Construction of a multidimensional oral health indicator for the older population in the city of Manaus-Amazonas

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Abstract

Objective: Produce a multidimensional indicator of oral health, based on dental and non-dental variables, for the older adult in the urban area of the city of Manaus-AM. *Method*: The data used are from a cross-sectional population-based study conducted in 2008 with randomly selected individuals aged 65 to 74 years, residing in the city of Manaus. To produce the proposed indicator, the dental variables (DMFT- Decayed, Missing and Filled Teeth; CPI- Community Periodontal Index; PIP- Periodontal Insertion Loss Index) and non-dental (socioeconomic and index GOHAI- General Oral Health Assessment Index) were considered. An exploratory factor analysis synthesized these variables, facilitating the construction of the multidimensional indicator. *Results*: The analysis generated three factors that, together, explained 72.9% of the model's variance (KMO = 0.749 and p<0.001 for Bartlett's test of sphericity). These three factors were reduced to the "sum" variable, calculated from the sum of the factor scores per individual. The median of this new variable was the reference value for categorizing the individual's oral health condition into "favorable" or "unfavorable". *Conclusion*: The indicator was able to aggregate several dimensions of oral health into a single measure, in addition to enabling its reproducibility for the construction of other health status indicators.

Keywords: Older Adults. Health Status Indicator. Oral Health. Tooth Loss.

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INTRODUCTION

Healthy aging is defined as "the process of developing and maintaining the functional capacity that enables well-being at an advanced age"[1]. It is important to consider the remarkable growth of longer-lived individuals, over 80 years of age in Latin American countries[2], in addition to the specificity and heterogeneity of aging processes in order to organize the functioning of health systems in the face of these demands[3]. In this context, oral health must be understood as an intrinsic aspect of general health[4]. However, the integration of oral health into national health programs is still incipient in most countries, requiring broad public health actions[5].

In the last national oral health survey (SB Brasil 2010), the results showed a high prevalence of edentulism (53.7%) in the older population and a high DMFT index (Decayed, Missing and Filled Teeth) as a result of the lost component[6,7]. Better oral health conditions can already be observed in children and adolescents in Brazil, this population may have benefited from preventive measures and improvements in the health system, adopted from the 80's onwards, such as the introduction of collective procedures and an increase in the offer of fluoride toothpastes. However, in older adults it is estimated that a reduction in tooth loss will only be significant from the year 2050 onwards[8]. It is known that the decrease in tooth loss in the older population is already observed in countries with high income, but with no impact on the oral health condition, since these teeth remain in the mouth, but with a high prevalence of decay and periodontal disease[9].

In view of the above, the oral health of older adults, when evaluated only by traditional dental indices, can be biased due to tooth loss, which impairs the accuracy of these indices[10]. Elani et al.[11], for example, demonstrated, using algorithms to assess the risk of tooth loss among adults, that the performance of models that incorporate the socioeconomic characteristic was better when compared to those based only on clinical dental indicators. Research shows that older individuals living in cities with low income and low education have a higher prevalence of tooth loss[12,13]. On the other hand, richer and more educated older people seek more preventive care[14,15].

These findings reinforce the definition of oral health as a physical, psychological and social state of well-being related to oral conditions, which significantly contribute to the quality of life of adults and older adults, affecting general health[16]. For this reason, the impact of oral health on the quality of life of older adults has been increasingly evaluated. The association between sociodemographic factors, health-related characteristics, functional status and OHRQoL (Oral Heath-Related Quality of Life) using the GOHAI (General Oral Health Assessment Index) scale shows consistent results on associations between self-rated health (subjective conditions) and oral health-related quality of life[17].

The importance of maintaining good oral health at older ages and the incorporation of oral health indicators in routine geriatric assessments has been discussed in the literature[18]. Thus, a comprehensive assessment of the oral health of these individuals is urgent, focusing on the comprehensive care of this population, which has peculiar characteristics regarding the presentation, installation and outcome of diseases and health problems, translated by greater vulnerability to adverse events[19]. Thus, the objective of the present study is to produce a multidimensional indicator of oral health, based on dental and non-dental variables, for older adults in the urban area of the city of Manaus-AM.

