

Impact of oral rehabilitation on the quality of life and cortisol levels of geriatric patients

Impacto da reabilitação oral na qualidade de vida e nos níveis de cortisol de pacientes geriátricos

Impacto de la rehabilitación oral en la calidad de vida y niveles de cortisol de pacientes geriátricos

Received: 11/04/2020 | Reviewed: 11/07/2020 | Accept: 11/10/2020 | Published: 11/13/2020

Fabiano Palmeira Gonçalves

ORCID: <https://orcid.org/0000-0003-2644-9968>

Universidade Federal Fluminense, Brasil

E-mail: fabianopalmeira@id.uff.br

Gutemberg Alves

ORCID: <https://orcid.org/0000-0003-0016-4809>

Universidade Federal Fluminense, Brasil

E-mail: gutopepe@yahoo.com.br

Felipe Oliveira

ORCID: <https://orcid.org/0000-0002-4689-7242>

Universidade Federal Fluminense, Brasil

E-mail: felipemb86@yahoo.com.br

Lívia Azeredo Alves Antunes

ORCID: <https://orcid.org/0000-0002-8432-0815>

Universidade Federal Fluminense, Brasil

E-mail: liviaazeredo@gmail.com

João Ricardo Almeida Soares

ORCID: <https://orcid.org/0000-0001-6517-1917>

Universidade Federal Fluminense, Brasil

E-mail: joaoricardo.almeida@yahoo.com.br

Matheus França Perazzo

ORCID: <https://orcid.org/0000-0003-1231-689X>

Universidade Federal de Minas Gerais, Brasil

E-mail: matheusperazzo@hotmail.com

Saul Martins Paiva

ORCID: <https://orcid.org/0000-0002-3968-1638>

Universidade Federal de Minas Gerais, Brasil

E-mail: smpaiva@uol.com.br

Miriam F. Zaccaro Scelza

ORCID: <https://orcid.org/0000-0002-2132-4755>

Universidade Federal Fluminense, Brasil

E-mail: scelza@terra.com.br

Abstract

The objective of this study was to assess the correlation between the improvement of oral health-related quality of life (OHRQoL) and salivary cortisol levels on elders under oral prosthetic rehabilitation. Oral problems can influence both quality of life and salivary cortisol. However, it remains unknown if cortisol may act as a biomarker of OHRQoL in elders. Forty-one elderly participants answered a sociodemographic questionnaire and the Oral Health Impact Profile (OHIP-14) for OHRQoL. Participants were clinically evaluated and referred to a Public Geriatric Dental Clinic for prosthetic oral rehabilitation. Saliva samples were collected for cortisol quantification through ELISA, before (T1) and after (T2) prosthetic oral rehabilitation. A comparison between T1 and T2 was performed using the Wilcoxon test at 5% significance. The Standardized Response Mean (SRM) tested the responsiveness of OHIP-14. Twenty-seven patients with a mean age of 74 ± 8.4 years old concluded the treatment. The OHIP-14 presented satisfactory responsiveness for the total score and in most domains ($SRM > 0.5$). The total score of OHIP-14 and the domains Physical Pain, Physical and Psychological Disability were improved after the treatment ($p < 0.05$). On the other hand, cortisol had a weak and non-significant correlation with OHIP-14 scores, except for the Functional Limitation domain ($r = 0.405$, $p < 0.05$). There was no difference between salivary cortisol levels between T1 and T2 ($p > 0.05$). The salivary cortisol level did not present a direct association with OHRQoL in elders. On the other hand, the OHIP-14 questionnaire evidenced changes after oral rehabilitation, confirming the improvement of the elderly participants' quality of life.

Keywords: Aged; Hydrocortisone; Oral health; Quality of life; Mouth rehabilitation.

Resumo

O objetivo deste estudo foi correlacionar a qualidade de vida relacionada à saúde bucal (OHRQoL) com os níveis de cortisol salivar em idosos em reabilitação protética oral. Quarenta e um participantes idosos responderam a um questionário sociodemográfico e ao Oral Health Impact Profile (OHIP-14) para OHRQoL. Os participantes foram avaliados clinicamente e encaminhados a uma Clínica de Odontologia Geriátrica Pública para reabilitação oral protética. Amostras de saliva foram coletadas para quantificação do cortisol através de ELISA, antes (T1) e após (T2) a reabilitação oral protética. A comparação entre T1 e T2 foi realizada pelo teste de Wilcoxon com significância de 5%. A média de resposta padronizada (SRM) testou a capacidade de resposta do OHIP-14. Vinte e sete pacientes com idade média de $74 \pm 8,4$ anos concluíram o tratamento. O OHIP-14 apresentou responsividade satisfatória para o escore total e na maioria dos domínios (SRM > 0,5). A pontuação total do OHIP-14 e os domínios Dor Física, Incapacidade Física e Psicológica melhoraram após o tratamento ($p < 0,05$). Por outro lado, o cortisol apresentou correlação fraca e não significativa com os escores do OHIP-14, exceto para o domínio Limitação Funcional ($r = 0,405$, $p < 0,05$). Não houve diferença entre os níveis de cortisol salivar entre T1 e T2 ($p > 0,05$). O nível de cortisol salivar não apresentou associação direta com OHRQoL em idosos. Por outro lado, o questionário OHIP-14 evidenciou alterações após a reabilitação oral, confirmando a melhora na qualidade de vida dos idosos.

