Impact of temporomandibular disorder on oral health-related quality of life in adolescents

Impacto da disfunção temporomandibular na qualidade de vida relacionada à saúde bucal em adolescentes

Impacto de los trastornos temporomandibulares sobre calidad de vida relacionada a la salud bucal en adolescentes

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Abstract
The aim of this cross-sectional study was to assess the impact of temporomandibular disorder (TMD) on oral health-related quality of life (OHRQoL) of adolescents. The OHRQoL of adolescents undergoing dental treatment at a University clinic in 2019 was measured using the Brazilian version of the Oral Heath Impact Profile – 14 (OHIP-14). The diagnosis of TMD was performed using Research Diagnostic Criteria for Temporomandibular disorders (RDC/TMD). The patients were examined for other oral conditions and the parents/guardians answered questions addressing socioeconomic/demographic characteristics and the general health of the adolescents. Statistical analysis involves simple and multiple logistic regression models. Ninety male and female adolescents between 13 and 18 years of age participated in the study. The prevalence of negative impact on OHRQoL was 34%. In the unadjusted analysis, negative impact on OHRQoL was associated with a poorer self-perception of general and oral health of the adolescent, nonspecific symptoms including pain, and generalized anxiety disorder, caries, reports of dental pain, muscle disorders and disc displacement, and chronic pain related to TMD. In the adjusted model, negative impact on OHRQoL was associated with all diagnoses related to TMD on the RDC/TMD, except signs of depression.
Adolescents with at least one diagnosis related to TMD were 4.13-fold more likely (95% CI:1.08-15.80) to have negative impact on OHRQoL than adolescents without a diagnosis of TMD. The different diagnostic categories of TMD had a negative impact on the OHRQoL of the adolescents analyzed in the present study.

Keywords: Quality of life; Oral health; Temporomandibular joint; Adolescent; Temporomandibular joint dysfunction syndrome.

Resumo
Esse estudo transversal objetivou avaliar o impacto da disfunção temporomandibular (DTM) na qualidade de vida relacionada à saúde bucal (QVRSB) de adolescentes. Pacientes entre 13-18 anos, em tratamento odontológico em uma clínica universitária no ano de 2019 tiveram sua QVRSB mensurada através da versão brasileira do Oral Health Impact Profile – 14 (OHIP-14). O diagnóstico de DTM foi realizado através dos eixos I e II do RDC/TMD. Os pacientes foram examinados para outras condições bucais e seus pais/responsáveis responderam questões socioeconômicas, demográficas e de saúde geral dos adolescentes. A análise estatística usou modelos simples e múltiplos de regressão logística. Noventa adolescentes, de ambos os sexos, participaram do estudo. A prevalência do impacto negativo na QVRSB foi de 34%, sendo os domínios de maior impacto “Desconforto Psicológicos” (28%) e “Incapacidade Psicológica” (19%). O impacto negativo na QVRSB esteve associado, nas análises não ajustadas, a uma pior autopercepção de saúde geral e bucal do adolescente, depressão, sintomas inespecíficos incluindo dor e transtorno de ansiedade generalizada, cárie, relato de dor de dente, DTM, desordem muscular e articular e de dor crônica relacionada à DTM. No modelo ajustado, o impacto negativo na QVRSB foi associado a todos os diagnósticos relacionados à DTM no RDC/TMD, exceto sinais de depressão. Adolescentes com pelo menos um diagnóstico relacionado à DTM tinham chance 4,13 (IC95%: 1,08-15,80) maior de apresentar impacto negativo na QVRSB do que adolescentes sem diagnóstico de DTM. DTM em suas diferentes categorias diagnósticas tiveram impacto negativo na QVRSB de adolescentes.

Palavras-chave: Qualidade de vida; Saúde bucal; Articulação temporomandibular; Adolescente; Síndrome da disfunção da articulação temporomandibular.

Resumen
El objetivo de este estudio transversal fue evaluar el impacto de los trastornos temporomandibulares (TTM) en la calidad de vida relacionada con la salud bucal (QARSO) de los adolescentes. La OHRQoL de adolescentes sometidos a tratamiento dental en una clínica universitaria en 2019 se midió utilizando la versión brasileña del Oral Health Impact Profile - 14 (OHIP-14). El diagnóstico de TMD se realizó utilizando los Criterios de diagnóstico de investigación para trastornos temporomandibulares (RDC / TMD). Los pacientes fueron examinados en busca de otras afecciones bucales y los padres / tutores respondieron preguntas sobre las características socioeconómicas / demográficas y la salud general de los adolescentes. El análisis estadístico implica modelos de regresión logística simple y múltiple. Participaron del estudio 90 adolescentes, hombres y mujeres, entre 13 y 18 años. La prevalencia de impacto negativo en la OHRQoL fue del 34%. En el análisis no ajustado, el impacto negativo en la OHRQoL se asoció con una pior autopercepción de la salud general y bucal del adolescente, síntomas inespecíficos como dolor y trastorno de ansiedad generalizada, caries, informes de dolor dental, trastornos musculares y desplazamiento del disco, y dolor crónico relacionado con TMD. En el modelo ajustado, el impacto negativo en OHRQoL se asoció con todos los diagnósticos relacionados con TMD en el RDC / TMD, excepto los signos de depresión. Los adolescentes con al menos un diagnóstico relacionado con TMD tenían 4,13 veces más probabilidades (IC 95%: 1,08-15,80) de tener un impacto negativo en la OHRQoL que los adolescentes sin un diagnóstico de TMD. Las diferentes categorías diagnósticas de TTM tuvieron un impacto negativo en la OHRQoL de los adolescentes analizados en el presente estudio.