METHOD

Data from the only cross-sectional population-based study carried out in 2008 with older people living in the city of Manaus-AM, aged between 65 and 74 years, were analyzed, according to the methodology adopted by the SB Brasil 2003. Data were observed about the socioeconomic and demographic conditions, clinical measures and self-perception of oral health-related quality of life. A stratified random sampling process was designed to obtain a representative sample of 27,853 older people living in Manaus, according to a demographic census carried out by the Brazilian Institute of Geography and Statistics (IBGE) in 2000, distributed among the

administrative areas of the city (North, South, East, West, Mid-South and Midwest). As a population-based survey, the sample was determined by drawing census sectors (1582 classified as urban areas), which were stratified according to the proportion of older residents in each one, totaling 254 sectors to participate in the draw. After the selection of sectors, the recruitment of individuals was carried out according to the methodology of the demographic census, that is, the blocks were covered, house by house, clockwise to identify the residences where there was the population of interest and interrupted when the size of the pre-set sample had been reached. The sample size calculation considered the proportion of edentulism estimated for the North region (53%), according to SB-Brasil 2003, with 95% of significance, margin of error of 2 and non-response rate of 20%, totaling 807 individuals[20].

Data were collected, in their own homes, by a single properly trained and calibrated researcher, whose intra-examiner Kappa statistic presented satisfactory values above 0.76 for the evaluated outcomes.

The baseline study sample after exclusion criteria and non-response rate was 667 subjects. Individuals who did not reach the minimum score in the cognition test (Verbal Fluency Test)[21] (1.5%), those who did not have health conditions to perform the exam (10.7%) were excluded, and the rate of non-response was 5.4%. The current study to formulate the multidimensional indicator used data from 621 individuals, as 5.7% of the sample presented incomplete data for the candidate variables for the construction of the proposed indicator.

After submission to the Research Ethics Committee of the Federal University of Amazonas/UFAM, the study obtained a favorable opinion for its execution 4,542,423. A Data Use Commitment Term (DUCT) was signed by the authors due to the impossibility of obtaining informed consent from the participants.

The variables studied for the construction of the multidimensional indicator are briefly described in Figure 1.

