

Oral impacts mediate the association between reduced dentition and self-perceived need for complete dentures

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Abstract

Background: To evaluate the direct association and oral impact-mediated association between a reduced dentition and the self-perceived need for complete dentures (CD) in dentate adults.

Methods: Data from the Brazilian National Oral Health Survey (2010) were analyzed. Self-perceived need for complete dentures was investigated by the question "Do you think you need to wear CD?". The hierarchical dental functional classification defined reduced dentitions: at least one tooth in each arch, 10 teeth in each arch, 12 anterior teeth, posterior occluding pairs (POPs) of premolars (≥ 3) and molars (≥ 1 bilateral). Presence of all these criteria were defined as functional dentition (FD_{ClassV}). Oral impacts were assessed using the Oral Impacts on Daily Performances scale. Associations were investigated using logistic regression and structural equations.

Results: FD_{ClassV} was associated with less self-perceived need for CD both directly ($p < 0.001$) and mediated by oral impacts ($p = 0.003$). Dentitions without molar POPs were associated with the outcome mediated by oral impacts ($p = 0.002$). Individuals with 10 teeth in each arch (with or without anterior teeth and POPs) had similar frequencies of self-perceived denture needs. Individuals with < 10 teeth in each arch and 12 posterior teeth did not have a higher frequency of self-perceived denture need.

Conclusions: Oral impacts mediated the association between reduced dentitions and self-perceived denture needs. Clinical relevance: Individuals with tooth loss may report need for CD, even when they have dental configurations compatible with functionality. The dentist must taken into account patient-centered measures to make decision about oral health prevention and treatment.

Background

Oral health is a fundamental component of general health, physical and mental wellbeing as well as the capacity to speak, smile, smell, taste, touch, chew, swallow and transmit a variety of emotions through facial expressions with confidence and without pain, discomfort or disease in the craniofacial complex [1]. Moreover, oral health is influenced by the values, perceptions, expectations, and attitudes of individuals and communities [2].

Patient-centered measures have been incorporated into the assessment of physical, psychological and social aspects of oral health beyond strictly clinical and normative measures [3,4]. This approach considers oral health to be a determinant of quality of life [1] and is especially important to the investigation of reduced dentitions with an emphasis on the functional components of oral health. Indeed, associations have been found between reduced dentitions and general quality of life [5] as well as oral health-related quality of life (OHRQoL) [3,6-8]. Reduced dentitions have been assessed using different definitions based only on the number or the type, location and function of remaining teeth. There is a consensus in the literature that reduced dentitions with the preservation of the anterior teeth and posterior occlusal units are compatible with quality of life and satisfaction [3,9]. In contrast, a greater number of missing teeth is associated with a negative perception of oral health [10,11] and general health [12] as well as lower general quality of life [5] and OHRQoL [4].

In cases of tooth loss, rehabilitation with complete dentures may be perceived as a definitive solution for oral problems. Studies with a qualitative approach have found that tooth extraction and the placement of complete dentures is often perceived as the only solution when tooth loss compromises basic oral functions, such as chewing, aesthetics and speech [13]. It is possible that this perception changes depending on the different types of reduced dentition and the occurrence of oral impacts. To the best of our knowledge, however, no analytical

epidemiological studies have investigated the direct association between different reduced dentitions and the self-perceived need for complete dentures or whether oral impacts mediate this association. Considering consistent evidence of the influence of socio-demographic and economic characteristics on clinical conditions and perceptions regarding oral health [14-16], such an analysis should consider other social determinants of health. The results of this study could contribute to the identification of priority groups for health promotion actions and more conservative rehabilitative treatment that value the preservation of the remaining teeth throughout life, despite the occurrence of missing teeth. Such strategies could contribute to reducing the prevalence of edentulism among adults and seniors, which is a situation that affects approximately 150 million people around the world [17].

In the present investigation, we tested the hypothesis that adults with dentitions that have fewer functionality criteria in terms of esthetics and occlusion as well as more oral impacts perceive the need for complete dentures (CD) with greater frequency. Thus, the aim of this study was to evaluate the direct association and the association mediated by oral impacts between reduced dentitions and the self-perceived need for CD among dentate adults.

Methods

Sample and study design

A cross-sectional study was conducted using secondary data from the 2010 National Oral Health Survey (SBBrasil 2010) developed by the Brazilian Health Ministry in the five regions of the country [18]. The geographic division of the country into regions was determined by the Brazilian Institute of Geography and Statistics and is adopted in epidemiological studies with a national scope. These regions were part of the sampling plan with the 27 state capitals (including the Federal District), totaling 32 domains formed by 177 municipalities (the 27 capitals + 30 municipalities in each region). The sample was obtained through a random selection of municipalities and census sectors, characterizing multi-stage cluster sampling with probability proportional to population size [19]. Detailed information on the sample planning can be found elsewhere [19,20].

The participants of the present study were dentate adults between 35 and 44 years of age who did not wear any type of fixed or removable denture. Edentulous individuals and those who wore dentures were excluded because the system adopted for the classification of reduced dentition, which was that proposed by NGUYEN *et al.* (2011) [21], is based on only natural remaining teeth. Moreover, this exclusion criterion was chosen considering the unavailability of information on satisfaction with one's dentures and therefore the impossibility of controlling for the effect of this variable on self-reported perceptions of denture need.

