INTRODUCTION

In March 2020, the World Health Organization (WHO) declared a state of pandemic and Public Health Emergency of International Concern (PHEIC). It occurred due to the rapid spread of the novel virus ‘severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)’, the causative pathogen of coronavirus disease 2019 (COVID-19). Globally, up to 5 November 2020, 48 136 225 COVID-19 cases have been confirmed by WHO, including 1 225 913 deaths. In relation to Brazil, up to the same date, 5 590 941 cases and 161 170 deaths had been declared. The transmission routes of COVID-19 occur through the inhalation of virus-infected particles dispersed in the air and through its direct contact with nasal, ocular, and oral mucous membranes.
Therefore, in order to minimize the degree of contamination, it was recommended the adoption of social distancing by the population, which has been applied in Brazil for 7 months. The measures of social distancing in Brazil recommend physical distance between individuals, involving the cancellation of mass events, suspension of face-to-face classes in schools, adoption of home office practice by family members when possible, blocking borders, and the instruction that population should stay home. These measures have been previously adopted in previous epidemics and pandemics, and it is expected that these changes may promote psychosocial and behavioural impacts on children and adolescents, which can perpetuate over time and affect issues related to general and oral health.

Recently published studies have shown changes in the behavioural pattern of individuals subjected to confinement during the COVID-19 pandemic. The demand and use of dental services showed a reduction of 38% at the beginning of the pandemic, which was also observed in access to primary oral health care in the Brazilian environment. Eating habits have undergone somewhat contradictory changes. Some results from different surveys indicated that individuals started to have a better diet during confinement, whereas others indicated the opposite. In relation to sleep quality, an improvement was observed in this issue among adults, who started to sleep better and for longer periods than before the pandemic. These results, even if inconsistent, prove the capacity of social distancing of leading to behavioural changes in people’s lifestyles.

Most of the studies published so far, however, have a cross-sectional design, were carried out outside the Brazilian context, and addressed samples of adult individuals. It is recognized that adolescence is an important transitional phase due to the vulnerability in the adoption of new health-related behaviours, which must be monitored in this unique period. Furthermore, as far as we know, no study has longitudinally assessed changes in oral health–related habits during confinement. Therefore, this study aims to assess psychosocial and behavioural changes related to oral health in Brazilian adolescents during the pandemic period of COVID-19. This cohort study with adolescents assessed immediately before the pandemic started made it possible to obtain the adolescents’ report in the pre- and pandemic periods.

3 | METHODS

3.1 | Ethical issues

This study was approved by the Human Research Ethics Committee of the Federal University of Santa Maria (protocol number: 54257216.1.0000.5346). A written informed consent form was obtained from all adolescents and their respective parents or legal guardians.

3.2 | Study design and sample

This study corresponds to a cohort with 10 years of follow-up conducted in the city of Santa Maria, southern Brazil. The study began in 2010 and involved 639 children aged 1 to 5 years, who were systematically selected during the National Children’s Vaccination Day. The sampling process included 15 municipal health centres with dental chairs proportionally distributed in the eight administrative regions of the city, which had a population of 261,031 inhabitants. Further details regarding the employed methodology and sampling process have been previously published.

This study had three evaluation phases (2010, 2012, and 2017). In November 2019, a 4th phase was performed, which was suspended in February 2020 due to the COVID-19 pandemic. Until the interruption, 290 adolescents had been located and reassessed. During the pandemic, those adolescents were recontacted by telephone to ask questions related to behavioural and psychosocial issues in this period. Therefore, this study used data collected in the 4th phase of the cohort, divided into two different steps: baseline (T1—November 2019 to February 2020) and follow-up (T2—June and July 2020).

3.3 | Data collection

At T1, adolescents were found using two search strategies. The first search strategy consisted of evaluating participants in the school that they were enrolled, after receiving
authorization from parents and/or guardians. When it was not possible to find participants in schools, the researchers conducted home visits. At T2, researchers contacted the same 290 participants and their guardians evaluated at T1 through telephone calls. Data on sociodemographic, behavioural, and clinical status, and variables related to the COVID-19 pandemic were collected over the course of T1 and T2.

