# Relationship Between Oral Health and Frailty in Community-Dwelling Elderly Individuals in Brazil

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**OBJECTIVES:** To test the hypothesis that clinical oral health conditions are associated with frailty independent of socioeconomic and general health status.

**DESIGN:** Cross-sectional.

**SETTING:** Population-based cohort study of health, well-being, and aging.

**PARTICIPANTS:** One thousand three hundred seventy-four community-dwelling individuals representing 998,528 individuals aged 60 and older in the city of São Paulo, Brazil.

**MEASUREMENTS:** Frailty was defined on the basis of five characteristics: weight loss, weakness, slowness, exhaustion, and low level of physical activity. Participants with three or more characteristics were classified as frail, with one or two as prefrail, and with zero as nonfrail. Oral health measures were number of teeth, use of dental prostheses, need for dental prostheses, presence of decayed teeth, clinical attachment loss of 4 mm or greater, and periodontal pocket of 4 mm or greater. Data on sociodemographic (age, sex, and schooling) and general health (number of self-reported chronic diseases and smoking status) data were assessed.

**RESULTS:** The prevalence of frailty was 8.5%, with 50.8% considered nonfrail. Elderly individuals with a need for dental prostheses were significantly more likely to be prefrail and frail. Participants with 20 or more teeth had a lower chance of being frail than edentulous individuals.

**CONCLUSION:** The need for dental prostheses was significantly associated with frailty, independent of socioeconomic and general health status. **J Am Geriatr Soc 61:809–814, 2013.**

**Key words: oral health; frailty; aging**

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Oral health is well recognized as an integral part of general health and a determinant of quality of life,[1] but the effect of oral health on general health is underinvestigated, especially in elderly individuals, in whom the effect is pronounced because of the cumulative burden of the disease. Although there has been a reduction in rates of tooth loss in older people worldwide, the prevalence of edentulism remains high.[1] Thus, the increase in life expectancy in recent decades has attracted growing interest in the effect of oral health on general health outcomes, especially those related to function, well-being, and mortality.

Studies have indicated that impaired oral health is related to disability,[2,3] weaker handgrip strength,[4] lower nutrient intake,[5–8] and weight loss.[9,10] According to the literature, these factors are significantly associated with the pathogenesis of frailty,[11] which is a term used to denote a multidimensional syndrome involving the loss of reserves (energy, physical ability, cognition, and health) that gives rise to vulnerability[12] and is significantly related to mortality,[13,14] although there is evidence that this is a dynamic process characterized by frequent transitions between states of frailty (nonfrail, prefrail, frail),[15] which underscores the need to identify the factors associated with this outcome to avoid it or help individuals recover from it.

Based on the evidence, oral health may be an important factor associated with frailty. The proportion of women with self-reported use of dentures increased significantly from nonfrail to prefrail and frail.[5] Although this finding is important, the use of only one oral health measure (the self-report of denture use) limits it. In addition, the statistical analysis did not involve adjustments for other important variables related to frailty.

The aim of the present study was to test the hypothesis that clinical oral health conditions are significantly related to frailty independent of socioeconomic and general health status in a representative sample of community-dwelling elderly individuals in Brazil.

## METHODS

### Study Design and Population

This was a cross-sectional study with data from the Health, Wellbeing and Aging cohort study (Saúde, Bem-estar e Envelhecimento—SABE) collected in 2006.



