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Association between waking-state oral parafunctional behaviors and bio-psychosocial characteristics

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Abstract

Background—The term “oral parafunctional behaviors” encompasses behaviors that are different from those required for, or associated with, physiological functional needs such as mastication, communication, swallowing, or breathing. Previous reports have associated waking-state oral parafunctional behaviors with biopsychosocial characteristics, such as, female gender, presence of psychological symptoms, intensity of pain, and pain-related Temporomandibular Disorders (TMD) diagnosis. However, the findings have been inconsistent, possibly due to methodological limitations and differences.

Objectives—In the present investigation, we aim to determine if any association is present between waking-state oral parafunctional behaviors and biopsychosocial characteristics.

Methods—All participants were investigated using a set of standardized and validated self-reporting questionnaires and diagnostic criteria for temporomandibular disorders (DC/TMD) examination protocol for clinical characterization.

Results and Conclusion—Univariate analysis found that self-reported waking-state oral parafunctional behaviors were statistically significantly associated with presence of anxiety, depression, and physical symptoms, pain intensity, and TMD diagnosis. However, forward model multiple linear regression analysis indicated that only self-reported presence of physical and depression symptoms could explain statistically significant portions of the variance in self-reported waking-state oral parafunctional behaviors.

Keywords

Temporomandibular Joint Disorders; Pain; Masticatory Muscles; Bruxism; Behavioral Symptoms; Females

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Background

The term "oral parafunctional behaviors" encompasses behaviors that are different from those required for, or associated with, physiological functional needs such as mastication, communication, swallowing, or breathing. Such behaviors can be sub-divided into sleep-related or waking-state oral parafunctional behaviors. Sleep-related oral parafunction is primarily bruxism (phasic, tonic, or both) (1, 2), whereas waking-state oral parafunction is relatively more diverse, including a variety of behaviors such as clenching, nail biting, excursive positioning, holding the jaw rigid and gum-chewing (1–3).

Previous reports have associated waking-state oral parafunctional behaviors with biopsychosocial characteristics, such as, female gender (4–6), presence of psychological symptoms (7), intensity of pain, and pain-related Temporomandibular Disorders (TMD) diagnosis (8–10). However, the findings have been inconsistent, possibly due to methodological problems associated with the characterization of oral parafunctional behaviors. That is, most past studies have used non-validated and non-standardized questionnaires and/or clinical oral examinations for the assessment of oral parafunctional behaviors and the focus has been restricted to clenching and bruxism (1, 7). In addition, the assessment of conditions associated with oral parafunctional behaviors, such as psychosocial symptoms, or pain-related TMD diagnosis have been inadequate (7, 8). Several different criteria have been used for the evaluation of psychological characteristics and symptoms, most of which were not validated. Moreover, there has been incorrect use of psychological terms such as "anxiety", which could indicate a temporary and non-pathological psychic state or a more complex psychiatric disorder (7). Similarly, clinical assessment of pain-related TMD diagnosis has been carried out by non-calibrated examiners using non-standardized and non-validated protocols (8).

The purpose of this investigation was to determine if there were associations between waking-state oral parafunctional behaviors and biopsychosocial characteristics, such as, gender, presence of psychological symptoms, intensity of pain, and pain-related TMD diagnosis. A set of standardized and validated self-reporting questionnaires and diagnostic criteria for temporomandibular disorders (DC/TMD) examination protocol were used for clinical characterization.

Methods

Study Participants

Recruitment—All participants were recruited at the University at Buffalo, School of Dental Medicine. Participants were recruited using community advertisements. Pamphlets asking for participants with "TMJ problems" were distributed in the dental school, and among local providers. Similar advertisement was also placed in the local newspapers.

Inclusion and exclusion criteria—Inclusion and exclusion criteria were same as the parent study (11–13) . To reiterate, adult males and females were included. Individuals who were pregnant were excluded to prevent radiation exposure of the fetus from the cone-beam computed tomography (CBCT). Adults diagnosed with systemic musculoskeletal or rheumatological disease (e.g. fibromyalgia, muscular atrophy) were excluded to eliminate the effects of co-morbidities on trigeminal afferent input to the central nervous system. Similarly, adults diagnosed with localized TMJ degenerative joint disease (using CBCT) were excluded to allow calculation of TMJ cartilage energy density, which was required for the hypothesis testing in the parent study. In addition, adults who were unable to read or follow tasks associated with filling out self-report questionnaires were excluded.

