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Functional dentition and associated factors: the evaluation of three indicators

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Studying the different indicators of functional dentition classification can contribute to the understanding of the associated factors, and thus help in the definition of strategies associated with oral health care. This approach has been little explored in the literature, especially when considering the older age group. **Aim:** The aim of this study is to evaluate the factors associated with three distinct functional dentition classification. **Methods:** Cross-sectional exploratory study using secondary data from the Frailty in Older Brazilians (FIBRA) Project of 876 older adults living in Campinas, Brazil. The indicators of dental function assessed was number of natural teeth present, occluding pairs of teeth and the Eichner index, which were verified by trained dentists, following the World Health Organization criteria for epidemiological studies in oral health. The explanatory variable assessed was the self-perception of oral health-related quality of life measured by the Geriatric Oral Health Assessment Index (GOHAI) and its dimensions. It was also collected sociodemographic information such as age, gender, race/ethnicity, schooling, family income, smoking behavior and frailty status. The association was verified through Poisson regressions for number of teeth and pairs of teeth in occlusion and multinomial regression for the Eichner index, adjusted by sociodemographic and health variables. **Results:** Lower prevalence of participants with less than 21 teeth who negatively perceived GOHAI´s pain and discomfort dimension and higher prevalence of having less teeth among the ones that negatively perceived GOHAI´s physical and functional dimensions. No association was found between the perception of quality of life and occlusion pairs of teeth and the Eichner Index. **Conclusion:** Two out of three indicators assessed were associated with quality of life. Therefore, it is important to select sensitive indicators to be able to identify and better comprehend this relationship.

Keywords: Aged. Dentition. Quality of life.

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Introduction

Oral health tends to decline with aging. Cumulative and progressive changes throughout life can result in tooth loss, which impairs the functionality of the dentition[1]. The reduction in the number of teeth can lead to a loss of masticatory efficiency, affecting nutrition[2], communication, self-esteem, general well-being[3], and even being associated with a higher risk of morbidity and mortality[4].

Few studies evaluate the relation between functional condition of dentition and quality of life[5], and there are even less about older populations. This is the age group with more sequelae in the dentition[1]. The multidimensional impairment of tooth loss can affect and be affected by quality of life, and thus evaluating the different types of classification can contribute to the understanding of associated factors and especially the quality of life evaluated globally and through different dimensions, such as pain/discomfort, physical and psychological aspects. This relationship is frequently studied with a focus on the number of teeth[1], but this impact may vary depending on the degree of the dentition functionality, as in the case of the Eichner indicator that is still barely used in the literature. As seen in a recent systematic review[6], which verified the association between oral health factors associated with oral health-related quality of life (OHQoL) in people aged 65 or more. In addition, the study found that the literature shows a consensus about the positive association between the number of natural teeth and occluding pairs of teeth with OHQoL.

One of the factors that hinder this relationship is the lack of consensus on the functional dentition definition[5]. The World Health Organization (WHO), FDI World Dental Federation (FDI) and International Association for Dental Research (IADR) have jointly established that to have a functional dentition, a person must retain at least 21 natural teeth[7]. This definition is widely used in research[8]; however, it does not consider the quantity and location of occlusal contacts. The evaluation of occlusal contacts seems to be more descriptive and discriminatory in determining the functional condition of the dentition[9,10]. However, studies in the literature are heterogeneous for study designs, populations, assessments of the measurements, and outcome tools[6]. This makes the evidence not conclusive and insufficient to determine the extent to which the functional condition of the dentition affects the quality of life of older adults.

Considering the aforementioned, the functional condition of the dentition was verified using three clinical indicators, aiming to evaluate the factors associated with each type of functional dentition classification focusing on the association with oral health-related quality of life.

Material and Methods

Study design and participants

The data employed in the present cross-sectional study were taken from the "*Fragilidade em Idosos Brasileiros*" – FIBRA (Frailty in Older Brazilians) study, conducted in 2008-2009. The FIBRA survey was a population-based, multicenter study designed to investigate conditions of frailty regarding health, sociodemographic, psychosocial,

and functionality variables in older people of the community. Methodological details have been previously published[11].