Palavras-chave: Idoso; Hidrocortisona; Saúde bucal; Qualidade de vida; Reabilitação bucal.

Resumen

El objetivo de este trabajo fue correlacionar la calidad de vida relacionada con la salud bucal (OHRQoL) y los niveles de cortisol salival en ancianos sometidos a rehabilitación protésica oral. Cuarenta y un participantes ancianos respondieron un cuestionario sociodemográfico y el Perfil de Impacto en la Salud Oral (OHIP-14) para OHRQoL. Los participantes fueron evaluados clínicamente y remitidos a una Clínica Dental Geriátrica Pública para la rehabilitación oral protésica. Se recolectaron muestras de saliva para la cuantificación de cortisol mediante ELISA, antes (T1) y después (T2) de la rehabilitación oral protésica. Se realizó una comparación entre T1 y T2 utilizando la prueba de Wilcoxon al 5% de significancia. La media de respuesta estandarizada (SRM) evaluó la capacidad de respuesta de OHIP-14. Veintisiete pacientes con edad media de $74 \pm 8,4$ años concluyeron el tratamiento. OHIP-14 presentó una respuesta satisfactoria para la puntuación total y en la mayoría de los dominios (SRM > 0,5). La puntuación total de OHIP-14 y los dominios Dolor físico,

Discapacidad física y psicológica mejoraron después del tratamiento ($p < 0,05$). Sin embargo, cortisol tuvo una correlación débil y no significativa con las puntuaciones de OHIP-14, excepto para el dominio de Limitación Funcional ($r = 0,405$, $p < 0,05$). No hubo diferencia entre los niveles de cortisol salival entre T1 y T2 ($p > 0,05$). El nivel de cortisol en saliva no presentó asociación directa con OHRQoL en ancianos. No obstante, el cuestionario OHIP-14 evidenció cambios tras la rehabilitación oral, confirmando la mejora de la calidad de vida de los ancianos.

Palabras clave: Anciano; Hidrocortisona; Salud bucal; Calidad de vida; Rehabilitación bucal.

1. Introduction

Quality of life is a comprehensive concept influenced by an individual's physical and psychological health, level of independence in social relationships, and their interactions with the environment. (Groupt, 1993) The quality of life of elders is especially limited in developing countries, where poverty and low educational levels significantly contribute to the appearance of issues such as poor sanitation and nutritional deficiency, which can affect the normal aging process. (Campos et al., 2014) Tooth loss and edentulism are oral conditions that increase exponentially with age. They may impact the Oral Health-Related Quality of Life (OHRQoL) multidimensions, such as well-being, social interactions, self-esteem, and satisfaction with oral health ("Oral Health in America: A Report of the Surgeon General,," 2000). Although there is a broad geographic variation in the prevalence of tooth loss and edentulism in elders, in some developing countries, the need to use prosthesis reaches almost 93% among the population with more than 65-year old (Kassebaum et al., 2017).

Data obtained from primary surveys can be used to assess the need for treatment and the prevalence of oral problems. Thus, it is possible to assess the appropriateness and effectiveness of oral services and health programs and prepare or modify them whenever necessary (World Health Organization, 2011). Research tools for self-report in oral health have focused on multi-item scales and questionnaires, which can evaluate various aspects of oral health, oral function, and quality of life among different populations, including elders. (D Locker et al., 2001) Several instruments have been applied to assess the Oral Health-Related Quality of Life (OHRQoL) in older people, such as the Oral Health Impact Profile (OHIP). (Atchison & Dolan, 1990; D Locker et al., 2001) While the original OHIP is composed of a lengthy and time-consuming questionnaire (49 items), its short-version (OHIP-14) comprises only 14 items with comparable reliability and validity. (Slade & Spencer, 1994) This

instrument is known as appropriate for assessing the perception of pain and discomfort (stress) associated with oral health problems and their impact on overall health (D Locker et al., 2001; Oliveira & Nadanovsky, 2005).

On the other hand, self-reported OHRQoL tools may have limitations with elderly populations. The higher prevalence of illiteracy or low literacy in poor and developing countries may impair the obtention of reliable answers by self-administered instruments in this age group. (UNESCO, 2017) Moreover, interviews could be time-consuming, labor-intensive for large samples, and present a potential bias related to non-trained interviewers. (Bolderston, 2012) Therefore, explore complementary ways to assess the OHRQoL could help to achieve more reliable results.