At T1, a structured questionnaire answered by adolescents provided information regarding age, sex (boys and girls), race, and maternal education. Age was collected in years and categorized as ‘10-12 years old’ and ‘13-15 years old’. The race was classified based on the criteria adopted by the Brazilian Institute of Geography and Statistics (IBGE) and dichotomized as ‘White’ or ‘Non-White’.\(^\text{15}\) Maternal education was collected based on the number of years of study and categorized into ‘≥8 years of formal education’, which corresponds to primary school in Brazil, and ‘<8 years of formal education’. Regarding the clinical examination, a team of 7 previously trained and calibrated examiners assessed the occurrence of untreated dental caries, recorded as a non-zero D/d component in the decayed, missed, or filled teeth indexes—DMFT/dmft. International criteria standardized by the World Health Organization for oral health research were applied during clinical examinations.\(^\text{16}\) Kappa statistics (inter- and intra-examiner) for dental caries measures were higher than 0.7.

At T2, parents and/or guardians answered two questions regarding the COVID-19 pandemic. In order to measure the degree of social distancing adopted by the family, the following question was asked: ‘Regarding the social distancing that is being guided by health authorities, that is, staying at home and avoiding contact with other people, how much do you think your family are managing to do?’, with the following response options: ‘Practically isolated’; ‘Quite’; ‘Middle’; ‘Little’; ‘Very little’.\(^\text{17}\) For descriptive analysis, responses were grouped and categorized as ‘High’; ‘Middle’; and ‘Low’. In addition, it was asked whether someone in the family lost their job due to the pandemic or suffered any injury at work. The answer options varied from ‘No’: ‘Yes’; and ‘Harmed’.

Some variables were collected both at T1 and at T2, in order to compare the results. Adolescents reported information on household income, frequency of toothbrushing, sugar consumption, bruxism, sleep quality, dental attendance, and perceived dental treatment need. If any information was unknown to the participants, the researchers contacted the parents and/or guardians in an attempt to complete the missing data. Household income was recorded in Reais (RS—official Brazilian currency—RS 5.62 was equivalent to US$ 1.00, approximately) of all individuals living in the house in the last month and dichotomized in ‘≤1 Brazilian Minimum Wage (BMW)’ or ‘>1 BMW’ (1 BMW is equivalent to US$197.00). The frequency of toothbrushing was measured by the number of times a day that adolescents brushed their teeth and was dichotomized in ‘<3 times a day’ or ‘≥3 times a day’. Dietary habits with consumption of sugary foods or drinks were assessed by the daily frequency and dichotomized into ‘≥1 time a day’ or ‘<1 time a day’. Regarding adolescent bruxism and sleep quality, they answered whether they ground their teeth while sleeping (‘Yes’ or ‘No’) and whether they rated their sleep quality as ‘Good’ or ‘Bad’. Adolescents were classified as ‘User’ or ‘Non-user’ according to the use of dental services in the last 12 months (T1) and during the pandemic period (T2), which comprised the last 4 months until the re-evaluation (March to June). In addition, they were classified according to their self-perceived need for current dental treatment (‘Yes’ or ‘No’).

3.4 | Data analyses

Statistical analyses were performed using STATA 14.2 (StataCorp. 2014. Stata Statistical Software: Release 14.2: StataCorp LP). The descriptive analyses showed characteristics of study participants at T1 and T2. The differences between the participants and non-participants were evaluated through the chi-square test. Multilevel-adjusted logistic regression models with a random effect for repeated measures at baseline and follow-up were used to assess the association between outcomes before (T1) and after pandemic (T2) and also according to social distancing, considering demographic and socioeconomic variables for adjusting. In the multilevel structure, the repeated measures over time (level 1) were nested in children (level 2) and these were nested in the neighbourhood clusters (level 3). Variables that presented \(P < .20\) in the unadjusted analysis were included in the adjusted model. The results were presented as odds ratio (OR) and 95% confidence interval (95% CI).