The minimum sample size was estimated at 601 elderly people living in the community (Campinas – SP). For this calculation, the formula and parameters were used as described: **$n=\{z^2 \times [p \times q / e^2]\}$** (formula for calculating sample size, without correction for finite populations); z=1.96 (95% significance level); p=q=0.50 (maximum confidence values to estimate prevalence in sample studies); e=4% (sampling error margin). A total of 90 census sectors were drawn, of which 88 sectors were part of the sample of 900 elderly people, totaling an average of 10.2 elderly people per sector. The sample was probabilistic by conglomerates, with the urban census sectors as the sampling unit. The number of census tracts was defined by dividing the number of existing urban census tracts by the desired number of elderly people. The recruiters received the map of each census sector and visited all the households to recruit as well as to identify those in which there were one or more elderly residents and interviewed those who met the inclusion criteria. In addition, they scheduled sessions for the next week with the elderly who agreed to participate.

This sample, representative of the older population of Campinas, Brazil, included participants aged 65 or over who had complete data for the dependent variables "functionality of dentition", as well as for the independent variables: "quality of life" (explanatory variable), and "sociodemographic/health conditions" (control variables). All procedures were approved by the Ethics Committee of the School of Medical Sciences of the University of Campinas (process nº 208/2007).

Functionality of dentition

Three clinical indicators were evaluated, through dental examinations performed by three trained dentists, with a gold-standard examiner with experience on data collection following the WHO criteria for epidemiological studies in oral health[12]. Individuals using dentures were asked to remove them. The variable occluding pairs of teeth was constructed based on the natural teeth present. Measurements:

- Number of natural teeth present: Categorized into up to 20 teeth (impaired) and 21 or more teeth (functional), according to the global goals for oral health 2020, proposed by WHO, FDI and IADR[7].
- Occluding pairs of teeth: Categorized according to the average number of occlusive teeth estimated in this research: up to 2 pairs and 3 or more pairs.
- Eichner Index: Posterior occlusal contacts were classified into four support regions (two molars and two premolars), and three categories were determined: "A" occlusal contacts in four posterior regions; "B" contacts in up to three posterior regions or only in the anterior area; and "C" without occlusal contacts[13].

Oral Health-related quality of life (OHRQoL)

We used the Geriatric Oral Health Assessment Index (GOHAI) validated in Brazil[14], designed to assess the perception of oral health problems that impact quality of life in older adults[15]. The instrument consists of 12 questions, whose answers "always", "sometimes", and "never" were weighted on a scale of 1 to 3 points in ascending

order, from the more negative condition to the more positive one, according to the context of the question. The higher the sum of the scores, more positive the evaluation is, therefore, lower perception of the impact of oral health on quality of life.

The questionnaire was analyzed globally and according to dimensions of oral health problems. Two categories were dichotomized based on a previous study[16]: positive perception that corresponded to a high score (in the global index greater than 34 points, and in the dimensions: physical/functional greater than 10 points, psychosocial/psychological 15 points, and pain/discomfort 9 points), and negative perception, corresponding to a moderate/low score (lower than the scores already indicated as high for the global index and for each dimension).

Sociodemographic/behavior/health conditions

Sociodemographic data were collected: age, gender, race/color dichotomized according to the sample distribution in "Caucasians" and "non-Caucasians" (category that included those who declared themselves as "black", "*mulato/caboclo/pardo*", "Indigenous" or "yellow/oriental"), literacy, schooling dichotomized in "up to three years of study" and "four or more years of study", if retired, family income according to the minimum wage (MW) in 2008 equivalent to R$ 415.00/US $ 231, being dichotomized into "up to two MW" and "three or more MW", and possession of residence (owner or not).

Data on self-reported smoking of older adults were also collected. Frailty according to the phenotype of Fried et al.[17] (2001), whose evaluation details were previously published[15]. Regarding oral health, access to dental services ("insurance/private" or "public") and self-assessed oral health dichotomized as "positive" (when the older person assessed it as "excellent" or "good") and "negative" (when the evaluation was "regular" or "bad").