Palabras clave: Calidad de vida; Salud bucal; Articulación temporomandibular; Adolescentes; Síndrome de la disfunción de articulación temporomandibular.

1. Introduction

Oral health is defined as physical, psychological, and social wellbeing related to the status of the oral cavity and is characterized by the absence of pain, discomfort, and abnormalities of the mouth and face (Locker, 2001; Glick et al., 2016). An imbalance in oral health can exert a physical and psychological impact on functional aspects of speech, chewing, and taste as well as social aspects, such as wellbeing, subjective happiness, and self-esteem (Zucoloto et al., 2016; Blanco Aguilera et al., 2017; Bitiniene et al., 2018).

Oral health-related quality of life (OHRQoL) is a complex, multidimensional concept (Colussi et al., 2017). In recent decades, negative impact on OHRQoL has been measured in different age groups to understand the perceptions of individuals with regards to oral problems and their consequences as well as treatment needs and satisfaction with treatment (Cortes et al.,
2. Methodology

2.1 Ethical aspects

The present study received approval from the institutional review board of Universidade Federal de Minas Gerais (certificate number: 01936918.8.0000.5149). Participation in the study was voluntary and authorized by the parents/guardians and individuals older than 18 years of age through a signed statement of informed consent. Adolescents under 18 years of age also signed a statement of consent.

2.2 Study design and sample

A cross-sectional study was conducted with a sample of adolescents. The inclusion criteria were 13 to 18 years of age, both sexes, undergoing care at the School of Dentistry of University. The exclusion criteria were currently undergoing orthodontic treatment, use of occlusal splints or dental prostheses, odontogenic pain, severe facial or dental anomalies, extensive tooth decay, and parental reports of cognitive/behavioral/speech problems or systemic disorders. The sample size was calculated considering a 95% confidence level, 80% test power, and frequency of impact on OHRQoL of 41% and 18%, among individuals with and without TMD respectively (Yap et al., 2020). The minimum sample size was determined to be 122 individuals (https://www.openepi.com/SampleSize/SSCC.htm).

2.3 Variables of interest

The parents/guardians answered a questionnaire addressing socioeconomic and demographic characteristics related to the adolescent (complete name, age, date of birth, and sex) and guardian (degree of kinship to adolescent, complete name, address, number of residents in the home, schooling, and monthly family income) as well as clinical information related to the adolescent (general health, use of medications, nail biting habit, otolaryngology problems, oral health, previous history of dental pain, history of facial muscle pain, and sleep quality/duration).
The adolescents answered the Brazilian versions of the Oral Health Impact Profile (OHIP-14) (Slade, 1997; Soe et al., 2004; Oliveira & Nadanoysky, 2005) and the Subjective Happiness Scale (SHS) (Pais-Ribeiro, 2012; Medeiros et al., 2014; Ortiz et al., 2021). The OHIP-14 has 14 questions distributed among seen domains. Each question has five scored response options (never = 0, hardly ever = 1, occasionally = 2, fairly often = 3, and often = 4). The total ranges from 0 to 56 points, with higher scores denoting greater impact (Slade, 1997; Soe et al., 2004; Oliveira & Nadanoysky, 2005). The SHS is a self-report measure addressing whether the respondent considers himself/herself to be happy or unhappy based on the answer to four statements. There is an increasing scale (1 to 7) for each item, with lower scores denoting less happiness (Pais-Ribeiro, 2012; Medeiros et al., 2014; Ortiz et al., 2021).

TMD was assessed using the Brazilian version of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD). This instrument is composed of two axes (Franco et al., 2014; Paiva Bertoli et al., 2018). Axis I involves a clinical evaluation for the classification of the individual in three diagnostic groups: Muscle disorders (myofascial pain and myofascial pain with limited opening), disc displacement (with reduction, without reduction, or without reduction and with limited opening), and joint disorders (arthralgia, osteoarthritis, and osteoarthrosis) (Franco-Micheloni et al., 2014). Axis II is self-administered and has 32 items that assist in a psychosocial assessment of nonspecific physical symptoms, such as pain, generalized anxiety disorder, and signs of depression (absent, moderate, or severe) (Simoen et al., 2020). To evaluate disability and psychological status by RDC/TMD Axis II, it was used scoring graded chronic pain (GPC Scale) and scoring the distress scale items.

During the intraoral clinical examination of the adolescents, the following conditions were also evaluated as possible confounding variables of the association between TMD and OHRQoL: dental caries (Decayed, Missing, and Filled Teeth index [DMFT]) (Whoqol Group, 1995), traumatic dental injuries (Cortes et al., 2002; Andreasen et al., 2018), fluorosis (Dean, 1934), malocclusion (Cardoso et al., 2011; Costa et al., 2011), tooth wear (Lobbezoo et al., 2018), molar incisor hypomineralization (Weerheijm et al., 2003), dental erosion (Vargas-Ferreira et al., 2011), and geographic/fissured tongue (Reamy et al., 2010).