4 | RESULTS

From the 290 adolescents evaluated at T1, 207 were followed up and contacted during the pandemic period (response rate of 71.3%). The reason for loss at follow-up included the inability of contacting due to the absence and/or error of the telephone number (n = 83). Regarding the followed and non-respondents’ adolescents, there was no difference in relation to all variables evaluated (\(P > .05\)). In addition, a sensitivity analysis was performed using the bootstrap simulation and the absence of difference was confirmed. As this study is part of a cohort that already had its original sample calculation established, this research considered the calculation of the study’s power. The present sample had a power of 70% to detect a significant difference in the self-perceived need for dental treatment before and during the COVID-19 pandemic, considering a sample size for both groups of 207 patients and
a lower self-perception of dental treatment of 46% for the exposed adolescents (during the pandemic) and 58% for the unexposed adolescents (before the pandemic).

Table 1 shows sociodemographic and clinical characteristics at T1, and issues related to the COVID-19 pandemic at T2, among the groups of evaluated and missed adolescents. Approximately 52% of the adolescents were aged between 13 and 15 years and were evenly distributed according to sex and race. Most adolescents (72%) had mothers with 8 or more years of formal education, a household income > 1 BMW (76%), and 27.5% had untreated dental caries. Most adolescents (72%) had mothers with 8 or more years of formal education, and 27.5% presented untreated dental caries.

At T2, 68% of the adolescents’ relatives did not lose their jobs during the pandemic, whereas 26% and 6% lost and suffered some type of financial loss, respectively. In addition, 66% of the adolescents’ guardians reported a high social distancing, 27% medium, and 7% considered their social distancing low. Comparing the participants with the non-participants, there were no statistical differences for any variable ($P > .05$).

Table 2 shows that, during the pandemic period, the odds of dental brushing frequency $\geq$ 3 times a day was 47% lower (OR 0.53; 95% CI 0.31-0.92). Sugar consumption and frequency of bruxism decreased during confinement, and sleep quality improved, however, without significant differences.

At T1, 63% of participants used dental services in the past 12 months, which dropped significantly to 15% during the pandemic (previous 4 months) (OR 0.06; 95% CI 0.03-0.14). Finally, the odds of self-perceived need for dental treatment among adolescents was 48% lower during confinement (OR 0.53; 95% CI 0.33-0.84). Age, sex, and household income were considered adjustment variables in the regression analysis, as they presented a $P < .20$ in the unadjusted analysis.

Table 3 shows the adjusted analysis of the changes in behavioural and psychosocial variables before and during the COVID-19 pandemic according to the degree of social distancing adopted by the adolescents’ families. After adjusting for demographic and socioeconomic variables, it was observed that social distancing did not significantly impact any of the considered outcomes ($P > .05$).

## 5 | DISCUSSION

This study explored the psychosocial and behavioural changes related to oral health that occurred in adolescents due to the COVID-19 pandemic. The results showed that the frequency of toothbrushing, use of dental services, and self-perceived need for dental treatment decreased significantly during the pandemic. To our knowledge, even though previous studies have evaluated changes in certain behaviours of the population, this is the first study that followed adolescents and evaluated changes in behavioural and psychosocial issues related to oral health during a pandemic.

### TABLE 1 Sociodemographic and clinical characteristics at T1, and issues related to the COVID-19 pandemic at T2 among the group of followed and dropout adolescents (n = 290)