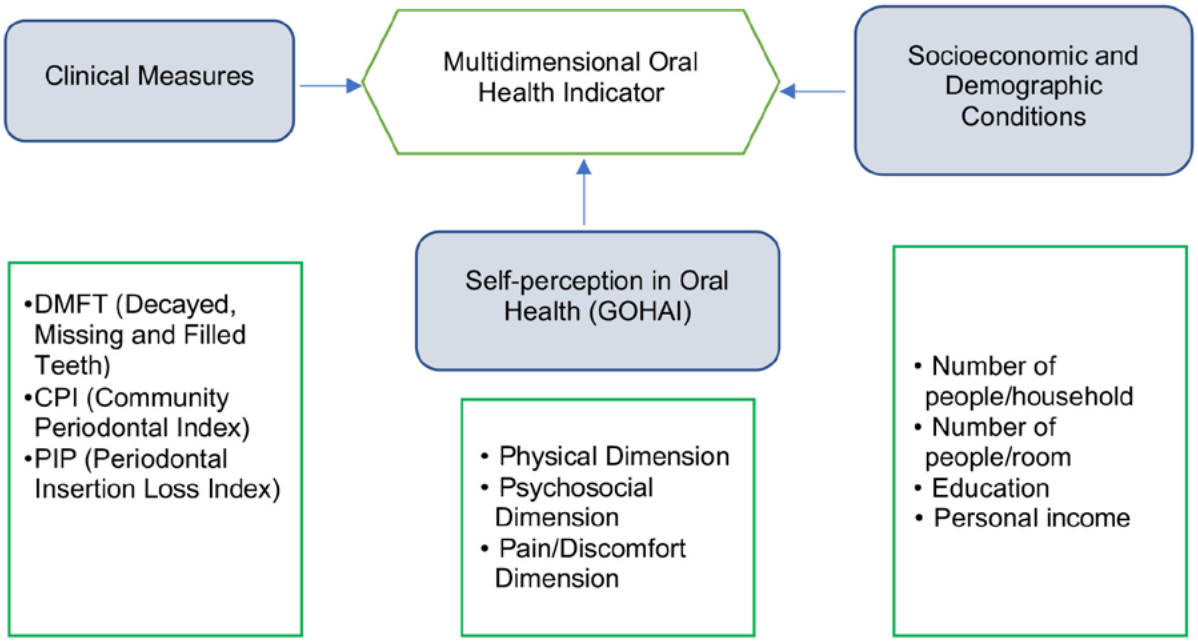

Figure 1. Conceptual model for the production of the multidimensional indicator of oral health of older adults.

Clinical measurements followed the criteria adopted by SB Brasil 2003[20]. Socioeconomic and demographic conditions were measured in interviews carried out using a questionnaire with objective questions and closed answers.

To assess the self-perception of quality of life related to oral health, the GOHAI index was used. Each individual answered twelve questions, whose answers fit into one of the following conditions: always, sometimes or never, corresponding respectively to scores 1, 2 and 3. The scores were added, the highest values indicate better self-assessment and the lowest values correspond to the worst self-rated oral health[22].

Through exploratory factor analysis (type R), the variables were reduced to common factors, which represent different dimensions of the oral health conditions of the older adults examined. To assess the applicability of the statistical model, a correlation matrix was used, based on Pearson's coefficient, followed by KMO statistics (Kaiser-Meyer-Olkin) and Bartlett's sphericity test. The factors were extracted using the Kaiser criterion and interpreted by the factor loading matrix. The production of a single indicator was conducted by adding the factor scores, followed by the dichotomization of this sum from the median for each individual in the sample. Finally, the validation of the indicator produced was carried out, through the criterion analysis. Thus, possible associations between the indicator produced and the variables that were not included in the model were tested, seeking relevant relationships with what was found in the literature.

RESULTS

Among the 621 participating individuals, it was observed that 432 (69.6%) individuals in the sample were female, with a mean age of 69.26 ± 3.00 and a mean monthly personal income of R$ 705.35 ± 908.03. As for skin color, 450 (72.5%) individuals declared themselves to be brown, followed by 96 (15.5%) who declared themselves to be white. Regarding education, 124 (20%) individuals had never attended school.

As for the impact of losses in the sample, related to incomplete data for factor analysis (5.7%), which were not considered in the baseline study, it was observed that they had little influence on the two main outcomes of the study. In the case of DMFT, it went from 29.08 to 29.27. For edentulism, this difference was 2.2, suggesting a low impact for the adopted model.

For the construction of the proposed indicator, initially, there were eighteen variables that could be incorporated into the proposed statistical model (Table 1). However, the best model, that is, the one with the best correlations and statistical applicability, had nine variables: "number of teeth present", "number of healthy teeth", "number of missing teeth", "number of sextants with calculus", "years of study", "personal income in reais", GOHAI score in the "physical", "psychosocial" and "pain/discomfort" dimensions.

The applicability of this model was initially confirmed from the analysis of Pearson's Correlation Matrix, in which a significant number of values greater than 0.30 and less than 0.90 were observed. In addition, other pre-tests were performed, the KMO statistic (Kaiser-Meyer-Olkin), also considered a measure of sample adequacy, whose value was 0.749, that is, a result greater than 0.5, indicated the adequacy of the model. Bartlet's sphericity test showed a p-value <0.001, confirming, once again, the use of factor analysis.

After confirming the adequacy of the model, some criteria must be adopted for the selection of factors (statistical variables). As for the selection of factors, the decision on the number of factors must be guided by the desired objective. For this study, the Kaiser criterion was used, from which three factors were extracted (Figure 2).

Table 1. Descriptive analysis of candidate variables for the production model of the multidimensional indicator of oral health for the older population. Manaus, AM, 2020.

