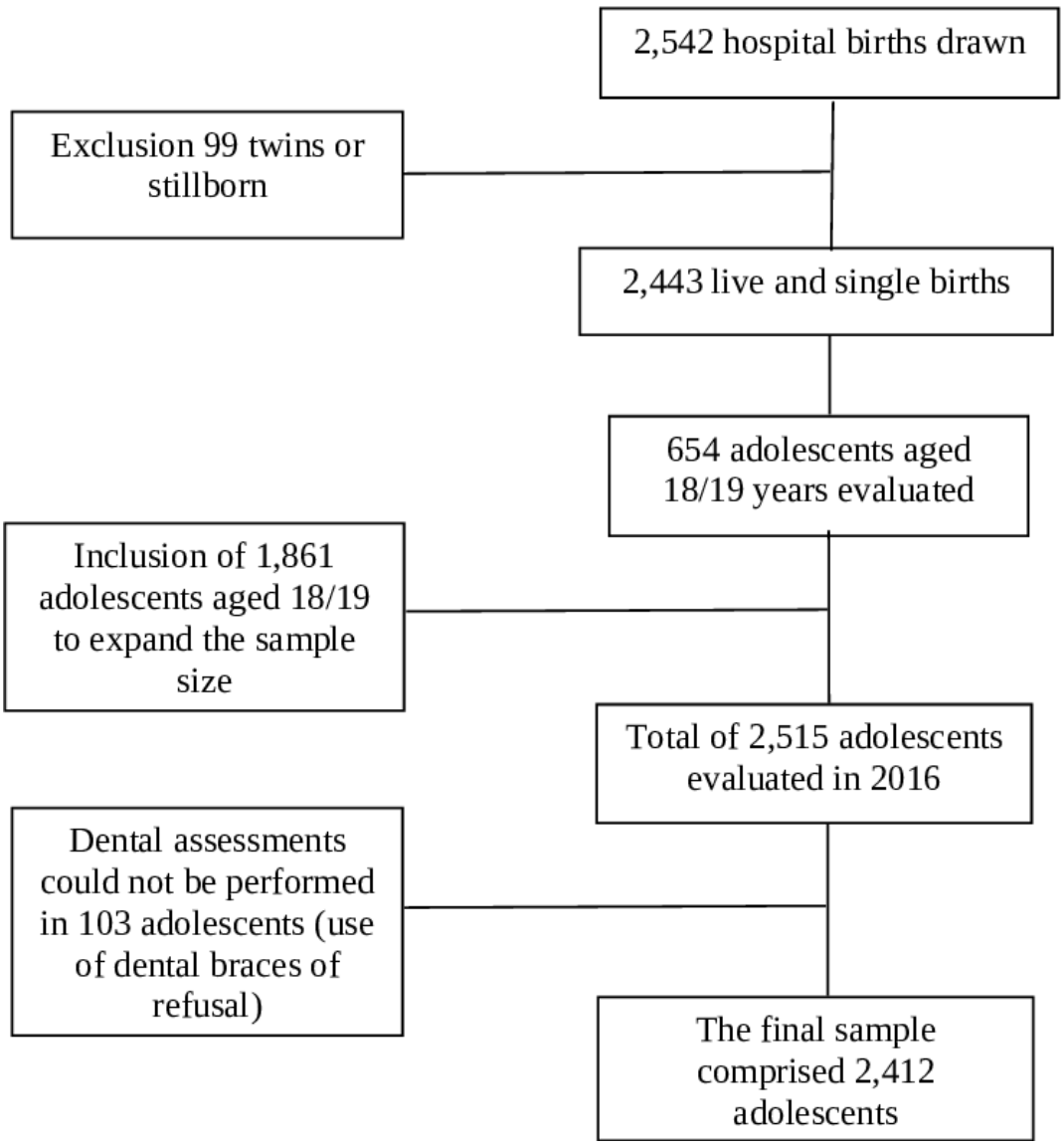

Figure 1. Sample flow chart

The remaining covariates were collected during the second follow-up (2016): gender (male or female); household head (father, mother, or other, including grandparents, uncles, and aunts, or the adolescent himself or herself); paved/asphalted street (yes or no); piped water (yes or no).

Descriptive statistics were used (absolute and proportions, means ± standard deviations, medians ± interquartile ranges) and 95% confidence intervals (95% CI). Bivariate analyses (chi-square test, Fisher's exact test, Mann-Whitney test, or Kruskal-Wallis test) compared the prevalence of TMD across sample characteristics using an alpha of 5%. Crude and adjusted logistic regression analyses determined the associations between socioeconomic variables and the presence of TMD. STATA version 14 (Stata Corp., College Station, TX, USA) was used was used for all analyses.