| Variables                                | Followed children (n = 207) | Dropout children (n = 83) | $P$-value* |
|------------------------------------------|-----------------------------|---------------------------|------------|
| Baseline (T1)                            |                             |                           |            |
| Age                                      |                             |                           |            |
| 10-12 y old                              | 100 (48.3)                  | 40 (48.2)                 | .98        |
| 13-15 y old                              | 107 (51.7)                  | 43 (51.8)                 |            |
| Sex                                      |                             |                           | .66        |
| Boys                                     | 108 (52.2)                  | 41 (49.4)                 |            |
| Girls                                    | 99 (47.8)                   | 42 (50.6)                 |            |
| Race                                      |                             |                           | .37        |
| White                                    | 103 (50.2)                  | 36 (44.4)                 |            |
| Non-white                                | 102 (49.8)                  | 45 (55.6)                 |            |
| Household income                         |                             |                           | .19        |
| $\leq$1 BMW                              | 50 (25.3)                   | 15 (34.9)                 |            |
| $>$1 BMW                                 | 148 (75.7)                  | 28 (65.1)                 |            |
| Maternal education                       |                             |                           | .61        |
| $\geq$8 y of formal education            | 145 (72.1)                  | 42 (68.9)                 |            |
| $<$8 y of formal education               | 56 (27.9)                   | 19 (31.1)                 |            |
| Untreated dental caries                  |                             |                           | .06        |
| Without                                  | 150 (72.5)                  | 51 (61.5)                 |            |
| With                                     | 57 (27.5)                   | 32 (38.5)                 |            |
| Follow-up (T2)                           |                             |                           |            |
| Loss of employment                       |                             |                           |            |
| No                                       | 140 (67.6)                  | -                         |            |
| Yes                                      | 54 (26.1)                   | -                         |            |
| Harmed                                   | 13 (6.3)                    | -                         |            |
| Social distancing                        |                             |                           |            |
| High                                     | 136 (65.7)                  | -                         |            |
| Middle                                   | 57 (27.5)                   | -                         |            |
| Low                                      | 14 (6.8)                    | -                         |            |

Abbreviation: BMW, Brazilian minimum wage—1 BMW is equivalent to US$197.00.

Unmatched values due to missing data.

*P-value of chi-square test.

Adolescents showed significant decrease in the frequency of toothbrushing and use of dental services during the pandemic. When the routine is changed, maintaining oral hygiene habits becomes a challenge. Previous findings suggest that, during the holidays, students tend to lose the good habits acquired during the school period, resulting in a worsening
in health-related activities, such as oral hygiene and physical activity. This is justified by the fact that individuals adopt fewer rigid behaviours on days that the daily routine is not followed. Although the social distancing recommended during the pandemic is not synonymous with holidays, it was associated with a change in the family routine. This change is capable to lead adolescents to adopt less healthier behaviours, as observed in this study.

Regarding the use of dental services, the demand for adolescent care decreased by approximately 50%, which is in line with the previous literature. The recommended social distance due to the pandemic has been shown to significantly impact the demand for dental services, as well as the degree of anxiety experienced by patients. It was observed that more anxious people were reluctant to leave their homes and reported that they would only go to the dentist in an emergency. Since it was determined that the clinical dental environment presents a high risk of contamination due to the production of aerosols during procedures, many patients and professionals have minimized contact with each other, resulting in a significant decrease in the availability of dental care.

Another explanation for the reduction in the use of dental services can be attributed to the significant decrease in dental procedures in children conducted in primary health care in the country, which contributed to a lower offer of dental care during the pandemic in Brazil.

Variables related to the psychosocial and emotional aspects of adolescents also showed changes during the follow-up period. Extreme situations, such as a pandemic, could change the psychosocial status of individuals, as was seen previously during the 2009 H1N1 influenza pandemic. Our results showed that adolescents’ self-perception regarding the need for dental treatment decreased significantly in the pandemic. It is recognized that socioeconomic and clinical factors are related to the individuals’ perception of their oral health. There are, however, no reports associating the perception of

