POOR SLEEP QUALITY AND ORAL HEALTH AMONG OLDER BRAZILIAN ADULTS

Oral health and sleep quality

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ABSTRACT

Objectives: This study evaluate the association between normative and subjective oral health measures and poor self-reported sleep quality among community-dwelling older adults in Brazil. **Methods:** This was a cross-sectional study with data from the Brazilian Longitudinal Study of Aging. The dependent variable was the poor sleep quality. Independent variables of interest included: number of teeth and self-reported impact of oral health on eating/chewing and on maintaining emotional stability. **Results:** Poor sleep quality was reported by 17.8 (95% CI 16.6; 19.2) of the participants, 29% of the participants were edentulous and 30% had 20 or more teeth. Impacts or oral health on eating and maintaining emotional stability were found among 33.3% and 20% of the older adults, respectively. After adjusting for all oral health measures and covariates the magnitude of the associations between the number of teeth and sleep quality was attenuated. Sleep quality was related to oral health impacts on eating [OR 1.19 (95% CI 1.00; 1.41)] and on emotional stability [OR 1.51 (95% CI 1.21; 1.87)]. **Conclusions:** This study found an association between oral health and sleep quality emphasizing the importance of oral health to general health.

Keywords: Oral Health, sleep, tooth loss, edentulous, cross sectional studies, epidemiology

INTRODUCTION

The increasing trend in sleep disorders, a variety of conditions that affect sleep physiology, quality, and/or duration, is an emerging public health issue with significant health and economic burden at both the individual and societal levels (Chattu et al., 2018; Hafner, Stepanek, Taylor, Troxel, & van Stolk, 2017; Ravan, Bengtsson, Lissner, Lapidus, & Björkelund, 2010; Stranges, Tigbe, Gómez-Olivé, Thorogood, & Kandala, 2012). Sleep complaints, related to poor sleep induction, maintenance and quality, range from 9.1% (China) to 37.7% (India), in low and middle-income countries (Mazzotti, Guindalini, Sosa, Ferri, & Tufik, 2012) and from 23% (Japan) to 56% (USA) in high-income countries (Léger, Poursain, Neubauer, & Uchiyama, 2008). Poor sleep quality and deprivation, (*i.e.* less than 7 hours), might influence and be affected by diabetes, hypertension, cardiovascular disease (St-Onge et al., 2016) and poor mental health (Alvaro, Roberts, & Harris, 2013; Stickley, Leinsalu, DeVylder, Inoue, & Koyanagi, 2019). The bidirectional relationship between sleep problems and these chronic conditions increases the risk of morbidity and mortality, especially among older adults, as these conditions increase with age (Chang, Skirbekk, Tyrovolas, Kassebaum, & Dieleman, 2019).

More recently, the consistent association between oral health and general health conditions (Kazemi et al., 2011; Morita et al., 2012; Tsakos et al., 2010; Yamamoto et al., 2017) (e.g. diabetes, hypertension, mental health, poor diet) which are well known to be related to sleep disorders and sleep quality (Alvaro et al., 2013; Liu et al., 2013; Stickley et al., 2019; St-Onge et al., 2016), raised the attention to the possible effect of poor oral health on sleep (Al-Jewair, Al-Jasser, & Almas, 2015; Al-Zahrani, Alhassani, & Zawawi, 2020; Beydoun et al., 2020; Carra et al., 2017; Sanders, Akinkugbe, Slade, & Essick, 2016). These studies investigated the impact of tooth loss and periodontal disease on obstructive sleep apnea (OSA) and sleep quality (Al-Jewair et al., 2015, p.; Al-Zahrani et al., 2020, p.; Azuma et al., 2019; Carra et al., 2017; Koyama et al., 2018; Sanders et al., 2016). In edentulous individuals, OSA could be caused by the loss of the occlusion vertical dimension resulting in a forward position of the mandible leading to tongue root retraction which might compromise the patency of the upper airway (Sanders et al., 2016). Some findings suggest a 2% increase in the prevalence of high-risk for OSA for each additional tooth loss among adults 25 to 64 years. The prevalence of high-risk for OSA

was 25 % and 36% greater among individuals with 5–8 missing teeth and 9–31 missing teeth, respectively than in those with 0-4 missing teeth (Sanders et al., 2016). A recent study found a 4% increase in the odds of having short sleep for each posterior tooth loss (Al-Zahrani et al., 2020). Short sleep duration is also more prevalent among individuals with less than 20 teeth (Al-Zahrani et al., 2020; Koyama et al., 2018). Another possible link between oral health and sleep problems could be attributed to the fact that the loss of natural teeth might lead to emotional stress and psychological problems (Kim et al., 2017). The pain and discomfort associated with TMD could also harm sleep quality and duration (Natu, Yap, Su, Irfan Ali, & Ansari, 2018).