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The first cohort (started in 2000) had 2,143 individuals and was made up of two subgroups. The first was the result of a probability sample of 1,568 interviewees. The second subgroup was included to compensate for the death of individuals aged 75 and older and to complete the desired number of interviews in this age group and was formed by 575 residents in the same districts of São Paulo. Sampling according to clusters was conducted in two stages using the partition criterion proportional to size. A permanent registry of 72 census sectors at the Epidemiology Department of the School of Public Health was the first-stage sample. This sample was taken from the records of the National Domicile Sample Survey (1995), made up of 263 census sectors selected by lots using the probability criterion proportional to the number of residences. The minimum number of residences in the second stage was estimated as 90. The complementation of the sample with individuals aged 75 and older was performed with residences near the selected sector or within the limits of the districts to which the selected sectors belonged. Each questionnaire had a weight calculated based on the census sector to which it belonged (weight = 1/f). For questionnaires from individuals (aged $\geq 75$) from residences that were selected but not randomly determined by lots, the calculation of weight was determined in relation to the elderly population in this age group in the city of São Paulo in 1998 and the number of individuals in this age group in the final sample of the study.[16] A detailed description of the methodology employed can be found at http://www.fsp.usp.br/sabe/.

For the second cohort (started in 2006), the sample was defined as 400 individuals, which established a sampling fraction of 400 per population of the age group in the year. In the first stage, 40 sectors were selected by lots, following the criterion by which the number of primary sampling units should be 30 or more, and the minimal number of interviews per sectors is 400/40 = 10. The minimal number of homes selected by lots per sector was 118; considering 10 interviews per sector, the 10:1 ratio is the inverse of one elderly individual for each 10 homes, and 0.85 is the expected success rate of the operation of locating and performing the interviews in the selected permanent private homes. The final sample size was 298.

Data for the present study were collected in 2006; the sample included survivors from the baseline study [2000] who participated in the second wave of the study, in 2006, and elderly individuals from the second cohort (started in 2006) for whom complete information on the covariates needed for analysis was available. Thus, the final sample comprised 1,374 participants.

All data were collected at participants' homes using an interviewer-administered structured questionnaire addressing socioeconomic variables, general health, living conditions, and a set of anthropometric measures. The oral examination was conducted based on World Health Organization criteria[17] and was performed by trained and calibrated examiners (mean kappa index for interexaminer agreement for caries was 0.90).

## Outcome of Interest

Frailty was examined using the phenotype determined by Fried.[11] According to the authors, the frailty syndrome is identified by the presence of three or more of the following five characteristics: weight loss, weakness, slowness, exhaustion, and low level of physical activity. These variables were measured as follows:

*Weight loss*: self-report of unintentional weight loss of more than 3 kg in the 3 previous months.[18]
*Weakness*: grip strength in the lowest quintile, stratified according to sex and body mass index quartiles; bedridden individuals and those unable to perform the test were considered weak.
*Slowness*: highest quintile of the time needed to walk 3 m, stratified according to sex and standing height; individuals unable to perform the test were considered slow.[19]
*Exhaustion*: self-report of at least a moderate amount of time feeling exhausted in the previous week, as identified by one or two questions on the Center for Epidemiologic Depression Scale.
*Scale*: "How often in the last week did you feel that everything you did was an effort?" "How often in the last week did you feel you could not get going?" The questions were scored 1 for rarely or none of the time (<1 day), 2 for some to a little of the time (1–2 days), 3 for a moderate amount of time (3–4 days), and 4 for most of the time (5–7 days). Individuals scoring 3 or 4 on either of the questions were categorized as positive for the exhaustion criterion.[20]
*Low level of physical activity*: lowest quintile of weekly kcal expenditure, stratified according to sex; the physical activity score was calculated in metabolic equivalent minutes per week and expressed in kcal, based on the Short Form of the International Physical Activity Questionaire.[21]

In the present study, the dependent variable was categorized as frail ($\geq 3$ characteristics), prefrail (1 or 2 characteristics), and nonfrail (0 characteristics).

## Covariates

The independent variables were sociodemographic data (age, sex, and education), general health (number of self-reported chronic diseases (diabetes mellitus, hypertension, heart disease, chronic obstructive pulmonary disease, osteoporosis, stroke and arthritis) and smoking), and oral health measures (number of teeth, use of dental prosthesis, need for dental prosthesis, presence of decayed teeth, clinical attachment loss, and periodontal pocket).