### TABLE 2
Differences between sociodemographic, behavioural, and psychosocial variables before and during the COVID-19 pandemic, determined by multilevel-adjusted logistic regression model for repeated measures (n = 207)

| Outcome variables                     | Before the COVID-19 pandemic (T1) | During the COVID-19 pandemic (T2) |
|---------------------------------------|-----------------------------------|----------------------------------|
|                                       | n (%)                             | n (%)                            |
| Toothbrushing                         |                                   |                                  |
| <3 times a day                        | 108 (52.2)                        | 126 (60.9)                       |
| ≥3 times a day                        | 99 (47.8)                         | 81 (39.1)                        |
| OR (95% CI)a                          | 1.00 (reference)                  | 0.53 (0.31-0.92)*                |
| Sugar consumption                     |                                   |                                  |
| ≥1 time a day                         | 157 (75.8)                        | 147 (71.0)                       |
| <1 time a day                         | 50 (24.2)                         | 60 (29.0)                        |
| OR (95% CI)a                          | 1.00 (reference)                  | 1.30 (0.80-2.12)                 |
| Bruxism                               |                                   |                                  |
| Yes                                   | 25 (12.1)                         | 20 (9.7)                         |
| No                                    | 181 (87.9)                        | 187 (90.3)                       |
| OR (95% CI)a                          | 1.00 (reference)                  | 1.59 (0.72-3.51)                 |
| Sleep quality                         |                                   |                                  |
| Good                                  | 178 (86.0)                        | 185 (89.4)                       |
| Bad                                   | 29 (14.0)                         | 22 (10.6)                        |
| OR (95% CI)a                          | 1.00 (reference)                  | 0.60 (0.29-1.25)                 |
| Dental attendance                     |                                   |                                  |
| User                                  | 129 (62.6)                        | 32 (15.5)                        |
| Non-user                              | 77 (37.4)                         | 175 (84.5)                       |
| OR (95% CI)a                          | 1.00 (reference)                  | 0.06 (0.03-0.14)*                |
| Self-perceived dental treatment need  |                                   |                                  |
| Yes                                   | 120 (58.2)                        | 95 (45.9)                        |
| No                                    | 86 (41.8)                         | 112 (54.1)                       |
| OR (95% CI)a                          | 1.00 (reference)                  | 0.53 (0.33-0.84)*                |

Abbreviations: OR, odds ratio; CI, confidence interval.

*aAdjusted for sex, age, and household income.

*P < .05.
TABLE 3 Changes in behavioural and psychosocial variables before and during the COVID-19 pandemic according to the degree of social distancing, determined by multilevel-adjusted logistic regression model for repeated measures (n = 207)

| Outcomes variables | Social distancing |  |
|-------------------|-------------------|---|
|                  | High      | Middle/Low |
| Toothbrushing     | n (%)     | n (%)    |
| < 3 times a day   | 76 (55.9) | 50 (70.4) |
| ≥ 3 times a day   | 60 (44.1) | 21 (29.6) |
| OR (95% CI)<sup>a</sup> | 1.00 (reference) | 0.54 (0.29-1.03) |
| Sugar consumption |          |          |
| ≥ 1 time a day    | 97 (71.3) | 50 (70.4) |
| < 1 time a day    | 39 (28.7) | 21 (29.6) |
| OR (95% CI)<sup>a</sup> | 1.00 (reference) | 1.04 (0.54-1.98) |
| Bruxism           |          |          |
| Yes               | 13 (9.6)  | 7 (9.9)   |
| No                | 123 (90.4)| 64 (90.1) |
| OR (95% CI)<sup>a</sup> | 1.00 (reference) | 0.95 (0.35-2.53) |
| Sleep quality     |          |          |
| Good              | 123 (90.4)| 62 (87.3) |
| Bad               | 13 (9.6)  | 9 (12.7)  |
| OR (95% CI)<sup>a</sup> | 1.00 (reference) | 1.40 (0.55-3.55) |
| Dental attendance |          |          |
| User              | 24 (17.7) | 8 (11.3)  |
| Non-user          | 112 (82.3)| 63 (88.7) |
| OR (95% CI)<sup>a</sup> | 1.00 (reference) | 0.62 (0.26-1.49) |
| Self-perceived dental treatment need | | |
| Yes               | 77 (56.6) | 35 (49.3) |
| No                | 59 (43.4) | 36 (50.7) |
| OR (95% CI)<sup>a</sup> | 1.00 (reference) | 1.32 (0.28-6.21) |

Abbreviations: OR, odds ratio; CI, confidence interval.
<sup>a</sup>Adjusted for sex, age, and household income.

oral health with the pandemic until then. A probable justification is that adolescents could minimize the perception of their oral problems during a period considered atypical and frightening. In this sense, the extent of their problems would become small in view of the vision of hospital admissions and deaths due to COVID-19 worldwide.