Statistical analysis

Associations between each dentition functionality indicator and independent variables were verified using the chi-square and Fisher's exact tests. Multivariate models were constructed with the variables that showed an association of $p < 0.25$ in the bivariate analyzes, performing Poisson regressions for number of teeth (model 1) and pairs of teeth in occlusion (model 2); and multinomial regression for the Eichner index (model 3). In the models, variables with a statistical significance of $p < 0.05$ were presented, showing prevalence and odds ratios with 95% confidence intervals. It was used the backward stepwise method in this exploratory study on which the variables considered in the analysis were based on the p value and the epidemiological relevance on the association.

Results

Research participants

Of the 900 participants in the FIBRA study, 876 had complete data to be included in the analysis; their characteristics are described in Table 1. The mean age of the vol-

unteers was 72.78 (± 5.8) years, with a predominance of women (69.3%), caucasians (70.9%), four years or more of schooling (58.7%), and a family income above two minimum wages (71.8%). Most of them assessed positively both their oral health (72.4%) and their quality of life in relation to oral health (69.8% - global GOHAI). GOHAI ranged from 12 to 36 points.

Functional dentition condition

Only 14.1% of the older adults had 21 or more teeth, 25.3% had three or more occluding pairs of teeth and 71.3% had no occlusal contact (Eichner C index), with a low prevalence of functional dentition (Table 1).

Table 1. Characteristics of the participants according to the studied variables (n= 876).

Variables	n (%)
Gender	
Man	276 (30.7)
Woman	624 (69.3)
Race/Color	
Caucasian	636 (70.9)
Non-Caucasian	261 (29.1)
Literate	
No	196 (21.9)
Yes	699 (78.1)
Schooling	
4 or more years	371 (41.3)
Up to 3 years	528 (58.7)
Retired	
No	261 (29.2)
Yes	634 (70.8)
Family Income*	
Up to 2 MW	221 (28.2)
3 or more MW	562 (71.8)
Home-owneship	
No	162 (18.0)
Yes	738 (82.0)
Smoking	
No	612 (88.8)
Yes	77 (11.2)
Frailty	
Not frail	359 (39.9)
Pre-frail	469 (52.1)

Continue

Continuation	
Frail	72 (8)
Use of Dental Service	
Insurance/private	440 (67.7)
Public	210 (32.3)
Oral Health Self-Assessment	
Negative	186 (27.6)
Positive	487 (72.4)
GOHAI - Global Index	
Negative (12 to 33 points)	265 (30.2)
Positive (34 to 36 points)	612 (69.8)
GOHAI – Physical / functional dimension	
Negative (4 to 9 points)	108 (12.3)
Positive (10 to 12 points)	769 (87.7)
GOHAI – Psychological /psychosocial dimension	
Negative (5 to 14 points)	320 (36.5)
Positive (15 points)	557 (63.5)
GOHAI – Pain/ discomfort dimension	
Negative (3 to 8 points)	236 (26.9)
Positive (9 points)	641 (73.1)
Number of teeth	
Up to 20 teeth	753 (85.9)
21 or more teeth	124 (14.1)
Paired teeth in occlusion	
Up to 2 pairs	655 (74.7)
3 or more pairs	222 (25.3)
Eichner Index	
A (occlusal contact in 4 posterior regions)	68 (7.7)
B (occlusal contact in up to 3 posterior regions/ anterior only)	184 (21)
C (without occlusal contact)	626 (71.3)

GOHAI, *Geriatric Oral Health Assessment Index* (positive perception: high score; negative perception: moderate/low score).
*MW, minimum wage (in 2008 2MW = R$ 830.00; on average US$ 462).

Perception of problems associated with functional condition of dentition

In Figure 1, the oral health problems that impact on quality of life (GOHAI) associated with the studied clinical conditions stood out. Regardless of the functional condition of the dentition, most older adults estimated that they had no problems that limited their diet (type and quantity), or speech, dissatisfaction with the smile, or discomfort eating in front of other people. The number of older adults with impaired dentition that indicated problems in chewing was higher.