The study was approved by the Research Ethics Committee of HU-UFMA (process no. 1.302.489, CAAE: 49096315.2.0000.5086). Participants or parents/legal guardians signed a consent form after they had been informed about the objectives of the study.

Results

Sixty percent (n=1,440) of the participants lived on a household per capita income up to 0.5 minimum wage, 24% between 0.51 and 1.0, 10.3% between 1.01 and 2.0, and 5.2% on more than 2.0 minimum wages (data not shown). The FAI score ranged from 0 to 90 points (median = 20, interquartile range10 - 30) (data not shown).

Participants had a mean DMFT of 3.7 (±3.2), of which 1.6 (±2.1) were decayed, 0.3 (±0.8) missing, and 1.8 (±2.4) filled teeth.

Half (51.4%) the participants had mild, moderate or severe TMD. The most common symptoms reported were malocclusion (50.3%), stress (47.5%), and frequent headaches (40.6%) (Table 1).

In crude analysis, TMD was more common in adolescents from social classes D-E, and C, and among poor adolescents, according to PIR. These relationships persisted after adjustment. TMD was also more common in female adolescents (Table 2).

Discussion

The prevalence of TMD in adolescents from São Luís is high and was more evident in those with greater socioeconomic vulnerability.

The prevalence seen here aligned with previous findings of frequent TMD (Casanova-Rosado *et al*., 2006; Da Silva *et al*., 2016; Tecco *et al*., 2017). In a systematic review conducted in northeastern Brazil, one in every six children or adolescents, aged 0 to 18 years, had clinical signs of TMD (Da Silva *et al*., 2016). Similarly, 44.1% of 567 Italian adolescents aged 11 to 19 years showed at least one sign or symptom (Tecco *et al*., 2017), as did 46.1% of 506 Mexican young people (Casanova-Rosado *et al*., 2006). However, some studies have contested this high prevalence (Paduano *et al*., 2018). A low prevalence (11.9%) among Norwegian adolescents might be explained by their access to social assistance programs promoting relaxation via health promotion, with activities aimed at chronic diseases and broader health determinants (Wakefield and Poland, 2005).

The young age of participants in these studies indicates that TMD is evident in childhood and perpetuates into

Table 1. Prevalence of TMJ symptoms and disorders in 2,412 São Luís adolescents

Symptoms from Fonseca anamnestic index	*%*	*95%CI*
Do you have any difficulty opening your mouth open wide?	7.8	6.7-8.9
Do you have any difficulty moving your jaw sideways?	5.5	4.6-6.5
Do you feel tired/have muscle pain on chewing?	19.0	17.4-20.5
Do you have frequent headaches?	40.6	38.5-42.5
Do you have neck pain or torticollis?	24.7	23.0-26.5
Do you feel pain in your ear or around it (TMJ)?	21.5	19.8-23.2
Have you noticed any popping/clicking in the TMJs when you chew or open your mouth?	22.4	20.7-24.1
Have you noticed if you have the habit of clenching or grinding your teeth?	24.4	22.7-26.1
Do you feel your teeth don't close well?	50.3	48.3-52.3
Do you think you are tense (nervous person)?	47.5	45.5-49.5
TMD, according to the Fonseca Anamnestic Index		
Absent/Normal	48.4	46.4-50.4
Mild	44.7	42.7-46.7
Moderate	5.5	4.7-6.5
Severe	1.2	0.8-1.7
No information provided	0.2	0.04-0.4

Table 2. Predictors of TMD in 2,412 São Luís adolescents

	Total	*No/Mild TMD 0<FAI<47.5*	*Moderate/ Severe TMD 50<FAI*	*Crude Logistic Regression*		*Adjusted Regression*	
	%	*%*	*%*	*OR*	*95% CI*	*OR*	*95% CI*
Gender[1]							
Male	46.4	96.2	3.8	Ref.			
Female	50.7	90.7	9.3	2.57	1.79-3.69	2.41	1.67-3.46
Household head[1]							
Father	39.6	93.6	6.4	Ref.			
Mother	32.7	92.8	7.2	1.14	0.78-1.66		
Other	26.8	93.2	6.8	1.07	0.71-1.60		
Receives social benefit[1]							
No	56.7	93.0	7.0	Ref.			
Yes	41.8	93.7	6.3	0.89	0.64-1.24		
Socioeconomic class							
A-B	24.1	96.2	3.8	Ref.			
C	50.9	93.1	6.9	1.89	1.17-3.05	1.82	1.12-2.99
D-E	25.0	90.8	9.2	2.57	1.55-4.28	2.60	1.48-4.55
Paved street[1]							
No	19.3	94.8	5.2	Ref.			
Yes	79.8	92.8	7.2	1.19	0.95-1.49	1.26	0.99-1.59
Piped water							
No	28.4	94.5	5.6	Ref.			
Yes	71.6	92.3	7.2	1.07	0.97-1.17	1.11	0.97-1.23
PIR[1]							
Poor (PIR<1.0)	44.0	95.0	5.0	1.79	1.17-2.73	1.50	1.02-2.33
Almost poor (1.0≤PIR<2.0)	17.1	93.0	7.0	1.81	1.17-2.79	1.29	0.81-2.06
Median income (2.0≤PIR<3.0)	18.2	91.3	8.7	1.44	0.90-2.30	1.21	0.75-1.96
High income (PIR≥3.0)	19.8	91.4	8.6	Ref.			