Bruxism, quality of sleep, and sugar consumption also showed changes, but they were not significant. The proportion of adolescents who reported to grind their teeth at night decreased, whereas the frequency of participants who reported a good quality of sleep increased. Probably, these conditions linked to the emotional aspects of the participants were not significant due to their age group, since young adolescents did not have as many concerns about the consequences of the current context as older individuals, who developed symptoms of depression, anxiety, hypochondria, and insomnia in this period. Another explanation is the use of self-report to measure bruxism, which, despite being commonly measured in this way, was considered as ‘possible bruxism’ in the latest international consensus.

In addition, the frequency of sugar consumption showed improvement reduction during the outbreak, even if not significant. The lack of significance can be linked to the way the information was measured. Most adolescents reported that they continued to consume sugar more than once a day, which would not change so much during the pandemic. The observed improvement can, however, be explained by confinement, in which families would have more time to cook at home and monitor their children’s food, contributing to an improvement in eating habits.

This study has some limitations. Due to the interruption of data collection from the 4th re-evaluation, only part of the total sample was assessed. This issue can compromise the external validity of the results. In addition, it is possible that a potential bias was formed due to the amount of missing data and lack of follow-up, in addition to the fact that the power of the study was less than 80%. As there are, however, no similar data to date, our results led to hypotheses that should be confirmed in studies with larger and more representative samples and with greater power in the future. Also, the sensitivity analysis showed no difference between the participants assessed at T1 (290) and those assessed at T2 (207). The use of self-reported measures, which requires the patient’s memory and collaboration, can be considered another limitation. Nonetheless, this issue is inherent in studies that involve the use of questions directed to participants. Another issue refers to the fact that the questions were asked through face-to-face interviews at T1 and by telephone during T2. Previous results, however, have shown that there is no difference in measuring aspects related to oral health in person or by telephone.

Despite these limitations, as far as we know, this is the first longitudinal study that evaluated changes in behavioural and psychosocial issues in adolescents during the COVID-19 pandemic. Since the data were collected until the moment of adopting social distancing, the results have great comparative value, precisely because they belong to an age group of great behavioural instability in a period without precedent in contemporary history. Our findings do not highlight the beneficial or harmful effects of the pandemic, but describe the impact of this scenario on issues related to adolescence and oral health. This information is useful for planning public health strategies that will be applicable at the end of the COVID-19 pandemic. In addition, future studies should consider an analysis of mixed methods to understand the qualitative aspects about the behaviours adopted during this pandemic period.

In conclusion, our results suggest that behavioural and psychosocial factors showed significant changes due to the
COVID-19 pandemic in adolescents. There was a significant decrease in the frequency of toothbrushing, dental attendance, and self-perception of dental treatment need. No significant impacts were, however, observed in the presence of bruxism, sleep quality, and sugar consumption. Furthermore, the degree of social distancing did not influence these behavioural and psychosocial factors.

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CONFLICT OF INTEREST
The authors declare no conflict of interest.

AUTHORS’ CONTRIBUTION
Ms Brondani conceptualized and designed the study, collected data, performed the statistical analyses, drafted the initial manuscript, and revised the manuscript. Ms Knorst and Dr Tomazoni conceptualized and designed the study, collected data, performed the statistical analyses, and revised the manuscript. DDS Costa, DDS Vargas, and DDS Noronha collected data and revised the manuscript. Dr Mendes and Dr Ardenghi designed the study, coordinated and supervised the data collection, and critically reviewed the manuscript. All authors have approved the final manuscript as presented and agreed to be accountable for all aspects of the paper.

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