2.4 Calibration exercise and pilot study

Two examiners (A.L.P.B. and G.A.F.) underwent training and calibration exercises coordinated by experienced dentists for the use of the clinical indices employed in the data collection process. The examiners received training in theory and practice involving the clinical examination of 28 patients. The Kappa coefficient for inter-examiner agreement regarding the diagnosis of TMD was 0.907. Calibration for dental caries (Whoqol Group, 1995), traumatic dental injury (Cortes et al., 2002; Andreasen et al., 2018), fluorosis (DEAN) (Dean, 1934), malocclusion (DAI) (Cardoso et al., 2011; Costa et al., 2011), tooth wear (Lobbezoo et al., 2018), molar incisor hypomineralization (Weerheijm et al., 2003), dental erosion (Vargas-Ferreira et al., 2011), geographic/fissured tongue (Reamy et al., 2010) was performed (theory and practice) involving the evaluation of photographs. For the Dental Aesthetic Index (DAI), training involved both theory and the use of plaster models. Intra-examiner and inter-examiner Kappa coefficients were ≥ 0.80 for all indices.

Prior to the data collection procedures, a pilot study was conducted with 10 adolescents to test the proposed methods. The results of the pilot study revealed no need to alter the methods. Therefore, the participants were included in the main study.

2.5 Data collection

All data were collected in a single session by researchers who had undergone the training and calibration exercises. The questionnaires were self-administered by the parents/guardians and adolescents. The adolescents were then clinically
examined in a dental chair under artificial light at the clinic of the UFMG School of Dentistry, using individual protective equipment and a sterile kit containing a mouth mirror and WHO probe.

2.6 Statistical analyses

Data analysis was performed with the aid of the Statistical Package for the Social Sciences (SPSS –version 20.0). The OHIP-14 items were dichotomized as “absence of negative impact” (answers of “never” and “hardly ever”) or “presence of negative impact” on OHRQoL (answers of “occasionally”, “fairly often”, and “often”) (Oliveira & Shelham, 2004; Oliveira et al., 2015). Individuals who answered “occasionally”, “fairly often”, or “often” to at least one of the OHIP-14 items were considered to have impact on OHRQoL. The same reasoning was employed for the interpretation of the separate domains. The answers to the RDC/TMD were assessed by axis. A positive diagnosis for any of the classifications on Axis I was considered indicative of the presence of TMD. All variables on Axis II were dichotomized (present [moderate and severe classifications] or absent [normal classification]) (Franco-Micheloni et al., 2014; Simoen et al., 2020).

The data were initially submitted to descriptive statistics (absolute and relative frequencies; mean and standard deviation). Unadjusted and adjusted binary regression models were used to evaluate the association between the dependent variable (OHIP-14: with/without impact) and socioeconomic/demographic characteristics, health-related characteristics, level of happiness, TMD, and other oral conditions. Independent variables with a p-value ≤ 0.20 in the univariate analysis were incorporated into the multivariate models. The selected variables were tested for the occurrence of multicollinearity. When collinearity was identified between a pair or group of variables, only one was incorporated into the model (based on the theoretical support model). As different diagnoses related to TMD determined by the RDC/TMD exhibited collinearity, five separate multivariate models (each with only one of the possible diagnoses as the independent variable of interest) were run to gain a better understanding of the contribution of the diverse aspects related the impact of TMD on OHRQoL. (Any positive diagnosis on Axis I in Model 1, Chronic pain in Model 2, Suggestive signs of depression in Model 3, Nonspecific symptoms including pain in Model 4, Generalized anxiety disorder in Model 5). Wald’s backward method was used to generate the final models with adjusted odds ratios (OR) and respective 95 confidence intervals (CI) for the impact on OHRQoL among the categories of independent variables.

Bivariate analyses (Mann-Whitney test, chi-squared test, or Fisher’s exact test, depending on the scales and distribution of the variables) were performed to investigate associations between each domain of the OHIP-14 (functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap) and the predictor variables. The level of significance on these tests was set at 5% (p < 0.05).

3. Results

With the advent of the COVID-19 pandemic, dental appointments at the University clinic were suspended and data collected was interrupted after finding 105 adolescents between 13 and 18 years of age who met the eligibility criteria, among whom 14.3% did not return the signed statements of consent (adherence rate: 85.7%). Among the 90 adolescents who were submitted to all clinical examinations and answered the data collection instruments, 51.15% (n = 46) were girls, mean age was 15.9 ± 1.7 years, 73% were self-declared as black, brown, or indigenous, and 27% were self-declared as white or yellow. Among the parents/guardians, 36% reported having studied eight years or less, mean age was 39 ± 12.1 years, and 30.5% had a family income of up to the Brazilian monthly minimum wage (corresponding to $ 235.95 in the year of the data collection (2019). The prevalence of TMD in the sample was 44% (95% CI: 34 to 55%). Among the diagnoses on Axis I of the RDC/TMD, the most prevalent was joint disorder (41%); 15% were diagnosed with muscle disorder and 12% were diagnosed with disc...
displacement. On Axis II, signs of depression were the most prevalent disorder (48%), followed by nonspecific physical symptoms including pain (47%), generalized anxiety disorder (43%), and chronic pain (29%).

Table 1 displays the prevalence of negative impact on the total OHIP-14 and each domain. A total of 34% of the adolescents reported a negative impact on OHRQoL. The domain with a great frequency of negative impact was psychological discomfort (28%), being the main complaints concern with mouth and teeth problems (27.0%), shame about oral problems (15.6%) and having pain in the mouth and teeth (12.2%). The mean total OHIP-14 score among the adolescents was 8.4 (standard deviation: 8.7) and the 25th, 50th, and 75th percentiles were 2, 6, and 12, respectively.