Data collection

Data collection involved oral examinations and interviews using questionnaires addressing demographic and socioeconomic characteristics as well as perceptions regarding oral health. The field teams were formed by examiners who had undergone calibration exercises ($Kappa > 0.65$) and trained annotators [20]. The oral examinations were performed following the guidelines of the World Health Organization (WHO) manual for epidemiological studies [22], using the Decayed, Missing and Filled Teeth (DMFT) index, Community Periodontal Index and clinical attachment loss for the determination of the dental and periodontal status, respectively. The total number of teeth was determined by the number of teeth present, excluding codes 4 and 5 (missing) and 8 (unerupted) of the DMFT index. A posterior occluding pair (POP) was defined as a pair of antagonist posterior teeth on each side of the mouth, such as the pair formed by teeth 16 and 46, for example.

Response variable

The self-perceived need for CD was determined by the answer to the following question: "In your opinion, do you need complete dentures or need to exchange your current dentures?" [18], for which the response options were "yes", "no" or "does not know/did not answer". As denture wearers were excluded from the study, the response referred to the self-perceived need for complete dentures. This criterion eliminated those who reported wanting to exchange their CD.

Assessment of dentition

A dentition classification system was employed for the definition of reduced dentitions. This system consists of five hierarchical levels based on the functionality of the teeth in terms of esthetics and occlusion [21,23]. A functional dentition (FD_{ClassV}) [21,23] was recorded when the dentition had all five of the following levels: Level I – at least one natural tooth in the maxilla and mandible; Level II – at least 10 teeth in each arch to enable nine to 10 pairs of opposing teeth; Level III – all 12 anterior teeth present; Level IV – at least three pre-molar POPs; and Level V – at least one molar POP bilaterally.

Based on this system, the following categories were defined:

- a) 10 teeth in each arch, <12 anterior teeth, with or without ≥ 3 premolar POPs, with or without ≥ 1 molar POP bilaterally (reference category)
- b) Functional dentition (FD_{ClassV})
- c) 10 teeth in each arch, 12 anterior teeth, ≥ 3 premolar POPs, without ≥ 1 molar POP bilaterally
- d) 10 teeth in each arch, 12 anterior teeth, without ≥ 3 premolar POPs, with or without ≥ 1 molar POP bilaterally
- e) Less than 10 teeth in each arch, 12 anterior teeth, with or without ≥ 3 premolar POPs, with or without ≥ 1 molar POP bilaterally
- f) Less than 10 teeth in each arch, <12 anterior teeth, ≥ 3 premolar POPs, with or without ≥ 1 molar POP bilaterally
- g) Less than 10 teeth in each arch, <12 anterior teeth, without ≥ 3 premolar POPs, ≥ 1 molar POP bilaterally
- h) Less than 10 teeth in each arch, <12 anterior teeth, without ≥ 3 premolar POPs, without ≥ 1 molar POP bilaterally
- i) Less than one tooth in each arch

The reference category was adopted based on the concept of "20 well-distributed teeth", with at least 10 teeth in each arch, which is believed to ensure minimum functionality. This category is also based only on the number of teeth, without considering tooth type and occlusal functions and was used for the purposes of comparison with other dentitions considering all or some of the functionality criteria defined by NGUYEN *et al.* (2011) [21]. This comparison enables the identification of specific criteria from which an association with a self-perceived need for CD may be found.

Assessment of oral impacts

Oral impacts were assessed using nine items of the Oral Impacts on Daily Performance (OIDP) scale, which is widely used for the assessment of OHRQoL [24]. The OIDP addresses problems caused by the teeth in the previous six months regarding the following aspects of daily living: eating, cleaning the teeth, affected mood, having fun, practicing physical activities, speaking, smiling without embarrassment, working and sleeping. Each item has dichotomous response options (0: absence of impact; 1: presence of impact). Oral impact was recorded for any individual who reported that problems with the teeth affected one or more aspects of daily living ($\text{OIDP} \geq 1$).

Covariables

The covariables were demographic characteristics (sex and self-declared skin color [white, black, brown, yellow/indigenous]), socioeconomic characteristics (income and schooling), perceptions regarding oral health and symptoms (satisfaction with teeth/mouth and reports of dental pain in the previous six months) and clinical variables (gingival bleeding, calculus, shallow periodontal pocket [4-5 mm] and deep pocket [6 mm]). Income was the sum of monthly family earnings determined in Brazilian currency and converted into American dollars (mean exchange rate in 2010: R\$1.76 = US\$1.00) in the following categories: \leq US \$ 284, US \$ 285 to US \$ 852, US \$ 853 to US \$ 2557 and $>$ US \$ 2557). Schooling was categorized based on complete years of study (\leq four years, five to eight years, nine to 11 years, and 12 or more years). Satisfaction with the teeth/mouth was assessed using the following question: "Regarding your teeth, would you say you are very satisfied, satisfied, neither satisfied nor dissatisfied, dissatisfied or very dissatisfied?" [14] The response options were grouped into satisfied (very satisfied + satisfied) and dissatisfied (neither satisfied nor dissatisfied + dissatisfied + very dissatisfied).

Statistical analysis

Descriptive analysis was performed to characterize the sample and obtain the frequency of adults according to the categories of the variables investigated. The chi-square test was used to compare denture wearers and non-wearers. Crude and adjusted logistic regression models were then used to estimate the association between dentition and the self-perceived need for CD. The variables maintained in the final multiple model were those for which the association with the response variable was statistically significant ($p \leq 0.05$) or that contributed to the fit of the model and had importance recognized in the literature (sex and schooling). The goodness of fit of the model was evaluated using the Hosmer-Lemeshow test. Variables that remained in the final model were used in a structural equation model to evaluate direct and indirect associations between a reduced dentition and the self-perceived need for complete dentures.