Although least investigated, the association between dental conditions and subjective sleep quality have also been observed (Azuma et al., 2019; Emami, Lavigne, de Grandmont, Rompré, & Feine, 2012). Overall subjective quality of sleep measures, although having a low correlation with objective evaluations (O'Donnell et al., 2009) are important for the evaluation of further screening and to assess the changes in sleep quality due to sleep or other medical disorders (O'Donnell et al., 2009). Unlike objective measures, which are more directed towards evaluating morbidity, self-reported health measures assess the perceptions and judgments regarding the individuals' health based on both individual and social beliefs and concepts (Kaplan & Baron-Epel, 2003). However, the relationship between self-reported sleep quality and oral health measures related to oral function and its perceived impact on daily activities has not been explored further and remains inconclusive. This study aimed to evaluate the association between normative (i.e. number of teeth) and subjective oral health measures (i.*e.* self-perceived impact of oral health on eating/chewing and emotional stability) and poor self-reported sleep quality among community-dwelling older adults in Brazil.

METHODS

This study used cross-sectional data from the baseline of the Brazilian Longitudinal Study of Aging (ELSI-Brazil). The baseline was conducted between 2015 and 2016 with a representative sample of community-dwelling older adults 50 years and older (9,412) living across the five Brazilian macro-regions. ELSI-Brazil is the first large-scale longitudinal study of older adults in Brazil and aims to evaluate the aging process by investigating its health, psychosocial and economic determinants, as well as the societal

consequences of aging. All the sampling procedure and study details were previously published. (Lima-Costa et al., 2018) Data were collected at the participant's home through face-to-face interviews, conducted with a structured questionnaire.

ELSI-Brazil was approved by the Research Ethics Committee of FIOCRUZ, Minas Gerais (CAAE 34649814.3.0000.5091). Participants signed separate informed consent forms for the interviews, physical measurements, laboratory assays, and authorized sample storages and access to administrative records.

In the present study, all participants aged 50 years and older (n= 8,654) with complete information for all variables of interest were included in the analyses. The dependent variable was the self-reported sleep quality with the following five possible answers: very good, good, regular, poor very, and poor. These categories were dichotomized as poor (poor very and poor) and good sleep quality (very good, good, regular). Oral health measures were the independent variables of interest and included the self-reported number of teeth (edentulous, 1-9 teeth, 10-19 teeth, 20+ teeth)(WHO, 2013) and self-reported impact of oral health on eating/chewing and on maintaining emotional stability. Both conditions were measured according to the instrument Oral Health Impact on Daily Activities (Adulyanon & Sheiham, 1997). The impacts were recorded as present or not. Other covariates included age (years), sex, years of schooling, physical activity (yes, no), obesity (yes, no), multimorbidity (yes, no), depression (yes, no), limitation on basic activities of daily living (BADL) (yes, no). Individuals reporting at least 150 minutes/week of moderate or 75 minutes/week of vigorous physical activities were considered active (WHO 2010). Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ). (Fan M, Lyu J, He P, & The IPAQ Group, 2005). Obesity was defined as a Body Mass Index $\geq$30 kg/m^2 (WHO, 1995). Older adults with two or more self-reported doctor-diagnosed chronic diseases were classified as having multimorbidity. (WHO, 2016) The chronic diseases were evaluated according to the self-reported history of medical diagnosis of the following diseases: hypertension, diabetes, heart disease, chronic lung disease, stroke, arthritis, asthma, cancer, and kidney disease. Limitation in BADL was based on the report of any difficulty in performing one or more of the six activities: bathing, dressing, feeding, using the toilet, getting out of bed, and crossing a room on the same floor. (Katz, Ford, Moskowitz, Jackson, & Jaffe, 1963)

Statistical analysis

Descriptive statistics (percentages, and 95% confidence intervals [CI]) were used to describe the characteristics of the sample in the study. Associations between sleep quality and the covariates were tested by chi-square analysis with Rao-Scott correction for complex samples. The association between poor sleep quality and oral health factors adjusted by covariates was evaluated using logistic regression models and the results expressed as odds ratios and 95% confidence intervals (95% CI). The results were presented according to three models: unadjusted analysis (Model 1), adjusted analysis including all oral health variables (Model 2) and the fully adjusted model (Model 3) that included the variables in Model 2 adjusted for sex, age, schooling, multimorbidity, depression, BADL limitation. All the analyses were performed with the Stata SE 15.0 program (Stata Corp., College Station, United States) and considered the complex design of the sample.