Table 1. Prevalence of negative impact on adolescents OHRQoL, by domain and considering the total OHIP-14 score

| Domain OHIP-14 | Prevalence (CI 95%) |
|---------------|---------------------|
| Functional limitation | 7% (1-12) |
| Physical pain | 15% (7-23) |
| Psychological discomfort | 28% (18-38) |
| Physical disability | 6% (1-11) |
| Psychological disability | 19% (10-27) |
| Handicap | 5% (0-9) |
| Social disability | -* |
| Mean total OHIP-14 | 34% (24-44) |

*There was no impact for the “Social disability” domain. Source: Authors.

No socioeconomic or demographic variable was associated with OHRQoL in the univariate analysis (Table 2). In contrast, impact on OHRQoL was associated with self-reported general and oral health of the adolescent (p = 0.009 and 0.012, respectively), nonspecific signs of pain (p = 0.018) and generalized anxiety disorder (p = 0.011) (Table 3), dental caries experience (p = 0.001), reports of toothache (p = 0.005), muscle disorders and disc displacement (p = 0.026 and 0.011, respectively), and chronic pain related to TMD in the previous six months (p = 0.004) (Table 4).

Table 2. Univariate binary logistic regression model for socioeconomic and demographic variables associated with the negative impact on adolescents' OHRQoL.

| Predictor variables | With impact n (%) | Without impact n (%) | Value of p |
|---------------------|-------------------|----------------------|------------|
| Sex                 |                   |                      |            |
| Male (ref*)         | 14 (31.8)         | 30 (68.2)            | 0.608      |
| Female              | 17 (37.0)         | 29 (63.0)            |            |
| Skin color (self-declared) |       |                      |            |
| White or yellow (ref) | 5 (20.8)    | 19 (79.2)            | 0.099      |
| Black, brown or indigenous | 26 (40.0) | 39 (60.0)            |            |
| Family income ($) – mean (SD#) | 1844.12 (1096.36) | 2622.43 (3616.90) | 0.450      |
| Adolescent age (in years) – mean (SD) | 15.9 (1.9) | 15.7 (1.6) | 0.278      |
| Parents/guardians age (in years) – mean (SD) | 38.1 (12.1) | 42.4 (10.6) | 0.147      |
| Parents/guardians education level |       |                      |            |
| ≤ 8 years of study (ref) | 13 (41.9)    | 18 (58.1)            |            |
| > 8 e ≤ 11 years of study | 15 (34.9)    | 28 (65.1)            | 0.538      |
| ≥12 years of study | 3 (25.0)        | 9 (75.0)             | 0.309      |

* Ref: reference; *SD: Standard deviation. Source: Authors.
Table 3. Unadjusted binary logistic regression model for health-related variables associated with the negative impact on adolescents OHRQoL.

| Predictor variables                                      | With impact n (%) | Without impact n (%) | Value of p |
|----------------------------------------------------------|-------------------|----------------------|------------|
| General health of the adolescent (self-reported)         |                   |                      |            |
| Good/Very good (ref*)                                    | 23 (29.1)         | 56 (70.9)            |            |
| Regular/Bad/Very bad                                     | 8 (72.7)          | 3 (27.3)             | **0.009**  |
| Oral health of the adolescent (self-reported)            |                   |                      |            |
| Good/Very good (ref)                                     | 16 (25.8)         | 46 (74.2)            |            |
| Regular/Bad/Very bad                                     | 15 (53.6)         | 13 (46.4)            | **0.012**  |
| Sleep quality (report of parents/guardians)              |                   |                      |            |
| Very good (ref)                                           | 8 (36.4)          | 14 (63.6)            |            |
| Good                                                      | 15 (30.6)         | 34 (69.4)            | 0.632      |
| Regular                                                   | 8 (47.1)          | 9 (52.9)             | 0.502      |
| Adolescent’s sleep hours (report of parents/guardians)   |                   |                      |            |
| ≤ 8 hours a night (ref)                                   | 19 (34.5)         | 36 (65.5)            |            |
| > 8 hours a night                                         | 12 (36.4)         | 21 (63.6)            | 0.863      |
| Subjective Happiness Scale (SHS) – mean (SD)#            | 17.7 (4.1)        | 18.5 (3.3)           | 0.326      |
| Chronic pain (RDC/TMD, Axis II)                          |                   |                      |            |
| Absent (ref)                                              | 16 (25.0)         | 48 (75.0)            |            |
| Present                                                   | 15 (57.7)         | 11 (42.3)            | **0.004**  |
| Signs of depression (RDC/TMD, Axis II)                   |                   |                      |            |
| Absent (ref)                                              | 12 (26.1)         | 34 (73.9)            |            |
| Present                                                   | 19 (44.2)         | 24 (55.8)            | 0.076      |
| Nonspecific symptoms including pain (RDC/TMD, Axis II)   |                   |                      |            |
| Absent (ref)                                              | 11 (23.4)         | 36 (76.6)            |            |
| Present                                                   | 20 (47.6)         | 22 (52.4)            | **0.018**  |
| Generalized anxiety disorder (RDC/TMD, Axis II)          |                   |                      |            |
| Absent (ref)                                              | 12 (23.5)         | 39 (76.5)            |            |
| Present                                                   | 19 (50.0)         | 19 (50.0)            | **0.011**  |

* Ref: reference; # SD: Standard deviation. Source: Authors.
Table 4. Univariate binary logistic regression model for variables related to oral conditions associated with the negative impact on OHRQoL of adolescents.