Structural equation modeling consists of a measurement model that establishes how latent constructs are measured and a structural model used to analyze associations between variables. In the present study, the latent variable (represented by a circle) was obtained through the nine OIDP items using confirmatory factor analysis. The parameters were estimated using weighted least squares and variance estimates. We estimated the total effects, which are composed of both direct effects (a direct path from one variable to another [e.g., dentition \rightarrow self-perceived denture need]) and indirect effects (path mediated by other variables [e.g., income \rightarrow self-perceived denture need via oral impacts]). The estimates of the parameters of direct and indirect associations and 95% confidence intervals (CI) were determined using the bootstrapping method with 1500 iterations. The goodness of fit of the model was evaluated using the root mean square error of approximation (RMSEA), the comparative fit index (CFI) and the goodness-of-fit index (GFI). RMSEA < 0.05 indicates a strong fit, 0.5 to 0.08 indicates a reasonable fit and > 0.1 indicates an inadequate fit. CFI and GFI of 1.0 indicate a complete fit of the model and CFI and GFI > 0.95 indicate a good fit [25,26].

All analyses were performed using Stata® 15.0 (StataCorp, College Station, Texas, USA) and Mplus® 8.3 (Muthén & Muthén, Los Angeles, California, USA), considering complex sampling and sample weights.

Ethical aspects

The SBBrasil 2010 project was conducted in accordance with the standards stipulated in the Declaration of Helsinki and received approval from the National Human Research Ethics Committee (certificate number: 15.498, on January 7th, 2010).

Results

The total sample was composed of 9547 adults, 24 of whom were completely edentulous and were excluded. Among the dentate individuals, 6083 (63.7%) did not use fixed, removable or complete dentures and composed the final sample of the present study. The excluded group had significantly more women ($p = 0.000$), individuals with brown skin color ($p = 0.004$), income up to R\$500 ($p = 0.000$) and oral impacts ($\text{OIDP} \geq 1$) ($p = 0.000$). The majority of adults did not perceive a need for CD (72.2%). The characterization of the sample is displayed in Table 1. Individuals with a functional dentition ($\text{FD}_{\text{ClassV}}$), those with oral impacts and those who were dissatisfied with their teeth/mouth comprised the majority of the sample (58.8%, 53.3% and 56.8%, respectively) (Table 1).

The additional file 1 displays the proportion of the self-perceived need for CD as well as the mean number of teeth and POPs according to the levels of the dental functional classification system. Among the entire sample, 6028 adults (99%) had at least one tooth in each arch (Level I). The self-perceived need for CD was higher among those with 10 teeth in each arch and the absence of all anterior teeth (36.1%). Among those with the complete anterior sextant, 23.4% perceived a need for CD. The proportion of self-perceived need for CD was higher among individuals who did not successively meet the criteria of the dental functional classification system (right side of additional file 1). Individuals with a functional dentition ($\text{FD}_{\text{ClassV}}$) had an average of 28.9 teeth and 7.6 POPs. Those with a dentition that did not meet the criteria for Levels II to V had an average of 16 teeth and 1.2 POPs.

Note: Level I - at least 1 tooth in each arch; Level II - ≥ 10 teeth in each arch; Level III - 12 anterior teeth; Level IV - ≥ 3 premolar POPs; Level V - ≥ 1 molar POP bilaterally. The left side of figure corresponds to individuals who met the criteria and those on the right side did not meet the criteria.

The results of the final multiple logistic regression models demonstrated a significant association between a reduced dentition and the self-perceived need for CD in the presence of the adjustment variables (sex, skin color, income and schooling). Greater self-perceived denture need was found among those whose dentitions were missing all anterior teeth with or without the presence of POPs (Table 2). Adults with a functional dentition ($\text{FD}_{\text{ClassV}}$) had a 56% lower chance of perceiving a need for CD ($\text{OR} = 0.44$; 95% CI: 0.28 to 0.70) compared to those with 10 well-distributed teeth, less than 12 anterior teeth and with or without satisfactory posterior occlusal contact. The odds of the self-perceived need for CD among adults with less than one tooth in each arch was 6.29-fold higher compared to those who had 10 well-distributed teeth in each arch ($\text{OR} = 6.29$; 95% CI: 1.55 to 25.52). A significant association was also found between oral impacts and the self-perceived need for CD. Individuals with $\text{OIDP} \geq 1$ had a 107% greater chance of a self-perceived need for CD than those without impact ($\text{OIDP} = 0$) ($\text{OR} = 2.07$; 95% CI: 1.51 to 2.85). Other factors associated in the final model were skin color and income. The variables included in the structural equation model were dentition, OIDP, skin color and income.

Figure 1 and table 3 respectively display the direct and indirect associations between the variables. Having a functional dentition (FD_{ClassV}) was associated a lower frequency of a self-perceived need for complete dentures directly ($[SC] = -0.250$; $p < 0.001$) and via oral impacts ($p = 0.003$). Having a functional dentition was also directly associated with a lower OIDP [$FD_{classV} [SC] = -0.206$; $p < 0.001$] and the dentition category '10 teeth in each arch + 12 anterior teeth + ≥ 3 premolar POPs and without molar POPs' ($[SC] = -0.149$; $p < 0.001$). Dentitions with missing anterior teeth and/or POPs (with the exception of the category 'less than 10 teeth in each arch, < 12 anterior teeth, ≥ 3 premolar POPs, with or without ≥ 1 molar POP bilaterally') were associated with a greater frequency of a self-perceived need for CD (direct positive association). The category '10 teeth in each arch, 12 anterior teeth, ≥ 3 premolar POPs, without ≥ 1 molar POP bilaterally' was not directly associated with the outcome, but an oral impact-mediated association was found ($p = 0.002$). The coefficients of the latent variable OIDP ranged from 0.688 to 0.882 and a significant direct effect of oral impacts was found on the self-perceived need for CD ($p = 0.042$). Significant direct and indirect (via oral impacts) effects were found among some skin color and income categories, which also had significant direct effects on the OIDP (Figure 1 and Table 3).