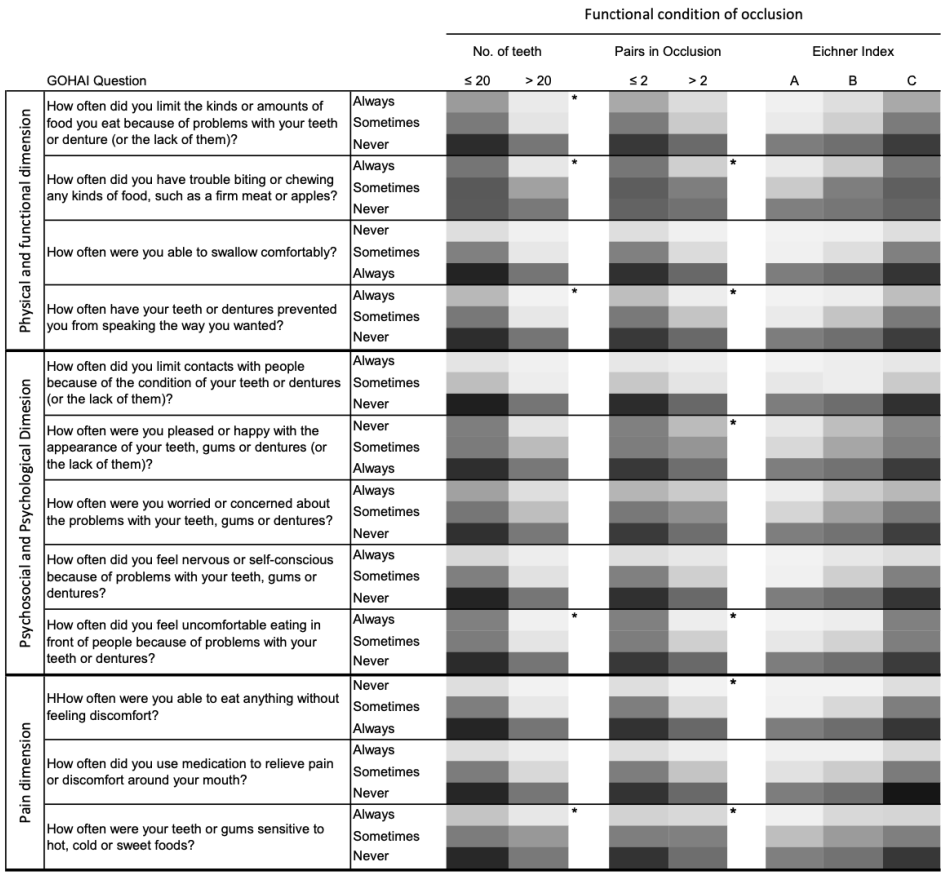

Figure 1. Frequency of response of older people to the GOHAI questions according to the functional condition of the dentition. The bar at the end of the figure symbolizes the range of colors that each category could acquire according to the number of older people who answered within it. It ranged from 0 individuals (white) increasing in intensity to black (876 responses), which is the maximum number of participants in this study. The categories of the Eichner Index mean: A, occlusal contact in 4 posterior regions; B, occlusal contact in up to 3 posterior regions/anterior only; and C, without occlusal contact. *p <0.05 for chi-square and Fisher's exact tests.

Perception of quality of life with different degrees of functionality in dentition

Regarding the presence of teeth and pairs of teeth in occlusion, Table 2 showed the profile of older adults impaired dentition: women, non-caucasian, with low education and low family income, who negatively perceived their quality of life due to problems in the physical/functional dimension. However, older adults with functional dentition negatively perceived the pain/discomfort dimension.

As for the Eichner index, Table 3 presented profiles of older people according to the number and location of occlusal contacts. Individuals with occlusal contact in all posterior regions (Eichner A) had higher education and higher family income. This characteristic is shared with those with occlusal contact in up to three posterior regions or only anterior (Eichner B). In addition, the latter group assessed their oral health negatively. No association was found between the perception of quality of life and these profiles.

Table 2. Poisson regression models with variables associated with the number of teeth (Model No. 1) and pairs of teeth in occlusion (Model No. 2).