| Predictor variables | With impact n (%) | OHIP-14 Without impact n (%) | Value of p |
|---------------------|-------------------|------------------------------|------------|
| TMD*                |                   |                              |            |
| Absent (ref)        | 13 (26.0)         | 37 (74.0)                    |            |
| Present             | 18 (45.0)         | 22 (55.0)                    | 0.062      |
| Muscle disorders    |                   |                              |            |
| Absent (ref<sup>3</sup>) | 21 (28.4)         | 53 (71.6)                    |            |
| Present             | 8 (61.5)          | 5 (38.5)                     | 0.026      |
| Disc displacement   |                   |                              |            |
| Absent (ref)        | 23 (29.9)         | 54 (70.1)                    |            |
| Present             | 8 (72.7)          | 3 (27.3)                     | 0.011      |
| Joint disorders     |                   |                              |            |
| Absent (ref)        | 16 (30.2)         | 37 (69.8)                    |            |
| Present             | 15 (40.5)         | 22 (59.5)                    | 0.311      |
| Toothache (self-reported) |         |                              |            |
| No (ref)            | 1 (4.3)           | 22 (95.7)                    |            |
| Yes                 | 30 (46.9)         | 34 (53.1)                    | 0.005      |
| Dental caries experience (DMFT) – mean (SD)<sup>2</sup> | 4.26 (3.27) | 1.95 (2.45) | 0.001 |
| Tooth wear          |                   |                              |            |
| Absent (ref)        | 21 (33.9)         | 41 (66.1)                    |            |
| Present             | 10 (35.7)         | 18 (64.3)                    | 0.865      |
| Dental erosion      |                   |                              |            |
| Absent (ref)        | 29 (34.5)         | 55 (65.5)                    |            |
| Present             | 2 (40.0)          | 3 (60.0)                     | 0.803      |
| Fluorosis           |                   |                              |            |
| Absent (ref)        | 18 (38.3)         | 29 (61.7)                    |            |
| Present             | 13 (30.2)         | 30 (69.8)                    | 0.422      |
| Molar incisor hypomineralization (MIH) | |                              |            |
| Absent (ref)        | 31 (35.2)         | 57 (64.8)                    |            |
| Present             | 0 (0.0)           | 2 (100.0)                    | 0.999      |
| Traumatic dental injury |           |                              |            |
| Absent (ref)        | 25 (33.3)         | 50 (66.7)                    |            |
| Present             | 3 (37.5)          | 5 (62.5)                     | 0.813      |
| Malocclusion        |                   |                              |            |
| No (DAI ≤ 25) (ref) | 11 (36.7)         | 19 (63.3)                    |            |
| Yes (DAI ≥ 26)      | 20 (33.3)         | 40 (66.7)                    | 0.754      |
| Geographic tongue   |                   |                              |            |
| No (ref)            | 28 (33.3)         | 56 (66.7)                    |            |
| Yes                 | 3 (50.0)          | 3 (50.0)                     | 0.414      |
| Fissured tongue     |                   |                              |            |
| No (ref)            | 15 (30.0)         | 35 (70.0)                    |            |
| Yes                 | 16 (40.0)         | 24 (60.0)                    | 0.322      |

<sup>a</sup>Presence of any diagnosis obtained by Axis I of the RDC / TMD (muscle disorders, disc displacement or joint disorders);<sup>b</sup>Ref: reference;<sup>c</sup>SD: Standard deviation. Source: Authors.

The adjusted regression models (Table 5) showed associations between practically all TMD diagnoses evaluated and OHRQL. Adolescents with muscle and/or joint disorders and/or disc displacement were 4.13-fold (95% CI: 1.08 to 15.80) more likely to have negative impact on OHRQoL (Model 1). Those with chronic pain, nonspecific symptoms including pain, and generalized anxiety disorder were 4.08-fold (95% CI: 1.01 to 16.53; Model 2), 5.48-fold (95% CI: 1.21 to 24.73; Model 4), and 10.50-fold (95% CI: 2.50 to 44.14; Model 5) more likely to have negative impact on OHRQoL in comparison to those who did not exhibit these signs and symptoms. On the other hand, the study was unable to detect an association between suggestive
signs of depression and negative impact on OHRQoL (Model 3). Caries experience (DMFT index) was kept associated with negative impact on OHRQoL after adjustments in all models.

Associations between each OHIP-14 domain and sociodemographic, health-related, and clinical variables are displayed in Table 6. Adolescents with younger parents/guardians (p = 0.046) and those with chronic pain related to TMD in the previous six months (p = 0.007), muscle disorders (p = 0.022), and nonspecific symptoms including pain (p = 0.009) reported a greater frequency of impact on the “functional limitation” domain. The prevalence of impact on the “physical pain” domain was associated with muscle disorders (p = 0.025), reports of toothache (p = 0.009), and all diagnoses on Axis II of the RDC/TMD (p <0.05), except signs of depression. These same variables were associated with an impact on the “psychological discomfort” domain, the latter was also associating with the dental caries experience. Only dental erosion exerted an impact on the “physical disability” domain (p = 0.036). Adolescents who considered their general and oral health to be fair or poor (p = 0.030 and 0.001, respectively) and those with chronic pain (p = 0.034), disc displacement (p = 0.033), signs of depression (p = 0.041), generalized anxiety disorder (p = 0.041), dental caries experience (p = 0.001) and reports of toothache (p = 0.004) reported impact on the “psychological disability” domain.
Table 5. Multiple binary logistic regression models for the presence of negative impact on OHRQoL.