Discussion

Individuals with less tooth loss (FD_{ClassV}) had fewer oral impacts and a lower frequency of self-perceived needs for complete dentures. Oral impacts mediated the association between a reduced dentition and the self-perceived need for CD. This mediation indicates that aspects of daily living related to the teeth and mouth should be addressed to gain a better understanding of the self-perceived need for CD and should be considered when developing educational actions directed at adults with the aim of preserving the teeth and their functions. This finding is consistent with previous evidence of greater satisfaction with oral health and a greater frequency of an absence of impact (OIDP = 0) among adults with a functional dentition (FD_{ClassV}) [3].

Oral impacts also mediated the association between a reduced dentition characterized by the absence of molar POPs bilaterally and the self-perceived need for CD. Individuals with this type of dentition did not have a greater self-perception of CD needs, but reported fewer oral impacts, which, in turn, were associated with the self-perception of the need for CD. The direct negative association between a dentition with an absence of molar POPs and OIDP is consistent with previous findings that a dentition with three premolar POPs, complete anterior region and no molar POPs is sufficient to satisfy the majority of individuals with regards to oral health [27]. Likewise, previous studies found that OHRQoL (mediated by oral impacts) did not differ between individuals with dentitions containing anterior teeth and premolars (reduced dental arch) and more complete dentitions [6,7].

The direct positive association between oral impacts and a self-perceived need for CD also reveals the importance of evaluating oral functions in person-centered care. The self-perception of denture needs by a dentate individual may be the consequence of the impact of the teeth and mouth on aspects of daily living and does not necessarily signify a need for CD defined by the clinical condition. A previous study conducted with the same sample of adults found that the measure of the self-perceived need for CD overestimated the normative need by about 30% [28], demonstrating that this is a measure of little usefulness in the estimation of normal dental needs. Moreover, the self-perceived denture need may be influenced by cultural aspects, beliefs and values regarding tooth loss, which is often seen as a natural part of aging [13]. The results of the present study show that the loss of a greater number of teeth resulting in dentitions with less than 10 teeth in each arch and no anterior teeth (even in the presence of POPs) was directly associated with a greater frequency of oral impacts and a self-perceived need for CD. Therefore, advanced

tooth loss and its impacts may limit the perception of partial dentures as a rehabilitation option for the recovery of function with the preservation of natural teeth.

The logistic regression model revealed that the frequency of the self-perception of the need for CD was similar among individuals with 10 teeth in each arch, independently of the presence/absence of anterior teeth and premolar and molar POPs. This finding is consistent with the concept that 20 well-distributed teeth ensure adequate oral function by providing nine to ten occlusal pairs [27]. In a population-based sample of Vietnamese adults, the distribution of teeth based on the limit of 10 teeth in each arch included greater percentages of complete anterior regions as well as sufficient premolar and molar regions [21]. These findings suggest that the criterion based on the number of teeth is associated with a dentition that ensures the basic functions of chewing and esthetics. The lack of a significant direct association or the negative direct association between dentitions with 10 teeth in each arch and OIDP in the structural equation model lend support to this finding.

Individuals with “less than 10 teeth in each arch, 12 anterior teeth, with or without > 3 premolar POPs, with or without > 1 molar POP bilaterally” did not have a significantly greater frequency of a self-perceived need for CD compared to those with “10 teeth in each arch, < 12 anterior teeth, with or without > 3 premolar POPs, with or without > 1 molar POP bilaterally”. This finding suggests that the presence of anterior teeth favors a more positive perception of the teeth even when individuals do not have 10 teeth in each arch, which may be explained by the importance attributed to esthetics and the strong associations between the anterior teeth and satisfaction with one's mouth, psycho-functional wellbeing and the absence of impact [3,29-32]. This may be due to the key role the anterior teeth play in the personal image of individuals [32] and their social relations [27], as the frequency of impact on smiling/speaking is lower among those who have complete anterior sextants [3].

Regarding demographic characteristics, adults who declared having brown or yellow/indigenous skin had greater impact measured by the OIDP. Individuals with brown skin also had a greater frequency of a self-perceived need for CD and this association was mediated by greater oral impact measured using the OIDP. These results may be partially explained by the greater dissatisfaction with oral health expressed by non-whites of different nationalities [15,33]. More dissatisfied individuals likely perceive impact and the need for CD more often.

In terms of socioeconomic characteristics, both the final regression model and structural equations identified that the self-perceived need for CD and oral impacts were less frequent among individuals with a higher income compared to those in a lower economic class. The association between a higher income and the lower frequency of perceived denture needs was both direct and mediated by oral impacts. Indeed, there seems to be a direct association between low income and dissatisfaction, as found among adults in northeastern Brazil [15].

These results underscore the occurrence of inequities in health, as individuals with a lower income and non-whites have greater oral impacts and a greater frequency of a self-perceived need for CD. The identification of such inequities is coherent with the recognition that socially and economically disadvantaged groups have worse health conditions and experience a greater impact of oral problems on quality of life [34], demonstrating that the present findings are in line with the theory of social determinants of health. Moreover, worse socioeconomic conditions are associated with the irregular use of healthcare services. As a result, individuals only seek care in urgent situations involving pain and complex oral problems, which culminate in tooth loss [35]. This is due to the fact that options for maintaining one's natural teeth are costly³⁵ and often not available at public healthcare services. Moreover, the acceptance in different cultures, especially those in developing countries, of tooth loss as a natural part of life [13] is related to this social vulnerability. It is therefore understandable that individuals with a lower income and non-whites perceive a greater need for CD.