The interviewers recorded the medications that individuals used, which were investigated during the questionnaire revision to help in the reporting of the diseases.

Number of teeth was categorized in four categories (0, 1–10, 11–20, $\geq 21$). Having 21 teeth or more was considered to be acceptable oral health and functional dentition.[22] Prosthetic need was determined according to the dentist's perceived need for insertion or replacement of dental prostheses (fixed or removable).[17] Replacement of dental prostheses was based on lack of retention (loose or tight), lack of stability, injury to oral tissues, and aesthetics (presence of spots or fractures or not suitable for participant facial profile).

Periodontal pockets were measured using the Community Periodontal Index.[17] The index teeth were 17, 16, 11,

26, and 27 in the upper jaw and 37, 36, 31, 46, and 47 in the lower jaw. If fewer than two functional teeth were present, the sextant was excluded. Each sextant was designated as healthy (score 0), bleeding after probing (score 1), calculus detected but no pockets (score 2), pockets of 4 to 5 mm (score 3), and pockets of 6 mm or more (score 4) according to the highest score recorded at the indexed teeth. The presence of periodontal pocketing was defined as the presence of at least one sextant scored as 3 or 4. The same index teeth were used to measure clinical attachment loss, which was defined as the distance in mm from the cementoenamel junction to the clinical base of the pocket. The sextants were scored as 0 for loss of attachment of 0 to 3 mm, 1 for loss of attachment of 4 to 5 mm, 2 for loss of attachment of 6 to 8 mm, 3 for loss of attachment of 9 to 11, and 4 for loss of attachment of 12 mm or more. Clinical attachment loss was defined as the presence of at least one sextant scored as 1 or more. The highest score for the Community Periodontal Index and loss of attachment might be found on different teeth in a sextant.

### Statistical Analysis

Statistical analysis involved descriptive and inferential analyses, with a 5% significance level and 95% confidence interval (CI). Associations between categorical variables were tested using Rao-Scott analyses,[23] and differences between means were evaluated using the adjusted Wald test. All independent variables with $P < .20$ in bivariate analysis were entered into a multinomial logistic regression model. Multinomial logistic regression analysis is an extended variation of binomial logistic regression in which the outcome variable has more than two categories. Because the outcome variable has k categories, k–1 in multinomial logistic regression is compared with a reference category that the researcher defines. The model is adjusted in the same way as binomial logistic regression, allowing simultaneous comparisons of the effects of independent variables with the dependent variable categories.[24] The variables were sorted according to the *P*-value and included in sets in the following order: sociodemographic data, general health, and oral health. The regression coefficients were used to calculate the probability of frailty according to the independent variables included in the final model. Stata 11.0 (StataCorp., College Station, TX) was used for the analyses, and a correction for the design effect was made using the "survey" command to analyze data originating from a complex sample. New weights were calculated and used to maintain the 2006 wave of the SABE study representative of the population.

### Ethical Considerations

This study received approval from the human research ethics committee of the School of Public Health, Universidade de São Paulo (Brazil). Written informed consent was obtained from subjects at the time of the interview.

## RESULTS

The study involved 1,374 participants representing 998,528 elderly individuals in the city of São Paulo. The prevalence of frailty in this sample was 8.5%, with 50.8% of the individuals considered nonfrail. Table 1 summarizes the characteristics of the population and shows the bivariate analysis between frailty categories and the independent variables. A total of 59.7% of the participants were female; 58.4% were aged 60 to 69, and 41.8% had less than 4 years of schooling. Approximately 45% of the individuals were edentulous; 79.5% used a dental prosthesis, and 47.5% needed a dental prosthesis.