This study was approved by the Health Sciences Institutional Review Board (HSIRB) of the State University of New York at Buffalo and informed consent was obtained from each participant.

Appointments for study—In the initial clinic visit, an examiner explained the study, obtained informed consent, reviewed the participant's medical history, and performed a screening examination. In the following visits, a calibrated examiner (SNK or YG) performed the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) examination (14).

Participants filled out questionnaires pertaining to the oral behaviors checklist, graded chronic pain scale for 6 month (GCPS-6), generalized anxiety disorders 7 (GAD-7), physical health questionnaire 9 (PHQ-9), and physical health questionnaire 15 (PHQ-15). In addition, participants had magnetic resonance (MR) and CBCT imaging of their temporomandibular joints.

Characterization of the participants

Self-assessments of oral parafunctional behaviors—The Oral Behavioral Checklist (OBC) is a self-reporting 21-item questionnaire. It has been shown that this instrument have excellent reliability, face and criterion-oriented validity (1, 2). It assesses the type and frequency of various oral parafunctional behaviors that individuals believe they perform. For the purpose of this investigation, the first two questions on the OBC, which assessed the sleeping-state parafunctional activity, were excluded from the analysis. Possible responses to each item on the questionnaire are: "none of the time", "a little of the time", "some of the time", "most of the time", and "all of the time", which are equivalent to scores of 0, 1, 2, 3, and 4, respectively, yielding a maximum score of 76. The mean OBC score was also calculated as a summary index of each participant's self-assessment of the severity of her/his waking-state oral parafunctional behaviors.

Assessment for presence of psychological symptoms—Each participant filled out self-reporting, reliable, and validated questionnaires GAD-7 (15), PHQ-9 (16), and PHQ-15 (17), for the assessment of the severity of anxiety, depression, and physical symptoms, respectively. Based on the responses and respective guidelines for the questionnaires (15–17), participants who were categorized as "Normal" or as having "Minimal" symptoms were combined into a single "Normal" group. Subjects characterized as Mild, Moderate, Moderate-Severe, and Severe were combined into a single "Presence of symptoms" group.

Assessment of pain intensity—The Graded Chronic Pain Scale for 6 months (GCPS-6) was used for assessment of the intensity of pain. The GCPS-6 has been reported to be a valid instrument that can reliably measure pain intensity using the Characteristic Pain Intensity scale (CPI). The CPI scores range from 0 to 100, where 0 is indicative of “no pain”, scores of 1 – 50 indicate “low intensity pain” and scores of 51 – 100 indicate “high intensity pain” (18).

Assessment of TMD—Participants had MR imaging of their temporomandibular joints and a clinical examination based on the DC/TMD criteria (14). Magnetic resonance imaging of TMJs was taken to characterize the position of the TMJ disc. According to the DCTMD guidelines, the sensitivity of clinical examination alone to accurately diagnose disc position is poor (0.34) (14). A calibrated and reliable radiologist interpreted the MR images for TMJ disc position (19). The radiologist was unaware of the participant’s clinical diagnosis or findings. Clinical examination was performed by calibrated and reliable examiners. Examiners participated yearly in calibration and reliability exercises, and had acceptable levels of reliability ranging from Kappa ≥ 0.90 – 1. Based on MR imaging and clinical examination findings, subjects were classified as having either pain-related TMD (myalgia, myofascial pain, and arthralgia), non-painful TMD (bilateral disk displacement with reduction) or as normal.

Statistics

If more than 5 of the 19 questions of the OBC were left blank, no mean OBC sum score for the participant was calculated. Similarly, for each of the GAD-7, PHQ-9, PHQ-15, and GCPS-6, if 2 or more questions were left blank, no total score was calculated.