This study evaluated a sample of Brazilian adults based on the methods standardized by the WHO (1997) [22] but has limitations that should be considered. The cross-sectional design does not enable the establishment of causal relations or the evaluation of the temporal relation assumed in the model tested (reduced dentition → oral impacts on daily performance → self-perceived need for CD). Another limitation is the possible selection bias of the participants, as the exclusion of denture wearers led to a significant loss of the representativeness of the sample. The associations between self-perceived denture needs and skin color, income and oral impacts may have been underestimated due to the profile of the sample included in the study. Moreover, individuals with a complete dentition (35.69%) were included among those classified as having a functional dentition (FD_{ClassV}). Such individuals may have an even lower frequency of oral impacts and self-perceived needs for CD compared to those that met all the functionality criteria defined by the dental functional classification system employed in the present study even with the loss of one or more teeth. Thus, the association between FD_(ClassV) and self-perceived denture needs may be underestimated due to this potential positive effect of a complete dentition.

The strengths of the present study include the estimates generated by the statistical analysis, which considered sample weights and the complex sampling design. We used established indices that indicated the goodness of fit of the model to the data when compared to reference values [25,26]. Moreover, the present study addressed an issue that remains under-explored in the literature, considering the association between different reduced dentitions and the self-perceived need for CD in a sample of Brazilian adults.

The present results suggest that individuals in situations of greater social disadvantage and those with greater tooth loss could benefit from educational approaches that highlight the importance of preserving their natural teeth and oral functions throughout life. Such actions should be accompanied by an increase in access to conservative treatment and rehabilitation with partial dentures. Recognizing the complexity of the subjective aspects of oral health and combining the clinical evaluation with an assessment of oral impacts with a focus on functionality centered on the person is fundamental to integral oral care contextualized to the social situation of each individual.

List Of Abbreviations

CD: Complete dentures; POP: Posterior occluding pair(s); FDClassV: Functional dentition; OHRQoL: Oral health-related quality of life; SBBrazil 2010: 2010 National oral health survey; WHO: World Health Organization; DMFT: Decayed, Missing and Filled Teeth; OI DP: Oral Impacts on Daily Performance; CI: confidence intervals; RMSEA: Root mean square error of approximation; CFI: Comparative fit index; GFI: Goodness-of-fit index; SC: Standardized coefficients

Declarations

Ethical approval and consent to participate

The Brazilian National Human Research Ethics Committee approved the 2010 NOHS under process number 15,498 on July 1st, 2010. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in this study.

Consent for publication

Not applicable.

Availability of data and materials

The data that support the findings of this study are available from the Brazilian Health Ministry, but restrictions apply to the availability of these data, which were used under license for the current study and are therefore not publicly available. However, data are available from the authors upon reasonable request and with permission of the Brazilian Health Ministry.

Additional file

File name: **Additional file 1** Distribution of individuals according to hierarchical dental functional classification system on five levels

File format: Microsoft word

Description of data: The additional file 1 displays the proportion of the self-perceived need for CD as well as the mean number of teeth and POPs according to the levels of the dental functional classification system. Among the entire sample, 6028 adults (99%) had at least one tooth in each arch (Level I). The self-perceived need for CD was higher among those with 10 teeth in each arch and the absence of all anterior teeth (36.1%). Among those with the complete anterior sextant, 23.4% perceived a need for CD. The proportion of self-perceived need for CD was higher among individuals who did not successively meet the criteria of the dental functional classification system (right side of additional file 1). Individuals with a functional dentition (FD_{ClassV}) had an average of 28.9 teeth and 7.6 POPs. Those with a dentition that did not meet the criteria for Levels II to V had an average of 16 teeth and 1.2 POPs.

Note: Level I - at least 1 tooth in each arch; Level II - ≥ 10 teeth in each arch; Level III - 12 anterior teeth; Level IV - ≥ 3 premolar POPs; Level V - ≥ 1 molar POP bilaterally. Left side of figure corresponds to individuals who met the criteria and those on the right side did not meet the criteria.

Competing interests

The authors RCF is a member of the editorial board of the BMC Oral Health.

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Authors' contributions

FLC is the principal researcher, has made substantial contributions to: obtaining, analyzing and interpreting data; writing of the article and relevant critical review of the intellectual content; final approval of the version to be published; participated of all aspects of work. IK made substantial contributions to: interpretation of data for the study; relevant critical review of intellectual content; final approval of the version to be published; participated of all aspects of work. GACR made substantial contributions to: obtaining and interpreting data for the study; writing of the article; final approval of the version to be published; participated of all aspects of work. AAS made substantial contributions to: interpretation of data for the study; relevant critical review of intellectual content; final approval of the version to be published; participated of all aspects of work. LLFH made substantial contributions to: analysis

and interpretation of data for the study; writing of the article and relevant critical review of intellectual content; final approval of the version to be published; participated of all aspects of work. RCF is the study supervisor, made substantial contributions to: data collection, analysis and interpretation; writing of the article and relevant critical review of the intellectual content; final approval of the version to be published; participated of all aspects of work. All authors read and approved the final manuscript.