Variables	Model No 1				Model No 2			
	Number of teeth* (up to 20 teeth)				Paired teeth in occlusion** (up to 2 pairs of teeth in occlusion)			
	Crude PR (95% CI)	p	Adjusted PR (95% CI)	p	Crude PR (95% CI)	p	Adjusted PR (95% CI)	p
Schooling								
Up to 3 Years (Ref. 4 or more years)	1.17 (1.11-1.23)	< 0.001	1.12 (1.07-1.18)	< 0.001	1.40 (1.26-1.55)	< 0.0001	1.28 (1.19-1.39)	< 0.0001
Family Income								
Up to 2 MW (Ref. 3 or more MW)	1.12 (1.06-1.18)	< 0.001	1.07 (1.02-1.12)	0.004	1.29 (1.17-1.43)	< 0.0001	1.15 (1.07-1.24)	< 0.0001
Gender								
Man (Ref. Female)	0.91 (0.85-0.97)	0.008	0.91 (0.85-0.97)	0.01	0.83 (0.73-0.95)	0.001	0.87 (0.79-0.96)	0.02
Race/Color								
Non-Caucasian (Ref. caucasian)	0.87 (0.83-0.91)	< 0.001	1.10 (1.05-1.16)	< 0.001				
GOHAI Physical/functional dimension								
Negative perception (Ref. Positive)	1.12 (1.07-1.18)	< 0.001	1.12 (1.05-1.20)	< 0.001				
GOHAI Pain/discomfort dimension								
Negative perception (Ref. Positive)	0.91 (0.85-0.98)	0.014	0.91 (0.84-0.98)	0.01				

*Reference category: 21 or more teeth
** Reference category: 3 or more pairs
PR, Prevalence Ratio; CI, confidence interval; SM, Minimum wage.

Table 3. Multinomial regression with variables associated with the Eichner Index * (Model No. 3).

Variables	A (occlusion in 4 posterior regions)				B (occlusion in up to 3 posterior regions/anterior only)			
	Crude OR (95% CI)	p	Adjusted OR (95% CI)	p	Crude OR (95% CI)	p	Adjusted OR (95% CI)	p
Schooling								
Up to 3 Years (Ref. 4 years or more)	0.17 (0.09-0.35)	< 0.001	0.27 (0.12-0.60)	0.001	0.35 (0.24-0.51)	< 0.001	0.35 (0.21-0.56)	< 0.001
Family Income								
Up to 2 MW (Ref. 3 or more MW	0.13 (0.04-0.38)	< 0.001	0.18 (0.05-0.61)	0.005	0.39 (0.25-0.61)	<0.001	0.44 (0.24-0.78)	0.005
Gender								
Man (Ref. Female)	1.20 (0.70-2.06)	0.51	1.32 (0.70-2.49)	0.38	2.01 (1.43-2.83)	< 0.001	1.97 (1.28-3.03)	0.002
Oral Health Self-Assessment								
Negative (Ref. Positive)	0.64 (0.32-1.26)	0.20	0.69 (0.33-1.44)	0.32	1.56 (1.05-2.32)	0.027	1.57 (1.01-2.48)	0.04

*Reference category: C (without occlusion)
OR, Odds Ratio; CI, Confidence Interval; MW, minimum wage.

Discussion

This research contributes to broaden the understanding of factors that affect oral health on older adults, with a still little explored approach in the literature. The associations found reveal two realities: older adults who perceive physical and functional problems have impaired dentition; and, surprisingly, those who do have functional dentition perceive problems related to pain and discomfort, probably because of the presence of unhealthy teeth. These two conditions (physical/functional and pain/discomfort) seem to have a negative impact on quality of life.

In general, the study shows low prevalence of functional dentition. Similar information was found in the literature[18,19]. Although there has been a worldwide trend in the last few decades to preserve more teeth in aging[20], this reality will probably occur in Brazil by 2050[21]. The causes are multifactorial; on the one hand, the current generation of older adults has belatedly benefited from the preventive public policies implemented in recent years[21], added to the limited use of dental services, and the legacy of a care model in which mutilating practices prevailed[22].

Even with the low prevalence of functional dentition, most older people have a positive perception of their oral health and overall quality of life, showing a difference between self-perception and real condition, also seen in other studies[16,22]. This finding can be explained because older adults are more resilient related to oral health[10] and they adapt to oral conditions, devaluing the impact of diseases because they assume that it is an inevitable consequence of aging[22].