Variables	Average ± SD	Median	$Q_{25} – Q_{75}$	CI (95%)
Age	69.26 ± 3.00	69.00	67.00 – 72.00	69.02 – 69.50
Years of study	4.54 ± 3.97	4.00	1.00 – 7.00	4.22 – 4.85
Personal income in reais	705.35 ± 908.03	415.00	415.00 – 800.00	633.26 – 777.43
Number of people/room	0.98 ± 0.75	0.80	0.58 – 1.25	0.92 – 1.04
Number of missing teeth	28.09 ± 5.37	32.00	25.00 – 32.00	27.67 – 28.52
Number of teeth present	3.82 ± 5.22	0.00	0.00 – 6.50	3.41 – 4.24
Number of healthy teeth	2.64 ± 3.70	0.00	0.00 – 5.00	2.34 – 2.93
number of decayed teeth	0.52 ± 1.46	0.00	0.00 – 0.00	0.41 – 0.64
Number of teeth restored	0.66 ± 1.95	0.00	0.00 – 0.00	0.50 – 0.82
DMFT	29.27 ± 3.86	32.00	27.00 – 32.00	28.97 – 29.58
Number of sextants with calculus	0.34 ± 0.64	0.00	0.00 – 1.00	0.29 – 0.39
Number of sextants with bleeding	0.01 ± 0.1	0.00	0.00 – 0.00	0.00 – 0.01
Number of sextants with shallow periodontal pocket (4-5 mm)	0.03 ± 0.21	0.00	0.00 – 0.00	0.01 – 0.05
Number of sextants with deep periodontal pocket (≥ 6 mm)	0.00 ± 0.00	0.00	0.00 – 0.00	0.00 – 0.01
Total GOHAI score	33.87 ± 2.74	35.00	33.00 – 36.00	33.65 – 34.09
GOHAI score physical dimension	11.29 ± 1.20	12.00	11.00 – 12.00	11.19 – 11.38
GOHAI score psychosocial dimension	14.26 ± 1.26	15.00	14.00 – 15.00	14.16 – 14.36
GOHAI score pain/discomfort dimension	8.32 ± 1.01	9.00	8.00 – 9.00	8.21 – 8.40

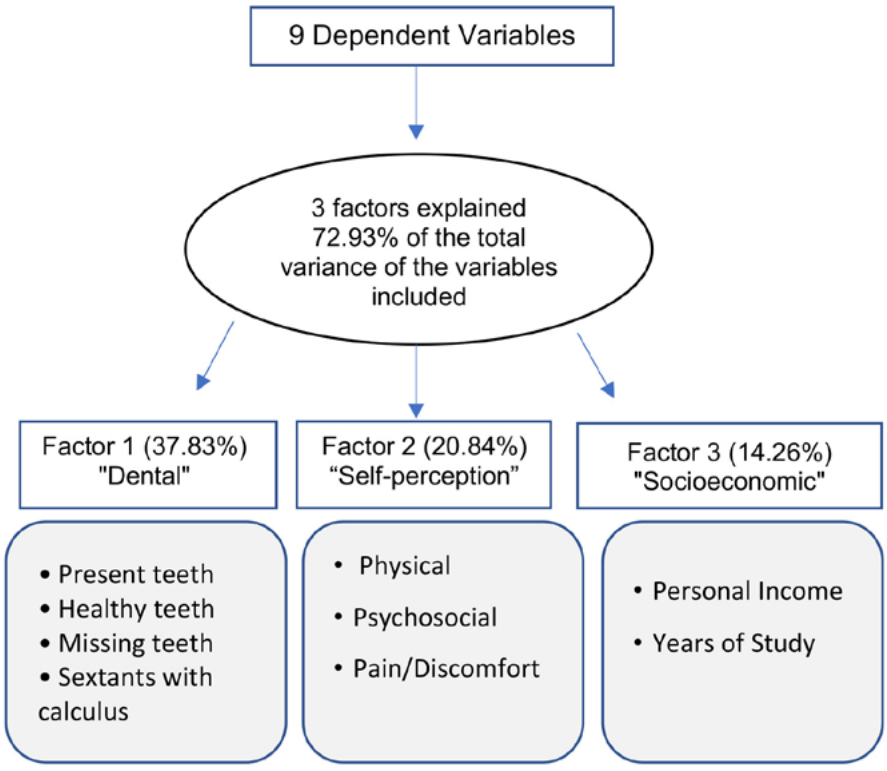

Figure 2. Data reduction, schematically represented, to obtain the factors of factor analysis.