[1]Categories do not total 100% reflecting non-completion by some participants

adulthood. Many of our participants also experienced other dental problems, including caries, which may contribute to the high frequency of TMD.

We used the FAI to classify TMD (Berni *et al*., 2014; da Fonseca *et al*., 1994). Of the questions that make up this index, the most frequently reported symptoms were those with a high prevalence in other studies: malocclusions (Tecco *et al*., 2017), stressful situations (Natu *et al*., 2018), and headache (Visscher *et al*., 2015). TMD was also more common among females in other studies and may be because of hormonal conditions and cultural factors that allow women to perceive and express pain (Bilgiç and Gelgör, 2017; Visscher *et al*., 2015).

Despite possible misclassification, as clinical or other objective assessments examination were not conducted, TMD was associated with poverty among our participants, whether determined using the ABEP criteria or the PIR. This finding is consistent with that of another Brazilian study, where socioeconomic background was associated with a diagnosis of myofascial pain and joint disorders among individuals from social classes D-E, who were considered extremely poor (28.6%) (Magalhães *et al*., 2014). The unfavorable situation in socioeconomically underprivileged groups is consistent with the influence of social determinants on health (Carrapato *et al*., 2017).

Few studies on this subject have included adolescents. Slade et al. (2015) investigated individuals aged 18 to 44 years in the United States and associated TMD with a lower level of education, but not with income.

Any differences in the prevalence between different countries may be explained by the country's wealth, cultural factors and the social programs and benefits granted to low-income people. Differences in study design (few cohorts and many cross-sectional studies), participants'

age (not always including only adolescents), data collection techniques (semi-structured questionnaires, telephone interviews, among others), and the diagnostic criteria for TMD (many times using fewer objective criteria) may also affect the results.

As it appears that a continuum of adverse situations predisposes adolescents to TMD, socio-economic status should be considered in this patient group (Magalhães *et al*., 2014). Social inequalities in health reflect how diseases can affect society unequally, depending on conditions resulting from the economic level (Barreto, 2017). Therefore, policies for the prevention and treatment of TMD targeting the population that is most affected by the disease might also be considered. Such policies could be conceptualised by professionals and guided by contemporary theories, ensuring that they are appropriate and effective.

This study recruited a large sample, used socioeconomic indicators that allow comparisons at national and international levels and controlled for possible confounders. Study implementation benefitted from training and supervision of the data collection team and the use of electronic forms for data collection, minimizing possible transcription/typing errors. However, the study has some limitations. The cross-sectional design does not allow causal inference. Despite several strategies for searching for the participants, some of the original sample could not be located. To deal with this problem, we included other people who had been born during initial recruitment period (October 1997 to September 1998), which enhanced the sample's power.

There are several criteria and no consensus on which should be used to diagnosis and classify TMD (Schiffman *et al*., 2014). The Research Diagnostic Criteria for Temporomandibular Disorders show reliability for detecting psychological and psychosocial abnormalities relating to TMD but little internal consistency for the homogeneity of specific aspects of chronic pain intensity and non-specific physical disability and symptoms (Berni *et al*., 2014). This study used FAI, which, although not based on a clinical examination, allows the collection of a large amount of information quickly and simply, favoring its use in large samples. It has been validated for the Brazilian population and has excellent psychometric properties. It consists of 10 questions that are easy to understand and can be used as continuous or categorical variable, depending on the severity of the disorder. It was not possible to analyze the four categories of TMD separately as moderate and severe diagnoses were uncommon, which would reduce the precision of the estimates.

Conclusion

The finding of the high prevalence of TMD in disadvantaged socioeconomic adolescents in São Luís allows the identification of risk groups. Thus, carefully public policies aimed at reducing social inequities in oral health might be directed towards those at greatest risk. Longitudinal and other population-based studies, using diagnostic strategies with greater accuracy are required.

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