The bivariate analysis revealed that frailty was significantly associated with two sociodemographic variables (age and schooling), both general health factors (number of self-reported chronic diseases and smoking), and three of the five oral health measures (number of teeth, clinical attachment loss, and need for a dental prosthesis). The multinomial logistic regression analysis (Table 2) revealed a similar pattern regarding the variables associated with

**Table 1. Descriptive and Bivariate Analysis of Frailty According to Covariates**

| | Total | Nonfrail | Prefrail | Frail | |
|---|---|---|---|---|---|
| **Characteristic** | | **%** | | | ***P*-Value** |
| Age | | | | | |
| 60–69 | 58.4 | 59.8 | 36.2 | 4.0 | |
| 70–79 | 30.1 | 45.1 | 46.4 | 8.5 | <.001 |
| ≥80 | 11.2 | 19.0 | 49.6 | 31.4 | |
| Sex | | | | | |
| Female | 59.7 | 49.4 | 41.1 | 9.5 | .35 |
| Male | 40.3 | 52.7 | 40.4 | 6.9 | |
| Education, years | | | | | |
| 0–3 | 41.8 | 43.4 | 44.6 | 12.0 | |
| 4–7 | 38.9 | 53.9 | 39.9 | 6.2 | <.001 |
| ≥8 | 19.2 | 60.3 | 34.4 | 5.2 | |
| Number of diseases | | | | | |
| 0–1 | 45.3 | 61.4 | 34.7 | 3.9 | <.001 |
| ≥2 | 54.7 | 41.9 | 45.9 | 12.2 | |
| Smoking | | | | | |
| No | 86.3 | 50.7 | 40.1 | 9.2 | .09 |
| Yes | 13.7 | 51.4 | 45.0 | 3.6 | |
| Number of teeth | | | | | |
| 0 | 44.8 | 44.8 | 43.3 | 11.9 | |
| 1–10 | 25.4 | 48.6 | 43.1 | 8.3 | <.001 |
| 11–20 | 16.5 | 60.3 | 35.6 | 4.1 | |
| ≥21 | 13.4 | 63.1 | 34.4 | 2.5 | |
| Periodontal pocket | | | | | |
| No | 90.5 | 50.9 | 40.1 | 8.9 | .10 |
| Yes | 9.5 | 49.0 | 47.3 | 3.7 | |
| Clinical attachment loss | | | | | |
| No | 68.0 | 48.9 | 41.5 | 9.6 | .12 |
| Yes | 32.0 | 54.8 | 39.3 | 5.9 | |
| Decayed teeth | | | | | |
| No | 73.6 | 49.8 | 40.9 | 9.4 | .18 |
| Yes | 26.4 | 53.5 | 40.6 | 5.9 | |
| Use of dental prosthesis | | | | | |
| No | 20.5 | 52.5 | 39.8 | 7.7 | .74 |
| Yes | 79.5 | 50.3 | 41.1 | 8.6 | |
| Need for dental prosthesis | | | | | |
| No | 52.5 | 53.9 | 38.4 | 7.7 | .09 |
| Yes | 47.5 | 47.2 | 43.5 | 9.3 | |

Total of descriptive analysis in columns; total of bivariate analysis in rows.