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Tables

ble 1 – Distribution of sample according to variables investigated in Brazilian adults. SBBrazil 2010. (n = 6083)

Variables	n	% (CI 95%)
Reduced dentition		
10 teeth in each arch, <12 anterior teeth, with or without ≥ 3 premolar POPs, with or without ≥ 1 molar POP bilaterally	480	8.24 (6.8-9.9)
Functional dentition (FDClassV)	3,384	58.8 (55.5-61.9)
10 teeth in each arch, 12 anterior teeth, ≥ 3 premolar POPs, without ≥ 1 molar POP bilaterally	557	9.1 (7.4-11.1)
10 teeth in each arch, 12 anterior teeth, without ≥ 3 premolar POPs, with or without ≥ 1 molar POP bilaterally	915	15.4 (13.5-17.4)
Less than 10 teeth in each arch, 12 anterior teeth, with or without ≥ 3 premolar POPs, with or without ≥ 1 molar POP bilaterally	299	3.6 (2.8-4.7)
Less than 10 teeth in each arch, <12 anterior teeth, ≥ 3 premolar POPs, with or without ≥ 1 molar POP bilaterally	59	0.1 (0.5-1.6)
Less than 10 teeth in each arch, <12 anterior teeth, without ≥ 3 premolar POPs, ≥ 1 molar POP bilaterally	50	0.5 (0.3-0.7)
Less than 10 teeth in each arch, <12 anterior teeth, without ≥ 3 premolar POPs, without ≥ 1 molar POP bilaterally	284	3.0 (2.2-3.9)
Less than one tooth in each arch	55	0.6 (0.4-1.1)
Self-perceived need for complete dentures		
No	3,912	72.2 (68.8-75.4)
Yes	1,974	27.8 (24.6-31.2)
Presence of oral impacts		
Absence (OIDP=0)	3,076	46.7 (41.8-51.5)
Presence (OIDP ≥ 1)	3,007	53.3 (48.4-58.1)
<i>Demographic characteristics and socioeconomic characteristics</i>		
Sex		
Male	2,233	38.9 (35.2-42.8)
Female	3,850	61.1 (57.2-64.8)
Skin color		
White	2,626	49.7 (45.6-53.9)
Black	671	10.7 (9.04-12.6)
Yellow	103	1.1 (0.7-1.8)
Brown	2,635	37.5 (33.2-42.1)
Indigenous	48	0.1 (0.5-1.6)
Family income (US)*		
\leq US \$ 284	820	11.8 (9.7-14.1)
US \$ 285 to US \$ 852	2,889	52.2 (47.8-56.6)
US \$ 853 to US \$ 2557	1,185	22.0 (19.2-25.0)
> US \$ 2557	1,041	14.0 (11.4-17.1)
Schooling (in years of study)*		
≤ 4	916	17.4 (14.2-

		21.2)
5 to 8	1,549	27.1 (24.5-29.9)
9 to 11	1,933	30.9 (27.3-34.8)
≥ 12	1,647	24.6 (20.0-29.7)
Age group (years)		
35-39	3,558	56.7 (53.7-59.6)
40-44	2,525	43.3 (40.4-46.3)
Total	6,083	100.0
<i>Subjective aspects of oral health</i>		
Dental pain*		
No	4,499	70.9 (67.5-73.9)
Yes	1,563	29.1 (26.0-32.4)
Satisfaction with teeth/mouth *		
Satisfied	2,516	43.2 (39.5-47.0)
Dissatisfied	3,535	56.8 (53.0-60.5)
<i>Oral health conditions</i>		
Presence of gingival bleeding		
No	3,262	51.4 (47.1-55.5)
Yes	2,821	48.6 (44.5-52.8)
Presence of calculus		
No	1,884	30.9 (28.1-33.8)
Yes	4,199	69.1 (66.2-71.9)
Presence of shallow periodontal pocket		
No	4,344	71.2 (68.1-74.2)
Yes	1,739	28.7 (25.8-31.9)
Presence of deep pocket		
No	5,733	92.9 (90.4-94.7)
Yes	350	7.1 (5.3-9.6)

te: *n≠ 6,083; Satisfaction n= 6,051; Dental pain n=6,062; Income n= 5935; Schooling (in years) n= 6,045; self-perceived need for complete denture n= 5,886

able 2 – Crude and adjusted logistic regression models of self-perceived need for complete dentures and associated variables in Brazilian adults. SBBrazil 2010.