It was also observed that the Sample Adequacy Measures (SAM) reinforced the applicability of the model since no variable presented SAM lower than 0.50 (Table 2). For the interpretation and composition of the extracted factors, the matrix of rotated factor loadings (VARIMAX-type Orthogonal rotation) was considered. The distribution of factor loadings is fundamental for the nomenclature of factors, because in addition to ensuring that the data meet the statistical requirements for an appropriate estimation of the factor structure, it is necessary that the set of variables present a conceptual foundation to support the results[23].

After extracting the three factors, each of the 621 individuals in the sample presented three scores referring to the factors obtained. Then, for each individual, the sum of the three scores was performed, where a new variable called "factorial sum" was added to the database. In this way, the oral health condition of older adults started to be categorized based on the median of the variable "factorial sum". Therefore, individuals who presented factorial sum values above the factorial median had their oral health condition classified as "favourable". On the other hand, individuals with factor sum values below this median had their oral health condition classified as "unfavorable".

For the criterion validation of the indicator produced, possible associations between the multidimensional indicator and independent variables that were not included in the model were investigated, in order to observe plausible associations according to the literature (Table 3).

Table 2. Factor loadings, Sample Adequacy Measures (SAM) and Commonalities of the final model for producing the multidimensional oral health indicator for the older population. Manaus, AM, 2020.

Variables	FACTORS			SAM	Commonalities
	F1	F2	F3		
Nº of missing teeth	**-0.961**	-0.007	-0.111	0.708	0.936
Nº. of teeth present	**0.965**	0.001	0.118	0.690	0.946
Nº. of healthy teeth	**0.940**	0.021	0.053	0.942	0.887
Years of study	0.155	0.019	**0.813**	0.612	0.686
Personal Income	-0.016	0.038	**0.810**	0.523	0.658
physical GOHAI	0.091	**0.823**	0.090	0.618	0.694
psychosocial GOHAI	-0.089	**0.773**	-0.109	0.631	0.617
pain GOHAI	-0.016	**0.760**	0.087	0.682	0.585
Nº. of sextants with calculus	**0.744**	-0.046	-0.026	0.958	0.556

Table 3. Criterion validation of the multidimensional oral health indicator for the older population. Manaus, AM, 2020.

Variable	Oral health status	Median ± DP	Difference between the medians	CI (95%)	*p**
Age	Unfavorable Favorable	69.52 ± 3.07 69.00 ± 2.92	0.52	0.05 – 0.10	0.03
Number of people/ room	Unfavorable Favorable	1.07 ± 0.84 0.90 ± 0.63	0.17	0.04 – 0.28	0.007
Family Income	Unfavorable Favorable	1153.62 ± 892.98 2058.06 ± 1974.61	-904.44	-1147.68 – -661.20	<0.001
Variable		Oral health status			*p***
		Unfavorable n (%)	Favorable n (%)		
Sex					
Male		72 (38.1)	117 (61.9)		<0.001
Female		238 (55.2)	193 (44.8)		
Housing Zone					
East		54 (69.2)	24 (30.8)		<0.001
Midsouth		20 (32.8)	41 (67.2)		
West		39 (39.0)	61 (61.0)		
South		114 (52.1)	105 (47.9)		
North		39 (52.0)	36 (48.0)		
Midwest		41 (55.4)	33 (44.6)		

* T test for independent samples; ** Pearson's Chi-Square Test.