**Table 2. Final Multinomial Logistic Model for Factors Related to Frailty in Elderly Individuals**

| Frailty (Reference Nonfrail) | Adjusted Odds Ratio (95% Confidence Interval) | *P*-Value |
|---|---|---|
| Prefail | | |
| Age (reference ≥80) | | |
| 60–69 | 0.26 (0.17–0.39) | <.001 |
| 70–79 | 0.39 (0.26–0.60) | <.001 |
| Education, years (reference ≥8) | | |
| 0–3 | 1.41 (0.87–2.28) | .16 |
| 4–7 | 1.10 (0.68–1.77) | .69 |
| ≥2 diseases | 1.85 (1.37–2.50) | <.001 |
| Number of teeth (reference 0) | | |
| 1–10 | 1.00 (0.64–1.59) | .98 |
| 11–20 | 0.66 (0.36–1.21) | .17 |
| ≥21 | 0.66 (0.38–1.22) | .12 |
| Periodontal attachment loss | 1.07 (0.69–1.70) | .76 |
| Need for dental prosthesis | 1.46 (1.09–1.94) | .01 |
| Frail | | |
| Age (reference ≥80) | | |
| 60–69 | 0.05 (0.03–0.11) | <.001 |
| 70–79 | 0.12 (0.08–0.18) | <.001 |
| Education, years (reference ≥8) | | |
| 0–3 | 1.70 (0.77–3.75) | .19 |
| 4–7 | 0.90 (0.45–1.83) | .78 |
| ≥2 diseases | 4.34 (2.47–7.62) | <.001 |
| Number of teeth (reference 0) | | |
| 1–10 | 0.86 (0.41–1.82) | .69 |
| 11–20 | 0.32 (0.09–1.17) | .08 |
| ≥21 | 0.25 (0.07–0.91) | .04 |
| Periodontal attachment loss | 1.21 (0.57–2.57) | .62 |
| Need for dental prosthesis | 1.84 (1.13–3.00) | .01 |

N = 1,374, representing 998,528 elderly individuals.

frail and prefrail individuals, except for the oral health conditions. Subjects with a need for dental prostheses had a 46% greater chance of being prefrail than those without such a need. The need for a dental prosthesis also increased the likelihood of being frail, whereas having more teeth was significantly associated with a lower chance of frailty. Elderly individuals with 21 or more teeth had a 75% lower chance of being frail than those who were edentulous. Older age was associated with a greater chance of being frail or prefrail.

Maintaining all the other variables constant (aged ≥80, 0–3 years of education, 0 teeth, ≥2 diseases, periodontal attachment loss), those with a need for dental prostheses had a greater probability of being frail than those with no such need. Moreover, in both groups, there was a trend toward a greater likelihood of frailty with fewer teeth (Figure 1). People with 21 or more teeth, with and without a need for dental prostheses had an approximately 23% and 24% lower probability of frailty, respectively, than edentulous individuals, demonstrating that the burden of dental impairment is greater in frail elderly individuals (Figure 1).

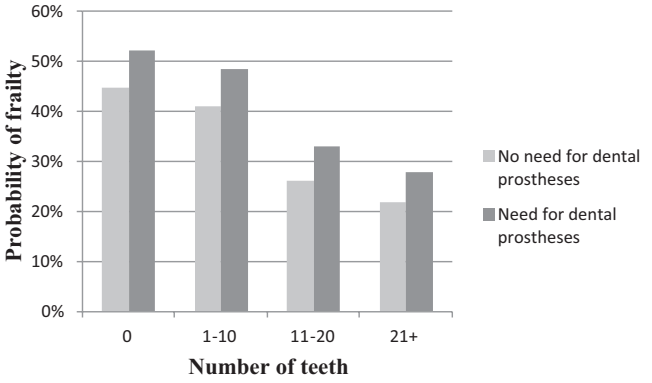


**Figure 1.** Probability of frailty according to independent variables. All other independent variables kept constant (aged ≥80, 0–3 years of education, ≥2 diseases, periodontal attachment loss). Differences in probability according to number of teeth were similar between individuals with and without need for dental prostheses: 0[a], 1–10[a], 11–20[a], ≥21[b]; different superscripts denote significant differences ($P < .05$).

## DISCUSSION

Most of the elderly individuals were classified as nonfrail and the prevalence of frailty was low (8.5%), which is in agreement with findings reported in previous studies using comparable methods[11,25] and findings reported for Brazilian elderly individuals.[26] To the best of the knowledge of the authors, the results also provide the first evidence, using a multiple regression analysis, to support the hypotheses that frailty may be independently related to clinical oral health measures.