| Variables                                                                 | Model 1 OR adjusted (CI 95%) | Model 2 OR adjusted (CI 95%) | Model 3 OR adjusted (CI 95%) | Model 4 OR adjusted (CI 95%) | Model 5 OR adjusted (CI 95%) |
|---------------------------------------------------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|
| TMD (present of TMD*)                                                    | 4.13 (1.08-15.8)             | -                            | -                            | -                            | -                            |
| Dental caries experience (DMFT)                                          | 1.34 (1.08-1.66)             | 1.32 (1.07-1.62)             | 1.29 (1.04-1.58)             | 1.37 (1.09-1.72)             | 1.44 (1.14-1.82)             |
| Toothache (self-reported)                                                | 11.09 (1.65-116.7)           | 10.47 (0.96-113.9)           | 11.27 (0.90-140.9)           | 7.25 (0.40-132.32)           | -                            |
| Oral health of the adolescent (self-reported)                            | -                            | -                            | 2.62 (0.71-9.66)             | 3.11 (0.77-12.55)            | -                            |
| Chronic pain (RDC/TMD, Axis II)                                          | -                            | -                            | -                            | -                            | -                            |
| Signs of depression (RDC/TMD, Axis II)                                   | -                            | -                            | 2.15 (0.59-7.86)             | -                            | -                            |
| Nonspecific symptoms including pain (RDC/TMD, Axis II)                  | -                            | -                            | -                            | 5.48 (1.21-24.73)            | -                            |
| Generalized anxiety disorder (RDC/TMD, Axis II)                          | -                            | -                            | -                            | -                            | 10.50 (2.50-44.14)           |

* Presence of any diagnosis obtained by Axis I of the RDC/TMD (muscle disorders, disc displacement or joint disorders)
Variables included in all models: DMFT; Toothache; Oral health of the adolescent (self-reported).
Source: Authors.
Table 6. Bivariate analysis for variables associated with the presence of impact in the OHIP-14 domains.

| Predictor variables                        | Functional limitation (p) | Physical pain (p) | Psychological discomfort (p) | Physical disability (p) | Psychological disability (p) | Handicap (p) |
|-------------------------------------------|---------------------------|------------------|-------------------------------|-------------------------|-----------------------------|--------------|
| Sex                                       | p=1.000                  | p=1.000          | p=1.000                        | p=1.000                 | p=1.000                      | p=1.000      |
| Skin color (self-reported)                | p=0.185                  | p=0.332          | p=0.135                        | p=0.183                 | p=0.140                      | p=0.185      |
| Family income ($)                         | p=0.838                  | p=0.763          | p=0.748                        | p=0.376                 | p=0.915                      | p=0.273      |
| Adolescent age (in years)                 | p=0.601                  | p=0.861          | p=0.209                        | p=0.867                 | p=0.099                      | p=0.259      |
| Parents/guardians age (in years)          | p=0.046                  | p=0.886          | p=0.247                        | p=0.783                 | p=0.740                      | p=0.815      |
| Parents/guardians education level         | p=0.587                  | p=0.814          | p=0.922                        | p=0.982                 | p=0.225                      | p=0.587      |
| Number of residents in the house          | p=0.486                  | p=0.162          | p=0.291                        | p=0.167                 | p=0.199                      | p=0.266      |
| Number of bathrooms (report of parents/guardians) | p=0.353                  | p=0.866          | p=0.879                        | p=0.746                 | p=0.299                      | p=0.947      |
| General health of the adolescent (self-reported) | p=0.155                  | p=0.070          | p=0.067                        | p=0.558                 | p=0.030                      | p=0.155      |
| Oral health of the adolescent (self-reported) | p=1.000                  | p=0.754          | p=0.215                        | p=0.374                 | p=0.001                      | p=1.000      |
| Sleep quality (report of parents/guardians) | p=0.284                  | p=0.565          | p=0.620                        | p=0.851                 | p=0.372                      | p=0.647      |
| Adolescent’s sleep hours (report of parents/guardians) | p=0.192                  | p=0.823          | p=0.428                        | p=0.869                 | p=0.834                      | p=1.000      |
| Subjective Happiness Scale (SHS) (total score) | p=0.916                  | p=0.968          | p=0.683                        | p=0.256                 | p=0.590                      | p=0.138      |
| Muscle disorders †                         | p=0.022                  | p=0.025          | p=0.005                        | p=0.100                 | p=0.054                      | p=0.218      |
| Disc displacement †                       | p=0.161                  | p=0.377          | p=0.070                        | p=0.165                 | p=0.271                      | p=0.687      |
| Joint disorders †                         | p=0.224                  | p=0.212          | p=0.165                        | p=0.100                 | p=0.271                      | p=0.687      |
| TMD*                                      | p=0.085                  | p=0.123          | p=0.055                        | p=0.402                 | p=0.062                      | p=0.400      |
| Chronic pain †                            | p=0.007                  | p=0.004          | p=0.003                        | p=1.000                 | p=0.034                      | p=0.350      |
| Signs of depression †                     | p=0.103                  | p=0.058          | p=0.054                        | p=0.678                 | p=0.041                      | p=0.678      |
| Non-specific symptoms including pain †     | p=0.009                  | p=0.001          | p=0.016                        | p=1.000                 | p=0.108                      | p=0.415      |
| Generalized anxiety disorder †            | p=0.080                  | p=0.002          | p=0.013                        | p=1.000                 | p=0.041                      | p=0.395      |
| Dental caries experience (DMFT)            | p=0.308                  | p=0.131          | p=0.037                        | p=1.000                 | p=0.001                      | p=0.876      |
| Traumatic dental injury (clinical examination) | p=1.000                  | p=0.608          | p=0.412                        | p=1.000                 | p=1.000                      | p=1.000      |
| Malocclusion (DAI)                         | p=0.173                  | p=1.000          | p=0.775                        | p=0.172                 | p=0.128                      | p=0.659      |
| Dental erosion (clinical examination)      | p=0.301                  | p=0.181          | p=0.620                        | p=0.036                 | p=0.242                      | p=0.301      |
| Molar incisor hypomineralization (MIH) (clinical examination) | p=1.000                  | p=1.000          | p=1.000                        | p=1.000                 | p=1.000                      | p=1.000      |
| Tooth wear (clinical examination)          | p=0.661                  | p=1.000          | p=0.764                        | p=0.663                 | p=0.679                      | p=1.000      |
| Fluorosis (clinical examination)           | p=0.420                  | p=0.499          | p=0.327                        | p=0.678                 | p=0.636                      | p=1.000      |
| Fissured tongue (clinical examination)      | p=0.689                  | p=0.338          | p=0.983                        | p=1.000                 | p=0.434                      | p=1.000      |
| Geographic tongue (clinical examination)   | p=1.000                  | p=1.000          | p=1.000                        | p=1.000                 | p=1.000                      | p=1.000      |
| Toothache (self-reported)                  | p=0.334                  | p=0.009          | p=0.002                        | p=0.186                 | p=0.004                      | p=0.334      |