For this reason, evaluating quality of life from a global point of view could mask the identification of specific functions that harm older adults. And therefore, each dimension in particular was analyzed, finding a negative impact on physical/functional and pain/discomfort dimensions when older adult has less than 20 teeth.

The physical/functional dimension of GOHAI assess several factors[14], including chewing ability, which was affected in most older people without functional dentition. This finding seems to be expected and confirmed in previous studies[23,24]. Many studies prove that older people with impaired dentition are more likely to have masticatory problems[8,23] and to perceive them as negative for their quality of life[10,24] emphasizing the need to maintain a functional dentition.

Precarious condition of the remaining teeth can explain the pain and discomfort that affect older people with functional dentition, as already observed in a similar study[25] endorsed by world statistics that indicate an increase in oral diseases and need for treatment not attended due to reduction of tooth loss[20]. Therefore, this is probably the cause of negative perception in this area.

The profiles also reveal that they come from different segments of society. Women, non-caucasians, with low educational level, and whose family group lives in poor economic conditions characterize the profile of older adults with impaired dentition. As the oral condition improves, the profile is associated with higher education and income. This social gradient was also observed for tooth loss[21]. Consequently, the functional condition of dentition could be considered an indicator of social inequality.

The low socioeconomic level is related to the lack of use of dental services[21,26], limited information on prevention habits[26,27], and difficulty in recognizing a health need[28]. Despite the efforts to reduce social inequalities, they still persist among older adults[28] and have an impact on the observed oral condition.

Gender seems to have a different effect according to the outcome evaluated. Being men was associated with a lower prevalence of having less teeth and less occluding pairs of teeth but a higher prevalence of having occlusal contact in up to three posterior regions or only in anterior region (Eichner B). Women tend to use more regularly the oral health services and consequently are more susceptible to have their teeth extracted as a result of overtreatment[29].

As a differential of other studies, the functional condition of dentition was assessed considering three clinical indicators[8], and as for quality of life it was used two indicators, one subjective (a self-perception single question) and another objective (The GOHAI instrument and its dimensions). The number of teeth was the indicator of dentition functionality that identified more associated factors, including quality of life, even though more precise measures such as occluding pairs of teeth and Eichner index were adopted[8]. On the other hand, the Eichner index characterized profiles in older adults, which to our understanding, have not yet been described in Brazil using this instrument, showing a differential of this study. Hence the importance of this study in expanding the understanding of associated factors according to the indicator used.

As a limitation, we recognize the lack of oral health variables to check the condition of the remaining teeth and the use of prosthesis, that could confirm the hypothesis of discussion about the association of functional dentition and the perception of pain/discomfort. As it is an exploratory cross-sectional study, it advances in recognizing the variability of associated factors according to the selected indicator.

Finally, we emphasize that despite the worldwide trend to preserve more teeth throughout life, older Brazilians still do not retain a number of teeth or adequate occlusal contacts to have a functional dentition and they perceive the negative impact of this condition. This reality reveals the need for preventive and therapeutic measures to maintain a healthy and functional dentition throughout life. Two out of the three indicators assessed in this study were associated with quality of life. Therefore, it is important to select sensitive indicators to be able to identify and better comprehend the relationship between a functional dentition and quality of life, especially in this age group that has great tooth loss.

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Data avaliability

The datasets related to this article belong to the FIBRA research group and will be available upon request from the author responsible for the project.

Conflict of Interest

None

Author contribution

Conceptualization: DDS, MLRS.

Methodology: RBH, LHNT, DDS, ALN, MLRS.

Formal analysis: LHNT, DDS, MLRS.

Investigation: RBH, DDS.

Resources: ALN.

Data curation: DDS.

Writing—original draft preparation: RBH, LHNT, DDS.

Writing—review and editing: RBH, LHNT, MJAM, TBA, DDS, ALN, MLRS.

Supervision: DDS, ALN, MLRS.

Project administration: DDS, ALN, MLRS.

Funding acquisition: DDS, ALN.

All authors have read and agreed to the published version of the manuscript.

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