Cortisol is a hormone-related to psychological and physiological functioning (Chida & Steptoe, 2009) produced by the adrenal cortex in response to stress through the hypothalamic-pituitary-adrenal axis (Dickerson & Kemeny, 2004). The release of cortisol due to continuous stress can lead to various physiological changes, playing a key role in metabolism control. (Dickerson & Kemeny, 2004; Lindfors et al., 2017; Zhang et al., 2017) Cortisol has been a successful biological marker in several studies related to stress, anxiety, and depression. (Bozovic et al., 2013; Chida & Steptoe, 2009; Pauly et al., 2016) In dentistry, salivary cortisol has been associated with periodontal disease (Refulio et al., 2013), orofacial dysfunctions (Strini et al., 2011), xerostomía (Agha-Hosseini et al., 2012), and treatment-related anxiety (Barbosa et al., 2012). Nevertheless, it remains unclear whether the salivary cortisol is a good measure for assessing biological improvement in the OHRQoL, especially in older people, where such studies are scarce.

Understanding how the OHRQoL changes after oral prosthetic rehabilitation in elders would help public health politics to intensify preventive/interventive actions in this age group. Moreover, exploring reliable alternatives to identify OHRQoL status could improve the assessment of clinical interventions as an indicator of treatment success. Therefore, this study employed a single-arm pre-post treatment study design to investigate two hypotheses: (i) that salivary cortisol levels are associated with oral-related quality of life in elders and (ii) if oral prosthetic rehabilitation of elders impacts OHRQoL, as measured by cortisol and the OHIP-14 questionnaire.

2. Materials and Methods

Participants and eligibility criteria

This interventional study was conducted with a convenience sample of 41 geriatric dental patients of a public educational institution between August 2017 to April 2019. The inclusion criteria of participants comprised clinically stable elders, independent for daily living activities with an indication for oral prosthetic rehabilitation. Participants were excluded if under treatment with corticosteroids or presenting dementia. This study was approved by the Antônio Pedro Hospital Human Research Ethics Committee (CAAE 68491317.5.0000.5243) and conducted according to good clinical practices (World Medical Association, 2015), in full accordance with the 1964 Helsinki declaration and its later amendments. All participants read and signed the statement of informed consent before the intervention.

Evaluation of OHRQoL and sociodemographic data

Sociodemographic data were collected on a questionnaire answered upon the arrival of the participants at the clinic, identifying age, gender, and educational level. The OHRQoL was assessed by the Oral Health Impact Profile-14 (OHIP-14). (D Locker et al., 2001; Oliveira & Nadanovsky, 2005) The OHIP-14 consists of 14 questions divided into seven different areas with two questions each: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap. Each question was answered on a scale comprising: “Never” (0) “Hardly ever” (1) “Occasionally” (2) “Fairly often” (3) and “Very often” (4). The results were calculated by the additive method on a total index of 56 points, where higher scores indicate a poor OHRQoL. A single researcher was responsible for applying the questionnaire privately upon the participant’s arrival and before the oral prosthetic rehabilitation (T1), and one week after the treatment (T2).

Previously to the main data collection, a pilot study was performed with 10 participants to evaluate the adequacy of the survey logistics. The questionnaire showed a satisfactory internal consistency ($\alpha = 0.77$) and measurement stability over time (intraclass correlation coefficient = 0.89).

Oral health assessment and treatment

Clinical examination was performed by a single previously trained examiner, with participants placed in a dental chair under an artificial light source, and using plane mouth mirror, metallic probe (in cases of doubt on the presence of caries), and gauze. The World Health Organization survey methodology of oral health problems (World Health Organization, 2011) was employed using the dental condition data and the need for treatment and use of prosthesis. After clinical examination, participants were referred to a University geriatric dentistry clinic for oral prosthetic rehabilitation, where treatments were carried out. These treatments included total, partial, and unitary prosthesis, periodontal and endodontic treatment, simple, direct restorations, and uncomplicated surgery. Besides the prosthesis, the intervention included periodontal and endodontic treatment, simple, direct restorations, and uncomplicated surgeries performed to adjust the oral environment to receive the prosthesis.

Detection of salivary cortisol

Participants were instructed to spit into sterile Falcon tubes (Corning Life Sciences, New York, USA) at T1 and T2, in the early hours of the morning. They were also instructed not to perform physical exercise or ingestion of caffeinated beverages, do not brush teeth, and refrain from food for at least 10 minutes before collection, only allowing water intake. To stimulate a higher volume saliva production, they chewed a small piece of rubber for 2 minutes and were seated with the head directed forward to prevent swallowed saliva. The saliva was collected by the same operator before (T1) and after (T2) oral prosthetic rehabilitation. All samples were stored in an ultra-freezer at -80°C until analysis.

Thawed samples were centrifuged at 2,500 rpm/20 min. The clear supernatant was collected and diluted at a 1:4 ratio in the assay buffer. Salivary cortisol was measured using the enzyme immunoassay Quite Arbor Assay Kit (Ann Arbor, Michigan, USA). TMB was employed as a substrate for the cortisol-peroxidase conjugate, and the optical density was detected in a microplate reader (BioTek Instruments, Winooski, VT, USA) at 450 nm.