RESULTS

Most of the individuals were female (54%), with a mean age of 62.3 years and had 8 or more years of schooling. Regarding oral health indicators, 29% were edentulous and 30% had 20 or more teeth. Impacts or oral health on eating and maintaining emotional stability were found among 33.3% and 20% of the older adults, respectively. Poor sleep quality was reported by 17.8 (95% CI 16.6; 19.2) of the participants. The proportion of self-reported poor sleep quality was associated with all the covariates, except for physical activity and obesity. The proportion of poor sleep quality was higher among those with oral health impacts on eating and emotional stability. The lower proportion of poor sleep quality was observed among those with 20 or more teeth (Table 1).

According to the unadjusted analyses, edentulous individuals had 1.38 higher chance of poor sleep quality than those with 20 or more teeth. Older adults reporting impacts of oral health on eating and emotional stability had 1.72 and 2.21 higher chances of poor sleep quality respectively (Table 2). The magnitude of the associations was attenuated when all oral health factors were included in the analyses (Model 2) and with further adjustment by covariates (Model 3) (Table 2). The fully adjusted model (Model 3) suggests that individuals with oral health impacts on eating had a 19% [OR 1.19 (95% CI 1.00; 1.41)] higher chance of poor sleep quality. Among those with reporting impacts on emotional

stability, the chances were 51% [1.51 (95% CI 1.21; 1.87)] higher than among individuals without impacts. The association between number of teeth and sleep quality was attenuated in the fully adjusted model (Model 3), the findings suggested about 9% higher chance of poor sleep quality among edentulous than individuals with 20+ teeth, with a point estimate of 1.03 (CI 95% 0.83; 1.27) among older adults with 1-9 teeth and 1.03 (CI 95% 0.84; 1.27) among the ones with 10-19 teeth (Table 2).

DISCUSSION

This study showed that almost one-fifth of older Brazilian adults reported poor sleep quality. The main finding was the association between poor sleep quality and the self-perceived impact of oral health on both chewing ability and maintaining emotional stability, independent of the adjustment of a comprehensive number of covariates.

Previous studies investigating this subject were conducted among adults and mostly evaluated sleep quality, as measured by the self-reported number of sleep hours, and used the number of teeth as the oral health measure (Al-Zahrani et al., 2020; Carra et al., 2017; Koyama et al., 2018). Their findings showed higher chances of short sleep duration among individuals with less than 20 teeth. (Al-Zahrani et al., 2020; Carra et al., 2017; Koyama et al., 2018) Like the present study, Azuma et al. (Azuma et al., 2019) observed that adults reporting poor chewing ability had a higher chance of poor sleep quality. Although these authors adjusted by other factors known to be related to sleep quality the concomitant association with the number of teeth was not evaluated. Unadjusted analyses (Emami et al., 2012) also suggested that higher self-reported negative impacts of oral health on quality of life were related to higher scores of poor sleep quality among edentulous ambulatory older adults aged 65 years or older.

The cross-sectional design of the present study does not allow the identification of potential pathways by which poor oral health might impact sleep quality, but the findings suggest an indirect effect of the number of teeth on sleep quality, mediated by chewing ability. The self-perceived impact of oral health on chewing might reflect a more accurate masticatory function than the number of teeth (Maekawa et al., 2020). Accordingly, the negative impact of the number of teeth and its distribution on eating and/or chewing ability could affect sleep quality through its effect on diet and nutrition (Kazemi et al.,

2011), factors that have been associated with sleep quality (Zhao, Tuo, Wang, & Zhao, 2020). Another explanation for the observed relationship might rely on the association between the self-reported negative impact of oral health on chewing ability and emotional stability on stress and depression (Kim et al., 2017; Yamamoto et al., 2017) as both mental health disorders lead to poor sleep quality (Alvaro et al., 2013; Stickley et al., 2019). Dental status has been associated with home boundness (Koyama et al., 2016) and social participation (Rodrigues, Oliveira, Vargas, Moreira, & e Ferreira, 2012) which increases the likelihood of isolation and loneliness, stress, and depression. Other studies suggest that the anatomical and functional changes associated with edentulism may predispose patients to obstructive sleep apnea which in turn affects sleep quality (Sanders et al., 2016). Finally, considering that periodontal disease is associated with diabetes and hypertension (Morita et al., 2012; Tsakos et al., 2010) and both conditions affect sleep quality (St-Onge et al., 2016)), the mediating effect of chronic disease in the association between periodontal disease and sleep quality might be a possible pathway that should be explored in future studies.