A multi-stage analytic approach was used to assess the associations between dependent and independent variables. In the first step, univariate associations were determined. The associations between mean OBC score and female gender and presence of psychological symptoms were determined using independent t-tests. In addition, association between mean OBC score and pain intensity and TMD diagnosis were evaluated using analysis of variance (ANOVA). Where it was appropriate, Tukey HSD post hoc tests were also conducted to determine subgroup differences. Additionally, a multiple linear regression analysis was conducted using a forward model approach to evaluate which of the independent biopsychosocial variables could better explain mean OBC score outcomes.

Results

There were 94 participants, 59.6 % females (n=56) with a mean age of 34.2 ± 12.1 years. No significant difference in age was observed between males and females (independent t-test, p ≥ .05). The percentages of participants with anxiety, depression, and physical symptoms were 45.2 %, 35.1 %, and 58.5 %, respectively (Table 1). While the breakdown of participants with no pain, low, and high pain intensities was 38.3 %, 42.6 %, and 19.1 %, respectively; and with normal, non-painful, and pain-related TMD diagnoses was 44.7 %, 17 %, and 38.3 %, respectively (Table 1).

Mean OBC score was found to be statistically significantly associated with presence of anxiety, depression, and physical symptoms, pain intensity, and TMD diagnosis ($p \leq 0.002$, Table 1) but not with gender ($p = 0.965$). From the subgroup analysis, it was determined that individuals with high pain intensity had a statistically significantly higher mean OBC score (1.27) than those with no pain (0.85) or low pain intensity (0.98) ($p = 0.002$, Table 1). Similarly, individuals with pain-related TMD diagnosis had a statistically significantly higher mean OBC score (1.18) than normal (0.91) or non-painful (0.76) TMD diagnoses groups ($p \leq 0.001$, Table 1). Furthermore, forward model multiple linear regression analysis, indicated two models that could account for statistically significant portions of the variance of mean OBC scores (table 2). The first model included presence of physical symptoms alone, while the second model included presence of physical and depression symptoms. The variances of the two models were 21.5 % and 25.5 %, respectively.

Discussion

The purpose of this study was to determine associations between self-reported waking-state oral parafunctional behaviors and biopsychosocial characteristics. Statistically significant associations were found between self-reported waking-state oral parafunctional behaviors and self-reported anxiety, depression, and physical symptoms, high intensity pain, and pain-related TMD diagnosis. However, when analyzed using a forward model multiple linear regression analysis, only self-reported presence of depression and physical symptoms were found to be statistically significantly associated with self-reported waking-state oral parafunctional behaviors. This modeling approach showed that the presence of physical symptoms could account for 22% of the variability in OBC, whereas presence of physical symptoms plus symptoms of depression could account for 26% of the variability in OBC.

Multiple investigations have reported similar causal relationships between oral parafunctional behaviors and presence of psychological symptoms (7, 20). However, the magnitudes of these associations have been inconsistent. This may be attributed to the variety of methodological techniques employed in the assessment and characterization of waking-state oral parafunctional behaviors and psychological symptoms. Furthermore, some investigators have used non-standardized methodological approaches, such as presence of pain or tooth wear for evaluation of oral parafunctional behaviors. Such approaches have low specificity and may influence the results in favor of a false positive association (7, 8, 21).

A proposed pathophysiological mechanism for the association between oral parafunctional behaviors and psychological symptoms is the role of fear-avoidance behavior. It has been suggested that psychological distress may result in fear-avoidance behavior, which may induce oral parafunctional behaviors such as holding masticatory muscles taut or rigid (22). Another proposed pathophysiological explanation for the association is a disorder of the dopaminergic system. Results of animal-based investigative models have suggested that presence of psychological symptoms result in activation of dopaminergic pathways, which may result in oral parafunctional behaviors (7, 23, 24). In particular, ability of psychological symptoms to induce parafunction depends on dopaminergic pathways activation, which in turn depends upon the type and duration of the psychological symptoms (7). In a recent investigation, Bayar et al. (25) reported statistically significant differences in the pathophysiological profiles of individuals with different types of oral parafunctional behaviors. However, these results need to be interpreted with caution because they were limited to the extreme parafunctional behaviors of teeth clenching and grinding. It remains to be determined if there are associations amongst individual characteristic waking-state oral parafunctional behaviors and differences in biopsychosocial characteristics.