Variables ^a	Categories	n*	% self-perceived need for CD(yes)	Crude		Final Model	
				OR (95% CI)	p	OR (95% CI)	P
Reduced dentition	10 teeth in each arch, <12 anterior teeth, with or without ≥3 premolar POPs, with or without ≥1 molar POP bilaterally	465	36.1	1		1	
	Functional dentition (FD _{ClassV})	3,275	18.5	0.40 (0.26-0.62)	<0.001	0.44 (0.28-0.70)	<0.001
	10 teeth in each arch, 12 anterior teeth, ≥3 premolar POPs, without ≥1 molar POP bilaterally	537	33.5	0.89 (0.53-1.51)	0.669	1.03 (0.62-1.71)	0.912
	10 teeth in each arch, 12 anterior teeth, without ≥3 premolar POPs, with or without ≥1 molar POP bilaterally	883	36.4	1.01 (0.59-1.75)	0.961	1.05 (0.60-1.82)	0.863
	Less than 10 teeth in each arch, 12 anterior teeth, with or without ≥3 premolar POPs, with or without ≥1 molar POP bilaterally	288	46.6	1.55 (0.78-3.07)	0.212	1.52 (0.75-3.09)	0.244
	Less than 10 teeth in each arch, <12 anterior teeth, ≥3 premolar POPs, with or without ≥1 molar POP bilaterally	57	61.6	2.85 (1.05-7.70)	0.039	3.99 (1.35-11.83)	0.013
	Less than 10 teeth in each arch, <12 anterior teeth, without ≥3 premolar POPs, ≥1 molar POP bilaterally	50	67.9	3.75 (1.34-10.46)	0.012	4.21 (1.34-13.19)	0.014
	Less than 10 teeth in each arch, <12 anterior teeth, without ≥3 premolar POPs, without ≥1 molar POP bilaterally	279	76.1	5.63 (2.95-10.76)	<0.001	5.42 (2.80-10.47)	<0.001
	Less than one tooth in each arch	52	79.6	6.92 (1.90-25.20)	0.003	6.29 (1.55-25.52)	0.010
Impact	Absence (OIDP=0)	2,993	19.0	1		1	
	Presence (OIDP≥1)	2,893	35.5	2.34 (1.70-3.23)	<0.001	2.07 (1.51-2.85)	<0.001
Sex	Male	2,164	26.8	1		1	
	Female	3,722	28.4	1.08 (0.84-1.40)	0.531	1.02 (0.77-1.35)	0.877
Skin color	White	2,528	25.1	1		1	
	Black	653	33.1	1.48 (1.06-2.06)	0.021	1.19 (0.82-1.72)	0.360
	Brown	2,565	28.8	1.21 (0.91-1.59)	0.181	0.90 (0.66-1.24)	0.536
	Yellow/Indigenous	140	46.4	2.59 (1.38-4.87)	0.003	2.14 (1.05-4.38)	0.037
Family income	≤ US \$ 284	793	40.9	1		1	
	US \$ 285 to US \$ 852	2,784	29.4	0.60 (0.40-0.90)	0.014	0.81 (0.52-1.26)	0.350
	US \$ 853 to US \$ 2557	1,156	22.4	0.41 (0.26-0.67)	<0.001	0.68 (0.41-1.12)	0.130
	> US \$ 2557	1,021	15.8	0.27	<0.001	0.50	0.022

					(0.17-0.44)	(0.28-0.90)	
Schooling	≤4 years of study	883	35.4	1			
	5 to 8 years	1,478	30.7	0.81	0.282	0.94	0.787
				(0.55-1.19)		(0.63-1.42)	
	9 to 11 years	1,876	28.5	0.73	0.151	1.31	0.291
				(0.47-1.12)		(0.79-2.16)	
	≥ 12 years	1,621	18.2	0.41	<0.001	0.95	0.819
				(0.27-0.62)		(0.60-1.50)	
Dental pain	No	4,376	25.4	1			
	Yes	1,498	33.3	1.46	0.004		
				(1.13-1.90)			
Satisfaction	Very satisfied/Satisfied	2,461	19.2	1			
	Neither satisfied nor dissatisfied/Dissatisfied/Very dissatisfied	3,404	34.2	2.19	<0.001		
				(1.66-2.90)			
Gingival bleeding	No	3,203	26.2	1			
	Yes	2,683	29.4	1.17	0.362		
				(0.83-1.64)			
Calculus	No	1,857	25.8	1			
	Yes	4,029	28.7	1.16	0.307		
				(0.87-1.53)			
Shallow periodontal pocket	No	4,216	25.7	1			
	Yes	1,670	32.8	1.41	0.036		
				(1.02-1.96)			
Deep pocket	No	5,545	27.2	1			
	Yes	341	34.1	1.38	0.337		
				(0.71-2.69)			

*total n equal to 5,886 due to missing dependent variable self-perceived need for complete dentures (3,2%)

Final model obtained from the adjustment sequence: Model 1 - reduced dentition, satisfaction, impact, pain, gingival bleeding, calculus, shallow periodontal pocket, deep pocket, sex, income, schooling and skin color; Model 2 - reduced dentition, satisfaction, impact, sex, income, schooling and skin color; Final Model - shortened dentition, impact, sex, income, schooling and skin color.

Table 3: Standardized coefficients of direct and indirect associations determined by structural equation modeling. SBBras 010.

total and Indirect effect	Standardized coefficient	SE	P value
<i>Functional dentition (FD_{ClassV}) → self-perceived need for complete dentures</i>			
Total	-0.294	0.068	<0.001
Indirect (via OIDP)	-0.044	0.015	0.003
<i>10 teeth in each arch, 12 anterior teeth, ≥3 premolar POPs, without ≥1 molar POP bilaterally → self-perceived need for complete dentures</i>			
Total	-0.063	0.051	0.215
Indirect (via OIDP)	-0.032	0.010	0.002
<i>10 teeth in each arch, 12 anterior teeth, without ≥3 premolar POPs, with or without ≥1 molar POP bilaterally → self-perceived need for complete dentures</i>			
Total	-0.037	0.054	0.495
Indirect (via OIDP)	0.005	0.010	0.610
<i>Less than 10 teeth in each arch, 12 anterior teeth, with or without ≥3 premolar POPs, with or without ≥1 molar POP bilaterally → self-perceived need for complete dentures</i>			
Total	0.002	0.039	0.958
Indirect (via OIDP)	-0.002	0.007	0.821
<i>Less than 10 teeth in each arch, <12 anterior teeth, ≥3 premolar POPs, with or without ≥1 molar POP bilaterally → self-perceived need for complete dentures</i>			
Total	0.038	0.029	0.184
Indirect (via OIDP)	0.006	0.005	0.212
<i>Less than 10 teeth in each arch, <12 anterior teeth, without ≥3 premolar POPs, ≥1 molar POP bilaterally → self-perceived need for complete dentures</i>			
Total	0.046	0.020	0.023
Indirect (via OIDP)	0.001	0.003	0.791
<i>Less than 10 teeth in each arch, <12 anterior teeth, without ≥3 premolar POPs, without ≥1 molar POP bilaterally → self-perceived need for complete dentures</i>			
Total	0.146	0.038	<0.001
Indirect (via OIDP)	0.003	0.006	0.592
<i>Less than one tooth in each arch → self-perceived need for complete dentures</i>			
Total	0.132	0.033	0.000
Indirect (via OIDP)	0.005	0.006	0.442
<i>Skin color (Black) → self-perceived need for complete dentures</i>			
Total	0.042	0.033	0.208
Indirect (via OIDP)	0.011	0.007	0.118
<i>Skin color (Brown) → self-perceived need for complete dentures</i>			
Total	0.003	0.038	0.946
Indirect (via OIDP)	0.025	0.008	0.004
<i>Skin color (Yellow/Indigenous) → self-perceived need for complete dentures</i>			
Total	0.052	0.028	0.060
Indirect (via OIDP)	0.010	0.005	0.057
<i>Income US \$ 285 to US \$ 852 → self-perceived need for complete dentures</i>			
Total	-0.162	0.043	<0.001
Indirect (via OIDP)	-0.045	0.011	<0.001
<i>Income US \$ 853 to US \$ 2557 → self-perceived need for complete dentures</i>			
Total	-0.116	0.049	0.019
Indirect (via OIDP)	-0.037	0.012	0.001
<i>Income > US \$ 2557 → self-perceived need for complete dentures</i>			
Total	-0.081	0.050	0.105
Indirect (via OIDP)	-0.014	0.010	0.142
Goodness of fit:			
SRMR= 0.052			
CFI= 0.974			
TLI=0.967			