Statistical analysis

The results were analyzed using SPSS 19.0 (IBM, Armonk, New York, USA). Data normality was verified through a Shapiro-Wilk test. Non-parametric tests were used at a

significance level of 5%. A Mann-Whitney test was employed to verify the differences between the initial sample and the dropouts.

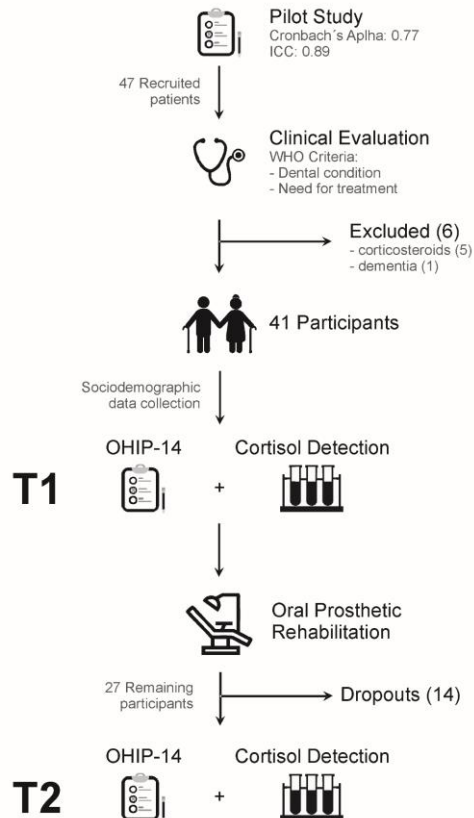
The OHIP-14 responsiveness was tested using the Standardized Response Mean (SRM). The SRM was evaluated by dividing the differences between mean scores T1 and T2 by the standard deviation of the change. In this manner, an SRM equal to 0.5 denotes no ability to detect a change, while 1.0 reflects perfect responsiveness (Zou, 2005).

The Wilcoxon test was used to assess the difference of OHRQoL and salivary cortisol levels in T1 and T2, while the Spearman's rank tested the correlations between the OHIP-14 and its domains with salivary cortisol levels. Considering the scores of the OHIP-14 in the OHRQoL scale as the dependent variable, it was verified if other variables in the study could explain the difference in behavior between the OHIP-14 scores.

3. Results and Discussion

Twenty-seven participants (65.8%) concluded oral prosthetic rehabilitation, while 14 (34.7%) dropped-out before or during the treatment (Figure 1). However, there was no difference ($p > 0.05$) of the OHRQoL total score between the remaining sample and the dropouts.

Figure 1. Flow diagram of the preliminary study conduction. T1: point of collection of saliva for cortisol detection by ELISA and answering of the OHIP-14 questionnaire upon arrival of participants. T2: point of collection of saliva for cortisol detection and answering of OHIP-14 questionnaire, one week after the end of the dental treatment.



Source: Authors.

The sample had a mean age of 74 (± 8.44) years and was mostly comprised of females (74.1%) with more than eight years of schooling (66.6%). The average length of oral prosthetic rehabilitation was 5.48 months (Table 1). The most frequent type of prosthesis was partial prosthesis (59.3%).

Table 1. Sample characterization.

Features	N(%)/ Mean (SD)
Gender	
Male	7 (25.9%)
Female	20 (74.1%)
Age (years)	73.81 (8.44)
School Education (years)	
≤8 years	18 (66.6)
>8 years	9 (33.4)
Prosthetic Oral Rehabilitation Time (months)	5.48 (4.85)
Type of Prosthesis	
Total prosthesis	6 (22.2%)
Partial prosthesis	16 (59.3%)
Unitary prosthesis	10 (37.0%)
Other Treatments	
Endodontics	5 (18.5%)
Periodontics	8 (29.6%)
Surgery	12 (44.4%)
Simple Direct restorations	10 (37.0%)

Source: Authors.

It is important to notice that some participants did not receive only prosthetic treatment, as other endodontic and periodontic procedures were also performed. Surgery was the more prevalent treatment for oral rehabilitation (44.4%).

The SRM values were above 0.5 in the total OHIP-14 score, as well as in four of its domains: Physical Pain (0.99), Physical Disability (0.72), Psychological disability (0.67), and Handicap (0.59), as shown in Table 2.

Table 2. Scores obtained in the OHIP-14 questionnaire administered to participants before and after treatment.

	T1-T2 *	SRM**
OHIP total	4.67	0.65
Functional limitation	-0.20	-0.14
Physical pain	0.94	0.99
Psychological discomfort	-0.02	-0.01
Physical disability	0.54	0.72
Psychological disability	0.63	0.67
Social disability	0.07	0.13
Handicap	0.37	0.59

* Differences between the means scores obtained in the OHIP-14

**0.5 = no ability to detect change; 1.0 = perfect responsiveness

Source: Authors.

The OHRQoL's total score improved significantly after oral prosthetic rehabilitation, as well as in the domains of Physical Pain, Physical Disability, Psychological Disability, and Handicap ($p < 0.05$) (Table 3).