DISCUSSION

This study found the importance of a multidimensional assessment of the oral health of older adults using a single indicator, since some variables that composed the model presented values that alone do not reflect the real situation of the oral health of this individual. Based on the factors extracted, it was observed that some variables with low factor loading, such as "pain GOHAI", proved to be adequate for the proposed model, that is, with acceptable values of SAM and commonalities. Thus, the oral health condition was measured by quantitative variables, capable of measuring dental and non-dental dimensions related to this outcome.

Unlike other indicators already proposed that sought to overcome the limitations of the DMFT index for the older population, such as the T-Health (*Tissue Health*) that assesses changes in soft tissue and the FS-T index (*Filled and Sound Teeth*), which considers dental functionality[24], the proposed indicator encompasses, in addition to dental variables, socioeconomic and quality of life aspects related to oral health, with all these dimensions represented by three factors that together explained 79.23% of the total variance.

The factors extracted from the linear relationships between the variables showed a greater representativeness (variance) of the first factor extracted (37.83%), that is, the dental characteristic. Within the "dental" factor 1, a low factor loading of the variable "number of sextants with dental calculus" can be observed, despite the great relevance of the periodontal condition for the Brazilian older population[6]. Even with the WHO goal to increase the number of older individuals with a functional dentition in the year 2000, the clinical indicators evaluated showed a difficulty in the analysis of periodontal indexes due to the high prevalence of excluded sextants, that is, a reduced number of teeth present[20].

The second factor extracted, "self-perception", is based on the residual amount of variance, and can be characterized as one of the factors that most differentiates the individuals in the sample[25]. A previous study corroborates this specificity of the older population, since only in this population the self-assessment of oral health presents better results in edentulous individuals[26]. Normally, the older person is more resilient and admits the loss of teeth as a natural process of aging, not realizing their negative condition. The absence of painful processes or aesthetic impairments leads them to underestimate oral problems, evidencing the importance of social and cultural determinants for the perception of the concept of oral health for the older population[27].

The validity of the model was verified from associations between oral health and contextual variables already described in the literature. It was observed that male individuals had a higher percentage of favorable indicator ($p<0.001$), which may be associated with a higher prevalence of edentulism among women and greater use of dentures[28]. Male sex and better socioeconomic conditions have already been identified as protective factors for edentulism among older individuals[29]. Furthermore, the worse health condition of older women may be associated with their greater longevity and implies a greater need for attention in all life cycles[30]. Regarding the family income variable, it is observed that individuals with a family income above R$ 1,974.61 showed a higher percentage of favorable indicator than those with income below this value, demonstrating an association already evidenced in the literature[31,32]. For the older population, lifetime socioeconomic inequities are associated with an increased risk of tooth loss[33].

The impact of the high prevalence of tooth loss and the low use of dentures in the Brazilian older population is reflected in the self-perception of quality of life related to oral health, more markedly in the country as a result of social inequalities[34]. The identification of the influence of contextual and individual health determinants is evidenced in the percentage of individuals with an unfavorable indicator in the East Zone of Manaus (69.2%), considering that it is one of the most populous regions of the city, with disorderly occupation, serious social and environmental problems, in addition to the lowest human development indicator (HDI) in the capital[35].

The results of the present study must be seen in light of its strengths and limitations. A limitation related to the base study was the non-inclusion of important variables in the health context of older adults, such as, for example, multimorbidity and polypharmacy. As strong points, the following stand out: the study scenario, as it is a region that has been little studied, mainly in relation to the outcome and specific population, and the construction of a model that allowed the production of a multidimensional indicator of oral health, approaching the current concept of oral health advocated by the WHO.

CONCLUSION

The indicator produced, by aggregating different dimensions of the oral health condition, was able to overcome the limitations of traditional dental indexes, due to the high tooth loss in the older population. Validation through comparisons with variables already described in the literature proved the role of social determinants of health, throughout life, in the oral health status of these individuals. It is noteworthy the possibility of reproducibility of the model in different databases, in the most diverse research scenarios, regardless of the moment when the data were collected, since the model is fixed for the construction of composite indicators. Therefore, this model allows decision-making for the formulation and improvement of policies, both for prevention and control, as well as for defining priorities and forecasting future demands related to the oral health of the older population.

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