Figures

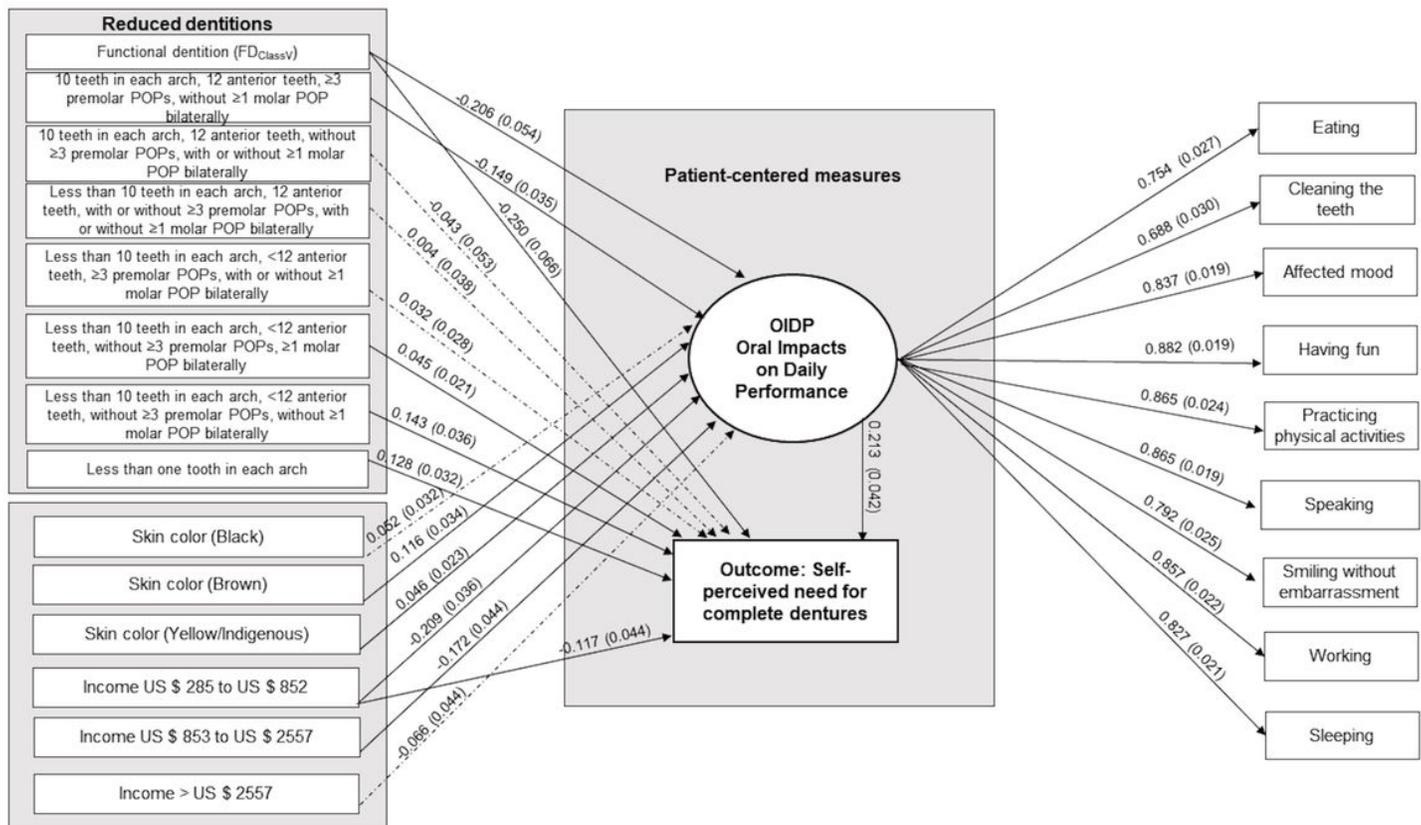


Figure 1

Standardized coefficients (SC) and standard error of direct associations between variables determined by structural equation modeling. SBBrazil 2010 Note: Rectangles represent observed variables and circle represents a latent variable. Dashed arrows correspond to non-significant associations.

Supplementary Files

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