*Persons Chi-square; †Fisher’s exact; ‡ Mann-Whitney test
RDC/TMD Axis I; RDC/TMD Axis II; Presence of any diagnosis obtained by Axis I of the RDC / TMD (muscle disorders, disc displacement or joint disorders)
There was no impact report for the “Social disability” domain, which is why it is not shown in the table.
4. Discussion

The present study estimated the negative impact of signs and symptoms of TMD on OHRQoL in Brazilian adolescents considering their general and oral health as well as psychological, socioeconomic, and demographic characteristics. The impact on OHRQoL is a complex phenomenon influenced by diverse physical and emotional aspects of general and oral health. The main findings were the high prevalence of TMD among the adolescents and its negative impact (along with variables of the psychological axis [chronic pain and anxiety]) on OHRQoL. Approximately one-third of the adolescents reported negative impacts on OHRQoL, with a mean OHIP-14 score of 8.4. Previous studies conducted with Brazilian adolescents report similar findings (Colussi et al., 2017; Aimée et al., 2017).

The physical pain domain is considered the most important in the measurement of OHRQoL in adolescents and the domain with the highest prevalence of impact in previous studies (Reamy et al., 2010; Aimée et al., 2017). In the present investigation, however, greater impacts were found on the psychological discomfort and psychological disability domains than physical pain domain, which is similar to data described in a previous study involving Brazilian adolescents (Keles et al., 2018). This finding may be explained by the fact that adolescence is a period of emotional, pubertal, psychological, and social maturation, when individuals are more vulnerable to the emergence of psychopathology, with increased emotional intensity and immature cognitive control (Dahl & Gunnar, 2009; Crone & Dahl, 2012; Cservenka et al., 2015).

The prevalence of signs and symptoms of TMD among the adolescents in the present study was 44%, which is slightly higher than the rate reported in the literature for Brazilian adolescents (40%) (Paiva Bertoli et al., 2018). Regarding the different diagnoses of TMD, the prevalence of joint disorders was higher in the present study. In contrast, Paiva Bertoli et al. (2018) found a higher prevalence of muscle disorders. Differences in the prevalence of TMD in the literature occur due to the diversity of the sample characteristics and the use of different diagnostic instruments (Sena et al., 2013). To avoid the risk of bias, a recognized, validated instrument was used for the diagnosis of TMD in the present study, which also enables comparisons with the results of other studies addressing this disorder (Franco-Micheloni et al., 2014).

Adolescents with TMD were fourfold more likely to have a negative impact on OHRQoL compared to those without TMD. Barbosa et al. (2016) report similar results in a study involving children and adolescents (8-14 years of age) using the Child Perceptions Questionnaires (CPQ) for the measurement of negative impact on OHRQoL (Barbosa et al., 2016). Moreover, a poorer perception of OHRQoL was associated with diagnoses of muscle disorders, disc displacement, chronic pain, and nonspecific symptoms including pain and generalized anxiety disorder. These findings are compatible with those reported by Paulino et al. (2018), who found that TMD exerted a negative impact on OHRQoL among Brazilian adolescents and young adults (Paulino et al., 2018).

The individual diagnoses of Axis I of the RDC/TMD exerted impacts on the functional limitation, physical pain, psychological discomfort and psychological disability domains of the OHIP-14, whereas disc displacement was only associated with psychological disability, muscle disorders were associated with functional limitation, physical pain, and psychological discomfort. Such findings were expected, as these diagnoses cause pain, mouth opening limitation, and sounds during the movements of the temporomandibular joint (Bitiene et al., 2018; Paiva Bertoli et al., 2018). The associations with the OHIP-14 domains underscores the disabling role of signs and symptoms of TMD and their influence on OHRQoL, which is compatible with data described in the literature (Resende et al., 2011; Lemos et al., 2015; Bitiniene et al., 2018; Paulino et al., 2018).

Pain is the most common symptom of TMD (Bitiene et al., 2018). In the present investigation, approximately one-third of the adolescents experienced chronic pain and 47% had nonspecific symptoms including pain due to TMD in the
previous six months. Adolescents with a report of chronic pain were fourfold more likely to report a negative impact on OHRQoL, and those diagnosed with nonspecific symptoms were nearly fivefold more likely to report an impact. Constant pain can lead to the development of psychological conditions, such as depression, stress, and anxiety, due to the difficulty in performing activities of daily living and maintaining interpersonal relationships (Cioffi et al., 2014; Silva et al., 2017; Bitiniene et al., 2018).