There was no difference between salivary cortisol levels before and after oral prosthetic rehabilitation ($p > 0.05$). Similarly, no significant correlation was found among cortisol and most OHIP-14 domains, except for Functional Limitation ($r = 0.405$, $p < 0.05$) (Table 3).

Table 3. Correlation between OHIP-14 scores (total and domains) and responses cortisol (CR) before (t1) and after (t2) prosthetic oral rehabilitation and score comparison between both moments.

Variables	T1					T2				
	Mean	SD	Median	Range	CR	Mean	SD	Median	Range	CR
OHIP-14										
Total score*	13.52	10.22	10.00	1-36	0.225	8.85	8.20	8.00	0-33	0.247
Functional limitation	0.72	1.08	0.00	0-4	0.092	0.93	1.06	0.50	0-4	0.405**
Physical pain*	1.69	1.07	2.00	0-4	0.124	0.74	1.13	0.00	0-4	-0.027
Psychological discomfort	1.56	1.27	1.50	0-4	0.222	1.57	0.87	2.00	0-3.5	0.134
Physical disability*	0.96	1.22	0.50	0-4	0.204	0.43	0.79	0.00	0-3	0.291
Psychological disability*	1.19	1.09	1.00	0-4	0.319	0.56	0.98	0.00	0-3.5	0.209
Social disability	0.20	0.42	0.00	0-1.5	0.261	0.13	0.58	0.00	0-3	0.268
Handicap*	0.44	0.71	0.00	0-2	0.260	0.07	0.30	0.00	0-1.5	0.268
CR	21.07	26.98	16.00	3-150	1.000	21.52	29.34	12.00	0-158	1.000

*p<0.05; Wilcoxon test between T1 and T2

** p <0.05; Spearman correlation in each moment

Source: Authors.

This study represents an assessment of the association of cortisol and an oral health-related quality of life questionnaire, considering its potential use as a biological marker to verify the impact of oral prosthetic rehabilitation on older people. Given the present results, salivary cortisol was not a reliable predictor of OHRQoL after treatment for this age group.

Salivary cortisol is a stable, non-invasive, and easy to collect biomarker (Pauly et al., 2016; Zhang et al., 2017), whose levels correspond to blood cortisol, independent of the individual's salivary flow (Lawrence, 2002). Furthermore, salivary cortisol has been associated with diverse clinical conditions in dentistry (Agha-Hosseini et al., 2012; Barbosa et al., 2012; Refulio et al., 2013; Strini et al., 2011). However, such correlations remain controversial. A study carried out in Sweden did not identify a relationship between stress and pain with increased cortisol. (Lindfors et al., 2017) Similarly, a study with Brazilian university students found an association of oral treatment and OHRQoL, but not with salivary cortisol. (Strini et al., 2011) In the present study, salivary cortisol levels after treatment remained comparable to the initial values, and it is not possible to establish an association between this marker and any OHIP-14 domain.

During the aging process, a decrease in autonomy, health, and social status may raise the levels of stress (Sonia J. Lupien, Bruce S. McEwen & Heim, 2009). Cortisol levels are sensitive to chronic and acute stress, although there are neurophysiological variations between individuals resulting in differences in the aging process, vulnerability, resilience, and response to stress (Gaffey et al., 2016), or even in previous experiences related to dental treatment. However, this relationship between cortisol levels in different age groups is not very well understood, and some authors suggest that elders experience an anticipated decline in health that is accompanied by decreased levels of cortisol. (Heaney & Phillips, 2012) Other studies suggest that cortisol levels increase with age (Karlman et al., 2013), while yet others maintain that there is no association between cortisol levels and aging (Lederbogen et al., 2010). Older people often remain toothless for a long time, and this condition may make them used to it and not consider it a problem. Also, if missing teeth do not pose a problem for cultural or social reasons (Esmeriz et al., 2012), the cortisol index tends not to change. Such controversies, and the lack of association identified in the present study reinforce that further studies should be performed to confirm the relevance of cortisol as a biomarker, considering specific oral treatments that may be relevant when strongly associated with acute stress responses such as abscess or toothache.

On the other hand, in the present study, OHIP-14 was able to detect relevant data related to the quality of life in elders. The questionnaire allowed the identification of the

domains with a more influential negative contribution to OHRQoL before the intervention, that is, the factors that resulted in demand for dental treatment. Among those, physical pain and psychological discomfort were the most significant, similarly to previous findings (Kohli et al., 2017), especially related to conditions such as edentulism and the need for a prosthesis (Bramanti et al., 2013; Lundegren et al., 2019). Tooth loss and edentulism are relevant oral health problems in elders, interfering in the masticatory capacity, malnutrition and associated morbidities, self-esteem, and other psychological aspects related to the quality of life. (Bramanti et al., 2013; Peres et al., 2013) Therefore, the excessive need for partial prosthesis identified in the present sample could relate to poor OHRQoL.