Frailty involves transitions that mostly occur between adjacent states, suggesting that it may be a reversible condition,[15,27] which underscores the importance of identifying factors related to the onset and progression of this condition through different stages. The association between oral health and frailty may rely on the association between oral health and nutrition, which has been widely addressed in the literature.[6,9,10,28] The evidence indicates that individuals with few teeth avoid fruits and vegetables, which are a significant dietary source of vitamins and fiber.[8] Dental impairment has also been associated with inadequate nutrient intake,[7] lower protein intake,[28] and lower serum levels of beta carotene,[6] which are factors related to the development[29] and prevalence[30] of frailty. Weight loss, which is also a component of the syndrome, has also been associated with tooth loss.[10] The results of this study suggest that number of teeth may be a significant factor in the pathway to frailty.

Unlike the results from a previous study,[5] the use of a dental prosthesis was not associated with any of the states of frailty, although individuals who needed a dental prosthesis were 46% more likely to be prefrail and 84% more likely to be frail than those who did not. The need for a dental prosthesis, which takes into account the quality of the prosthesis (e.g., adaptation and retention), may be a more-reliable measure of functional oral impairment and its negative effect on nutrient intake and nutritional status than the use of a dental prosthesis and may therefore play an important role in the biological pathway to frailty, as suggested previously regarding the use of dental prostheses.[5]

Although the direct relationship between frailty and oral health has not been adequately explored, considering that this outcome has different components, the relationship between oral health impairment and the frailty syndrome

may have different intermediate factors besides nutrition, although there is little evidence to corroborate this association. A previous study[4] found that decline in handgrip strength over a 5-year period was more than two times as great in elderly individuals with periodontitis as in those without, whereas no association was found with regard to number of teeth. A cross-sectional analysis[31] found that the association between the number of teeth and fatigue at the age of 70 and its onset at 5- and 10-year follow-up became nonsignificant after adjusting for socioeconomic status and smoking habits. Nevertheless, the lack of an association was explained as a result of the lack of statistical power due to attrition or ceiling effects.

This study has strengths that should be considered. The first is the use of a large representative sample of community-dwelling elderly individuals, which increases the possibility of generalizing the results. Second, frailty and oral health were measured using well-defined methods, allowing future comparisons between studies. Finally, the model was adjusted for socioeconomic and general factors known to be related to the outcome. Limitations of the study include the use of self-reported data regarding chronic diseases and frequency of physical activities, which may introduce biases that are difficult to control, although investigation of medications that individuals used to help in reporting diseases may have minimized memory bias. Furthermore, the cross-sectional design of the study does not allow the establishment of a causal relationship between oral health and frailty, which needs to be confirmed in future studies. Another thing that needs to be considered is that the need for a dental prosthesis, which was related to the outcome, was evaluated according to the dentist's perceived need. Finally, there was a high prevalence of edentulism and tooth loss in the population, which may have led to a low prevalence of periodontal disease. These conditions are related to a high number of sextants being excluded, which led to the low prevalence of periodontal pocket and clinical attachment loss. Moreover, the dichotomization of the periodontal conditions (yes vs no) may explain the lack of association between periodontal disease and frailty, because it may be different in terms of severity and extension of periodontal disease, whether a person has one tooth with a clinical attachment loss of 4 mm or more or several teeth with more-advanced periodontal destruction. The same can be true in terms of periodontal pockets, which are considered to reflect current periodontal disease, whereas clinical attachment loss reflects the cumulative result of periodontal disease over the life course.

The findings of the present study confirm an association between frailty and one clinical oral health measure (need for dental prostheses) within this age group independent of socioeconomic and general health status, underscoring the importance of tooth maintenance and the value of a multidisciplinary approach in providing health care to this age group.

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**Author Contributions:** FB Andrade and ML Lebrão: conception and design of the research project, data analysis, interpretation and drafting of the article, critical review of the manuscript, approval of the final version to be published. JLF Santos: data analysis and interpretation, critical review of the manuscript, approval of the final version to be published. YAO Duarte: interpretation of the data, critical review of the manuscript, approval of the final version to be published.

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