From the univariate analysis, self-reported waking-state oral parafunctional behaviors were found to be significantly associated with high intensity pain, and presence of pain-related TMD. However, neither of these pain-related variables were found to be statistically significant in the forward-model multifactor linear regression analysis. Investigations of the association of oral parafunctional behaviors and pain-related TMD diagnosis have not been consistent (9, 10, 26). This may be due to poor methodological techniques employed in characterization and assessment of oral parafunctional behaviors and pain-related TMD. It has been hypothesized that oral parafunctional behaviors may cause "microtrauma" and activation of nociceptive pathways in the masticatory system, which may lead to development of pain-related TMD. However, this hypothesis has found limited support in the literature (27). In contrast, some investigators have suggested that oral parafunctional activity may be reduced in presence of pain. They speculate that in the presence of pain there is a general decline in jaw motor activity to protect the masticatory system from further trauma (pain-adaptation model) (3, 28). Recently another hypothesis has been proposed. It suggests that oral parafunctional behaviors may have a bidirectional relationship with the pain-related TMD and that it may be both the cause and the consequence of the pain associated with TMD (9, 10).

No association was found between gender and self-reported waking-state oral parafunctional behaviors. This finding contradicted previously reported significant associations between oral parafunctional behaviors and female gender (4–6). However, circumspection of these previously reported results reveals that these investigations have focused only on adolescents [4], children [5], or clinical cases [6]. These study populations have notably different physiological and psychological characteristics compared to adults or community cases. In addition, some investigators have used presence of pain, or clinical examination alone, as an indicator of oral parafunction behaviors, which may act as potential confounds and bias.

A possible limitation in the present investigation was the use of the OBC for assessment of waking-state oral parafunctional behaviors. The OBC has been shown to be a reliable tool for the assessment of various classes of oral behaviors, which result in significantly different use of muscles, as demonstrated by distinct electromyographic (EMG) patterns when recorded in laboratory settings. However, the clinical validity of the OBC has not yet been confirmed in the natural environments of participants. Hence, in future, ambulatory EMG recordings during the awake and sleep periods should be compared with subjects' self-reported oral parafunctional behavior scores. This would ideally require analytical pattern recognition methods to process the ambulatory EMG data so that classes of oral behaviors can be identified and characterized for magnitudes and durations of jaw muscle activations. Nonetheless, until future improvements are realized, currently the OBC is the most acceptable self-reporting tool available for comprehensive assessment of waking-state oral parafunctional behaviors.

In conclusion, self-reported presence of physical and depression symptoms are associated with self-reported waking-state oral parafunctional behaviors.

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Table 1

Associations between mean OBC score and various biopsychosocial characteristics.

Biopsychosocial Characteristic		Mean OBC score	Sum (N)	P - value
Gender	Female	0.99	56	.965
	Male	0.98	38	
Anxiety symptoms	Absent	0.84	51	≤ .001
	Present	1.15	42	
Depression symptoms	Absent	0.86	61	≤ .001
	Present	1.23	33	
Physical symptoms	Absent	0.75	39	≤ .001
	Present	1.16	55	
Characteristic pain intensity	No pain	0.85	36	.002
	Low pain intensity	0.98	40	
	High pain intensity[1]	1.27	18	
TMD diagnoses	Normal	0.91	42	.001
	Non-pain TMD	0.76	16	
	Pain-related TMD[2]	1.18	36	

[1]Tukey HSD indicated that the mean OBC score of the high pain intensity group was statistically significantly higher than the mean OBC scores of the other subgroups ($p \leq 0.05$).

[2]Tukey HSD indicated that the mean OBC score of the pain-related TMD group was statistically significantly higher than the mean OBC scores of other subgroups ($p \leq 0.05$).

Table 2

Multiple linear regression model evaluating biopsychosocial characteristics

Model [a]	Biopsychosocial characteristic	Standardized coefficient Beta	*P*-value	95 % Confidence interval	
				Lower bound	Upper bound
1	Physical symptoms	.473	≤ .001	.627	.868
2	Physical symptoms	.353	.001	.129	.480
	Depression symptoms	.252	.016	.043	.408

[a] Mean OBC score is the dependent variable. Note: Model 1: R^2 = .215; Model 2: R^2 = .256