It was possible to verify that improvement on OHRQoL in elders also occurred after oral prosthetic rehabilitation, regardless of the type of treatment. Indeed, elimination of physical pain is often identified as an essential factor in improving the OHRQoL, also impacting the psychological and aesthetic aspects of the OHIP domains. (Masood et al., 2017; Peršić & Čelebić, 2015) However, a large-scale Dutch dental survey, where elders were part of the sample, identified that oral problems contribute more to the physical aspects of OHIP, and exert less influence on OHIP domains related to psychological improvement. (Visscher et al., 2014) Since most of the participants of this study were total or partially edentulous, these characteristics probably contributed to detectable positive results in the OHRQoL after treatment, such as in physical, psychological, and handicap domains. (Bramanti et al., 2013)

Responsiveness is an essential attribute of OHRQoL instruments, which are used as evaluative measures to assess the post-treatment changes. (David Locker et al., 2004) The assessment of responsiveness is absent in many studies of OHRQoL, which is a significant lapse, given the increasing tendency to use OHRQoL measurements as outcomes in clinical trials and evaluation studies. (Terwee et al., 2003) Different measures of responsiveness lead to diverse conclusions since they were developed for different purposes. Terwee et al. (2003) identified 25 different definitions and 31 indices for measuring responsiveness in the literature. Two conceptually similar standard indices to analyze a single group in pre–post-study designs are the effect size and SRM (Zou, 2005). However, there is a growing understanding that it may be misleading to apply the effect size, as defined by Cohen (1988), to quantify the responsiveness of quality of life measurement tools (Zou, 2005). Therefore, in our study, we chose to use SRM evaluation to enhance the interpretability of our findings with the most informative presentation approach. SRM confirms the ability of the OHIP-14 instrument to identify change after an intervention, and whether the elderly participants had improved their quality of life after treatment. In our results, physical pain, physical disability,

psychological disability, and handicap were items with proper responsiveness, which may be explained by the rehabilitation of chewing, aesthetic and functional capacity with prosthetic treatment in elders. (Zou, 2005)

Among the main limitations of this study, we may include the difficulty of recruiting eligible participants that resulted in a relatively small sample size, which limited the statistical analyses performed. It is important to notice, however, that the dropout of 14 individuals did not influence the results obtained since no statistical significance was found between these individuals and the remaining group. Another limitation was the impossibility to consider the potential interference of depression among the participants, as the vast majority of older persons with depression are not clinically diagnosed (Pauly et al., 2016), even though depressive symptoms and syndromes in later life are a major public health problem. Also, we can point to the lack of randomization and a follow-up of symptomatic cases as another limitation of the study, preventing the establishment of causality between the symptoms and the oral health-related quality of life. Nevertheless, the present study design allowed to preliminarily identify a significant improvement in the overall OHRQoL of the older people subjected to oral prosthetic rehabilitation, as detectable by a questionnaire-based tool, but not by salivary cortisol.

4. Conclusions

Salivary cortisol levels did not present a direct association with OHRQoL in elders. On the other hand, the OHIP-14 questionnaire was able to evidence changes after oral rehabilitation, confirming the improvement of the elderly participants' quality of life.

References

- Agha-Hosseini, F., Mirzaii-Dizgah, I., & Mirjalili, N. (2012). Relationship of stimulated whole saliva cortisol level with the severity of a feeling of dry mouth in menopausal women. *Gerodontology*, 29(1), 43–47. <https://doi.org/10.1111/j.1741-2358.2010.00403.x>
- Atchison, K. A., & Dolan, T. A. (1990). Development of the Geriatric Oral Health Assessment Index. In *Journal of dental education*, 54(11), 680–687. <https://doi.org/2229624>
- Barbosa, T. S., Castelo, P. M., Leme, M. S., & Gavião, M. B. D. (2012). Associations

between oral health-related quality of life and emotional statuses in children and preadolescents. *Oral Diseases*, 18(7), 639–647. <https://doi.org/10.1111/j.1601-0825.2012.01914.x>

Bolderston, A. (2012). Conducting a Research Interview. *Journal of Medical Imaging and Radiation Sciences*, 43(1), 66–76. <https://doi.org/10.1016/j.jmir.2011.12.002>

Bozovic, D., Racic, M., & Ivkovic, N. (2013). Salivary Cortisol Levels as a Biological Marker of Stress Reaction. *Medical Archives*, 67(5), 374. <https://doi.org/10.5455/medarh.2013.67.374-377>

Bramanti, E., Maticena, G., Cecchetti, F., Arcuri, C., & Ciccì, M. (2013). Oral health-related quality of life in partially edentulous patients before and after implant therapy: a 2-year longitudinal study. *ORAL and Implantology*, 2, 37–42.