In the study, approximately half of the individuals had signs of depression and generalized anxiety disorder (43%) diagnosed by RDC/TMD. Furthermore, those diagnosed with generalized anxiety disorder were 10-fold more likely to have a negative impact on OHRQoL. Previous studies have described an increased prevalence of mental disorders in individuals with TMD (La Torre et al., 2018; Simoen et al., 2020; Resende et al., 2020), these disorders, in turn, could affect quality of life (Sawyer et al., 2002; Ravens-Sieberer et al., 2008; Bonsard et al., 2013). Some studies also indicate that signs and symptoms of depression and anxiety are risk factors for the initiation (Slade et al., 1997; Filingim et al., 2013; Simoen et al., 2020), installation (Velly et al., 2011; Dunn et al., 2011; Simoen et al., 2020), and establishment of a more difficult response to the treatment of pain in cases of TMD (Gardea et al., 2001; Turner et al., 2006; Barbosa et al., 2011), indirectly contributing to a greater negative impact on quality of life. This dual direct/indirect pathway may explain the large effect that we found on OHRQoL and, along with the high prevalence of these conditions, underscores the importance of the psychosocial assessment of patients diagnosed with TMD in a multidisciplinary approach. The screening of patients with these conditions that have a known impact on quality of life would also provide information related to the prognosis with regards to the persistence of pain and the response to treatment for TMD (Barbosa et al., 2011; Natu et al., 2018).

Dental caries was another clinical condition that exerted a negative impact on OHRQoL. Divergences are found in the literature on the association between dental caries and OHRQoL due to the different age groups analyzed, differences in the prevalence and severity of caries in distinct populations, and differences in the methods of analysis (Paula et al., 2012; Oliveira et al., 2015). In the present investigation, as occurred in a previous study involving Brazilian adolescents (Oliveira et al., 2015); individuals with higher DMFT scores were nearly twofold more likely to have negative impact on OHRQoL after the adjustments for the other variables in all multivariate models. Moreover, toothache was strongly associated with a poorer OHRQoL. This finding is compatible with the results of a systematic review and meta-analysis, which reported that children and adolescent with dental pain are more likely to experience a negative impact on OHRQoL (Barasoul et al., 2020).

Self-rated general health and oral health represent how adolescents perceive their health and were strongly associated with OHRQoL. Oliveira et al. (2015) reported similar findings in a study involving incarcerated adolescents. These results demonstrate the influence that self-perceived conditions, such as esthetics and pain, can have on OHRQoL (Oliveira et al., 2015). Adolescents who rated their oral health as fair/poor/very poor were approximately fourfold more likely to have an impact on OHRQoL than those who rated their oral health as good/very good. Both self-reports were associated with the psychological disability domain of the OHIP-14. We opted not to include self-rated general health in the adjusted models because this variable exhibited collinearity with self-perceived oral health.

To control for possible confounding factors in the association between TMD and OHRQoL, we analyzed not only self-rated general and oral health, toothache, and dental caries, but also sociodemographic and health-related characteristics, the habits of the adolescents, and other oral conditions. These variables were included based on theoretical references: (Oliveira & Sheiham, 2004; Michel-Crosato et al., 2005; Al-Omari et al., 2006; Biazevic et al., 2008; Moreno et al., 2009; Reamy et al., 2010; Vargas-Ferreira et al., 2011; Miettinen et al., 2012; Oliveira et al., 2015; Tuchtenhagen et al., 2015; Mangold et al., 2016; Rosa et al., 2016; Li & Bernabé, 2016; Dantas-Neta et al., 2016; Sun et al., 2017; Colussi et al., 2017; Blanco Aguilera et al., 2017; Bitiniene et al., 2018; Lopez et al., 2019; Barasoul et al., 2020). However, we found no associations between these conditions and the
negative impact on OHRQoL. This may have occurred due to the particularities of the present sample, such as difference in age and number of participants.

The present study has limitations that should be considered: Data collection was interrupted due to the COVID-19 pandemic in 105 adolescents who represented a non-population-based convenience sample recruited from a dental clinic, which likely a higher prevalence of TMD had compared to the general population. However, this limitation did not impede us from identifying the association between different diagnoses of TMD and OHRQoL, which was our main objective. Another limitation regards the cross-sectional design, which does not enable the establishment of cause-and-effect relationships between variables.

This study also has strong points. We used reliable, validated instruments for our main variables. We examined clinical conditions that could be considered confounding factors in the association of interest, using established indices, following a careful calibration exercise, and with the entire support of a dental office. We have also subjectively assessed aspects related to general and oral health, and considered a large gamut of socioeconomic and demographic variables. These procedures enabled us to have a broader view of aspects that influence OHRQoL in adolescents and enhanced the reliability of our results, which corroborate the current literature, contributing to the understanding of the impact of TMD on the quality of life of adolescents. The findings of this study can assist in preparing dentists and pediatric dentists for the diagnosis of TMD and assessment of the likelihood of developing the disorder in this phase as well as minimizing its negative impact on the quality of life of adolescents. However, future studies should advance in investigating the impact of multiple simultaneous diagnoses of TMD on the quality of life of adolescents, in a larger and representative population-based sample to ensure adequate power to identify all possibly associations.

5. Conclusion

TMD was one of the orofacial conditions that most consistently exerted negative impact on the OHRQoL of the adolescents. Besides clinical diagnosis, variables of the psychological axis, such as chronic pain and anxiety, were associated with negative impact on OHRQoL even after adjusting for control variables.

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