The use of a large representative sample of older adults in Brazil is one of the strengths of the present study. Besides, the analyses were adjusted for well-known confounders to both sleep quality and oral health. The use of a self-reported number of teeth is a limitation, although it has been considered a valid measure when compared to objective clinical evaluations (Sekundo, Stock, Jürges, & Listl, 2019). As previously mentioned, the cross-sectional design does not allow the investigation of the causal relationship between oral health and sleep quality. Therefore, the reverse causality cannot be ruled out even though tooth loss in this cohort is expected to have occurred at younger ages.

In conclusion, this study found an association between oral health and sleep quality underscoring the importance of oral health to general health and the need for a multidisciplinary approach to tackle both oral health and sleep disorders as a bi-directional relationship is expected. These findings also highlight the need for longitudinal studies to address the pathways linking these conditions as both conditions are highly prevalent among older adults and are essential to the quality of life.

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Table 1 – Characteristics of the study population for the total sample and by sleep quality

	Total	Poor sleep quality
	% (95% CI)	% (95% CI)
Sex		
Male	46.3 (43.2; 49.3)	13.2 (11.8; 14.7)
Female	53.7 (50.7; 56.8)	21.8 (20.3; 23.5)
Age (mean)	62.3 (61.5; 63.2)	62.1 (61.1; 63.1)
Schooling		
0-3 years	31.8 (28.4; 35.5)	21.7 (19.6; 24.0)
4-7 years	31.7 (29.2; 34.3)	16.6 (14.7; 18.6)
8-11 years	28.1 (25.5; 30.8)	15.7 (14.1; 17.5)
12+ years	8.4 (7.3; 9.7)	15.2 (12.2; 18.7)
Physical activity		
No	56.3 (53.4; 59.2)	18.6 (17.2; 20.1)
Yes	43.7 (40.8; 46.6)	16.8 (15.1; 18.7)
Obesity		
No	70.5 (69.1; 71.9)	17.7 (16.3; 19.1)
Yes	29.5 (28.1; 30.9)	18.2 (16.1; 20.5)
Multimorbidity		
No	64.2 (62.3; 66.0)	14.3 (13.0; 15.7)
Yes	35.8 (34.0; 37.7)	24.2 (22.3; 26.2)
Depression		
No	81.8 (79.9; 83.6)	14.2 (12.9; 15.6)
Yes	18.2 (16.4; 20.1)	34.2 (31.5; 36.9)
Limitation BADL		
No	85.1 (83.7; 86.5)	15.8 (14.5; 17.1)
Yes	14.9 (13.5; 16.3)	29.8 (26.9; 32.9)
# of teeth		
Edentulous	29.1 (26.7; 31.6)	19.9 (17.8; 22.1)
1-9 teeth	23.0 (21.1; 25.0)	18.4 (16.2; 20.8)
10-19 teeth	17.9 (16.7; 19.1)	18.2 (15.8; 20.9)
20+ teeth	30.0 (27.7; 32.4)	15.2 (13.4; 17.2)
Oral health impact on eating/chewing		
No	66.7 (64.9; 68.5)	15.1 (13.7; 16.6)
Yes	33.3 (31.5; 35.1)	23.4 (21.4; 25.6)
Oral health impact on emotional stability		
No	80.0 (78.7; 81.2)	15.2 (13.8; 16.7)
Yes	20.0 (18.8; 21.3)	28.4 (25.8; 31.2)

Table 2 – Unadjusted and adjusted analyses of factors associated with poor sleep quality

	Model 1[a]	**Model 2[b]**	**Model 3[c]**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**
# of teeth (20+ teeth)			
Edentulous	1.38 (1.14; 1.68)	1.36 (1.12; 1.66)	1.09 (0.88; 1.36)
1-9 teeth	1.26 (1.03; 1.54)	1.18 (0.96; 1.44)	1.03 (0.83; 1.27)
10-19 teeth	1.24 (1.02; 1.52)	1.13 (0.92; 1.40)	1.03 (0.84; 1.27)
Oral health impact on eating/chewing (no)			
Yes	1.72 (1.47; 2.01)	1.36 (1.15; 1.60)	1.19 (1.00; 1.41)
Oral health impact on emotional stability (no)			
Yes	2.21 (1.85; 2.65)	1.87 (1.53; 2.27)	1.51 (1.21; 1.87)

[a]Model 1 – Unadjusted

[b]Model 2 – Adjusted by all oral health variables

[c]Model 3 – Model 2 adjusted for sex, age, schooling, multimorbidity, depression, BADL limitation