Campos, A. C. V., Ferreira e Ferreira, E., Vargas, A. M. D., & Albala, C. (2014). Aging, Gender and Quality of Life (AGEQOL) study: factors associated with good quality of life in older Brazilian community-dwelling adults. *Health and Quality of Life Outcomes*, 12(1), 166. <https://doi.org/10.1186/s12955-014-0166-4>

Chida, Y., & Steptoe, A. (2009). Cortisol awakening response and psychosocial factors: A systematic review and meta-analysis. In *Biological Psychology* (Vol. 80, Issue 3, pp. 265–278). <https://doi.org/10.1016/j.biopsycho.2008.10.004>

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences*. Hillsdale, NJ: Lawrence Erlbaum and Associates.

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: a theoretical integration and synthesis of laboratory research. *Psychological Bulletin*, 130(3), 355–391. <https://doi.org/10.1037/0033-2909.130.3.355>

Esmeriz, C. E. C., Meneghim, M. C., & Ambrosano, G. M. B. (2012). Self-perception of oral health in non-institutionalised elderly of Piracicaba city, Brazil. *Gerodontology*, 29(2), e281–e289. <https://doi.org/10.1111/j.1741-2358.2011.00464.x>

Gaffey, A. E., Bergeman, C. S., Clark, L. A., & Wirth, M. M. (2016). Aging and the HPA axis: Stress and resilience in older adults. *Neuroscience & Biobehavioral Reviews*, 68, 928–945. <https://doi.org/10.1016/j.neubiorev.2016.05.036>

Groupt, W. (1993). Study protocol for the World Health Organization project to develop a Quality of Life assessment instrument (WHOQOL). *Quality of Life Research*, 2(2), 153–159. <https://doi.org/10.1007/BF00435734>

Heaney, J. L. J., & Phillips, A. C. (2012). *Experimental Aging Research : An International Journal Devoted to the Scientific Study of the Aging Process Aging , Health Behaviors , and the Diurnal Rhythm and Awakening Response of Salivary Cortisol*. August, 295–314.

Karlamangla, A. S., Friedman, E. M., Seeman, T. E., Stawksi, R. S., & Almeida, D. M. (2013). Daytime trajectories of cortisol: Demographic and socioeconomic differences—Findings from the National Study of Daily Experiences. *Psychoneuroendocrinology*, 38(11), 2585–2597. <https://doi.org/10.1016/j.psyneuen.2013.06.010>

Kassebaum, N. J., Smith, A. G. C., Bernabé, E., Fleming, T. D., Reynolds, A. E., Vos, T., Murray, C. J. L., Marcenes, W., Abyu, G. Y., Alsharif, U., Asayesh, H., Benzian, H., Dandona, L., Dandona, R., Kasaeian, A., Khader, Y. S., Khang, Y. H., Kokubo, Y., Kotsakis, G. A., Yonemoto, N. (2017). Global, Regional, and National Prevalence, Incidence, and Disability-Adjusted Life Years for Oral Conditions for 195 Countries, 1990–2015: A Systematic Analysis for the Global Burden of Diseases, Injuries, and Risk Factors. *Journal of Dental Research*, 96(4), 380–387. <https://doi.org/10.1177/0022034517693566>

Kohli, R., Sehgal, H. S., Nelson, S., & Schwarz, E. (2017). Oral health needs, dental care utilization, and quality of life perceptions among Oregonian seniors. *Special Care in Dentistry*, 37(2), 85–92. <https://doi.org/10.1111/scd.12221>

Lawrence, H. P. (2002). Salivary markers of systemic disease: noninvasive diagnosis of disease and monitoring of general health. *Journal (Canadian Dental Association)*, 68(3), 170–174.

Lederbogen, F., Kühner, C., Kirschbaum, C., Meisinger, C., Lammich, J., Holle, R., Krumm, B., von Lengerke, T., Wichmann, H.-E., Deuschle, M., & Ladwig, K.-H. (2010). Salivary cortisol in a middle-aged community sample: results from 990 men and women of the KORA-F3 Augsburg study. *European Journal of Endocrinology*, 163(3), 443–451. <https://doi.org/10.1530/EJE-10-0491>

Lindfors, P., Folkesson Hellstadius, L., & Östberg, V. (2017). Perceived stress, recurrent pain, and aggregate salivary cortisol measures in mid-adolescent girls and boys. *Scandinavian Journal of Psychology*, 58(1), 36–42. <https://doi.org/10.1111/SJOP.12347>

Locker, D, Matear, D., Stephens, M., Lawrence, H., & Payne, B. (2001). Comparison of the GOHAI and OHIP-14 as measures of the oral health-related quality of life of the elderly. *Community Dentistry and Oral Epidemiology*, 29(5), 373–381. <https://doi.org/com290507> [pii]

Locker, David, Jokovic, A., & Clarke, M. (2004). Assessing the responsiveness of measures of oral health-related quality of life. *Community Dentistry and Oral Epidemiology*, 32(1), 10–18. <https://doi.org/10.1111/j.1600-0528.2004.00114.x>

Lundegren, N., Sohrabi, M. M., Molin Thorén, M., & Åkerman, S. (2019). Prosthetic dental restorations in Swedish samples: prevalence and agreement between self-report, clinical findings, and influence on quality of life. *Acta Odontologica Scandinavica*, 77(4), 296–302. <https://doi.org/10.1080/00016357.2018.1542505>

Masood, M., Newton, T., Bakri, N. N., Khalid, T., & Masood, Y. (2017). The relationship between oral health and oral health related quality of life among elderly people in United Kingdom. *Journal of Dentistry*, 56, 78–83. <https://www.sciencedirect.com/science/article/pii/S0300571216302202>

Oliveira, B. H., & Nadanovsky, P. (2005). Psychometric properties of the Brazilian version of the Oral Health Impact Profile-short form. *Community Dentistry and Oral Epidemiology*, 33(4), 307–314. <https://doi.org/10.1111/j.1600-0528.2005.00225.x>

Oral health in America: a report of the Surgeon General. (2000). *Journal of the California*

Dental Association, 28(9), 685–695. <http://www.ncbi.nlm.nih.gov/pubmed/11324049>

Pauly, T., Lay, J. C., Nater, U. M., Scott, S. B., & Hoppmann, C. A. (2016). How We Experience Being Alone: Age Differences in Affective and Biological Correlates of Momentary Solitude. *Gerontology*, 63(1), 55–66. <https://doi.org/10.1159/000450608>

Peres, M. A., Barbato, P. R., Reis, S. C. G. B., Freitas, C. H. S. D. M., & Antunes, J. L. F. (2013). [Tooth loss in Brazil: analysis of the 2010 Brazilian Oral Health Survey]. *Revista de Saude Publica*, 47 Suppl 3(suppl 3), 78–89. <https://doi.org/10.1590/s0034-8910.2013047004226>

Peršić, S., & Čelebić, A. (2015). Influence of different prosthodontic rehabilitation options on oral health-related quality of life, orofacial esthetics and chewing function based on patient-reported outcomes. *Quality of Life Research*, 24(4), 919–926. <https://doi.org/10.1007/s11136-014-0817-2>

Refulio, Z., Rocafuerte, M., de la Rosa, M., Mendoza, G., & Chambrone, L. (2013). Association among stress, salivary cortisol levels, and chronic periodontitis. *Journal of Periodontal & Implant Science*, 43(2), 96. <https://doi.org/10.5051/jpis.2013.43.2.96>

Slade, G. D., & Spencer, A. J. (1994). Development and evaluation of the Oral Health Impact Profile. *Community Dental Health*, 11(1), 3–11.

Sonia J. Lupien, Bruce S. McEwen, M. R. G., & Heim, and C. (2009). Effects of stress throughout the lifespan on the brain, behaviour and cognition. *Nat Rev Neurosci*, 10(6), 434–445. <https://doi.org/10.1139/H08-013>

Strini, P. J. S. A., Strini, P. J. S. A., De Souza Barbosa, T., & Duarte Gavião, M. B. (2011). Assessment of orofacial dysfunctions, salivary cortisol levels and oral health related quality of life (ORHQoL) in young adults. *Archives of Oral Biology*, 56(12), 1521–1527. <https://doi.org/10.1016/j.archoralbio.2011.06.009>

Terwee, C. B., Dekker, F. W., Wiersinga, W. M., Prummel, M. F., & Bossuyt, P. M. M. (2003). On assessing responsiveness of health-related quality of life instruments: guidelines

for instrument evaluation. *Quality of Life Research : An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation*, 12(4), 349–362. <https://doi.org/10.1023/a:1023499322593>

UNESCO. (2017). Literacy Rates Continue to Rise from One Generation to the Next. *Unesco*, 2016(45), 1–13.

Visscher, C. M., Lobbezoo, F., & Schuller, A. A. (2014). Dental status and oral health-related quality of life. A population-based study. *Journal of Oral Rehabilitation*, 41(6), 416–422. <https://doi.org/10.1111/joor.12167>

World Health Organization. (2011). Oral Health Surveys. In *Oral Health Surveys: Basic Methods*, 651, 43–56. https://doi.org/10.1007/978-3-642-20479-1_4

World Medical Association (2015). Declaration of Helsinki Ethical Principles for Medical Research Involving Human Subjects. *JAMA*, 310(20), 2191–2194.

Zhang, Q., Chen, Z., Chen, S., Xu, Y., & Deng, H. (2017). Intraindividual stability of cortisol and cortisone and the ratio of cortisol to cortisone in saliva , urine and hair. *Steroids*, 118, 61–67. <https://doi.org/10.1016/j.steroids.2016.12.008>

Zou, G. Y. (2005). Quantifying responsiveness of quality of life measures without an external criterion. *Quality of Life Research*, 14(6), 1545–1552. <https://doi.org/10.1007/s11136-004-0027-4>

Percentage of contribution of each author in the manuscript

Fabiano Palmeira Gonçalves – 25%

Gutemberg Alves – 15%

Felipe Oliveira – 5%

Lívia Azeredo Alves Antunes – 15%

João Ricardo Almeida Soares – 5%

Matheus França Perazzo – 5%

Saul Martins Paiva – 15%

Miriam F. Zaccaro Scelza – 15%