Original Article

Functional dentition and prosthodontic status in an Indigenous population from the South of Brazil

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Aim: to analyze the prevalence of different definitions of functional dentition, prosthodontic status and associated factors, in an indigenous population from Brazil. **Methods:** a cross-sectional oral health survey was conducted with Indigenous adults aged 35-44 years. A single examiner collected clinical data through oral examinations and sociodemographic data using a structured questionnaire. Dentitions were classified according to four classification systems of functional dentition: FD_{WHO} (> 20 teeth), FD_{GROUP2} (> 10 teeth in each arch), FD_{GROUP3} (all anterior teeth), and FD_{GROUP4} (> 10 teeth in each arch, all anterior teeth, and sufficient posterior region). Use and need of prosthodontics was also evaluated. Uni and multivariate analysis were conducted at the level of significance of 5%. **Results:** Indigenous adults presented considerably low frequencies of prosthodontic use and functional dentition, independently of the definition analyzed. Substantial differences of prevalence rates were observed among the four definitions of functional dentition, ranging from 48.62% to 11.93%. Age and municipality were associated with use of dental prosthesis and prosthodontic need, respectively. Significant discrepancies in functional dentition rates were observed regarding sex and time of the last dental appointment. **Conclusions:** Indigenous adults are severely affected by tooth loss and, consequently, by low frequencies of functional dentition. The scenario is worsened by the elevated need of the population for prosthodontics. The phenomenon was associated with age, sex, access to specialized dental care and time of the last dental visit.

Keywords: Oral health. Health services, Indigenous. Population groups. Health equity.

Introduction

Oral health inequalities are particularly striking among Indigenous peoples from different nations[1]. Native populations constitute culturally different societies, with highly heterogeneous epidemiological profiles and treatment needs. Although it is not normally explored in studies with Indigenous, tooth loss might be an important parameter for assessing oral health status in different populations[2]. Tooth loss represents one of the most severe injuries to oral health due to its mutilating effects and the potential repercussions to the quality of life[3]. The resulting sequels reflect on a complex combination of epidemiological, socioeconomic, cultural, racial, and health-related factors[4-6]. Vulnerable groups and individuals belonging to lower social strata from different societies are most strongly affected by the problem, which implicates in identifying these injuries as a manifestation of oral health inequalities[6-8].

The World Health Organization (WHO) defines the retention of a natural dentition of at least 20 teeth throughout life not requiring prosthetic replacement as the goal for oral health in adult populations[9]. This quantitative concept of Functional Dentition (FD) has been largely employed in dental research, although its appropriateness in assessing functionality has been challenged[8,10-12]. By questioning whether simply the number of teeth present is adequate to describe the functional status of dentitions, more comprehensive definitions of FD have emerged. According to Gotfredsen and Walls[13] (2007), oral functionality must encompass aspects of masticatory efficiency and ability, appearance, psychological and social comfort, tactile perception, speech ability, and taste. Thus, in accordance with more demanding notions of FD, new classificatory systems that consider teeth distribution, aesthetics, and occlusal units have been tested in different populations[14-17].

Furthermore, the absence of a functional dentition is directly associated with the individual's prosthodontic status, since it constitutes a therapeutic approach to compensate functional and aesthetic implications of tooth loss. We hypothesize that more complex and qualitative concepts of functional dentition present greater implications to public health and oral rehabilitation of Indigenous populations than concepts that are essentially quantitative.

Studies assessing the oral health of Indigenous populations have essentially focused on the epidemiological analysis of dental caries. This context of epidemiological invisibility undermines the construction of scientific evidence needed to expose and reduce situations of health inequalities[18]. Thus, investigating functional dentition and prosthodontic status offers an original perspective to evaluate the extent and severity of edentulousness in vulnerable ethnic groups.

The Guarani e Kaingang ethnic groups represent the second and third largest Indigenous peoples from Brazil, respectively. Yet, data regarding their health status remains scant. The Guarani people belong to the Tupi linguistic family and is present in eight states, from Pará to Rio Grande do Sul. The total Guarani population living in Brazil is estimated at 85,255 individuals. The Kaingang people belong to the Jê linguistic family and occupy approximately 30 territories distributed over São

Paulo, Paraná, Santa Catarina e Rio Grande do Sul. The total Kaingang population is estimated at 45,620 individuals. Although Guarani and Kaingang peoples present different linguistic, cultural and historical trajectories, it is not unusual that these two groups co-inhabit the same territory[19].

This study aimed to analyze the prevalence of different definitions of functional dentition, prosthodontic status and associated factors in an Indigenous population from Brazil.

Materials and methods

This exploratory, cross-sectional, population-based study was conducted from February and to August 2017, among the Kaingang and Guarani Indigenous peoples living on the Guarita Indigenous Reservation, Rio Grande do Sul State. The research project was previously presented to the local Indigenous leaders, who agreed to its realization. Human ethics research approval was granted by the Research Ethics Committee of the University of São Paulo Dentistry School, and the National Research Ethics Committee (process n. 1.756.066). This paper was prepared in accordance with the STROBE checklist for cross-sectional studies.

The Guarita Indigenous Reservation is located in the northwest region of the state of Rio Grande do Sul, southern region of Brazil, and is legally recognized as a land traditionally occupied by the Kaingang and Guarani peoples. The Indigenous population is distributed in 12 villages belonging to three different municipalities (*Tenente Portela, Redentora, and Erval Seco*). The infrastructure of all villages includes a public health care facility, electric energy network, and a public elementary school. Drinking water is extracted from the local drilled wells and does not receive fluoride addition. Access to all villages is carried out by land, and the distances to the Indigenous Health Office vary between 2 and 40 kilometers.

The total population of the Guarita Reservation is estimated by the Special Secretariat for Indigenous Health (SESAI) at 5867 individuals. Of those, the Guarani correspond to a small group of approximately 200 individuals concentrated in the most remote village. The number of inhabitants in each community varies from 181 to 744 people.

In order to obtain a representative sample, a census-based strategy was employed. Thus, all Indigenous adults from the Guarita Reservation who met the inclusion criteria were potentially eligible to be participants of the study. Inclusion criteria were individuals self-identified as Kaingang or Guarani and aged 35-44 years (age group specified by WHO to assess the oral health status of adults). All households from all villages were visited and individuals within the selected age group were invited to take part in the study by signing a written consent form. In addition to their native languages, all participants were Portuguese speakers.

Individuals unable to provide informed consent due to cognitive or physical impairment were excluded. The total number of adults aged 35-44 years is estimated by the SESAI at 300 individuals. Only 12 individuals actively refused to be included in the study. Number of losses was expressively affected by a seasonal outflow of

Indigenous workers, mainly men, to another region of the state during the time of the study.

Oral examinations were performed by a single examiner (GHS) previously trained and calibrated, in open areas near the houses of the participants, under natural light, with the aid of sterilized clinical instruments (flat mouth mirror and classic-round periodontal probe) and individual protection equipment. Conditions of dental crowns, periodontal status, and use and need of prosthodontics were evaluated following the methodology recommended by the WHO to oral health surveys[20]. Dental crowns were classified according to the decayed, missing and filled (DFMT) index. Periodontal status was assessed by the Community Periodontal Index (CPI). Use of prosthodontics was assessed based on the presence of any type of removable dental prosthesis at the time of examination. Prosthodontic need was measured based on the extension, location, and number of edentulous areas in both dental arches. In case of prosthodontic users, dental prostheses were visually inspected, and their general condition was considered in the classification of prosthodontic need. Therefore, participants might be prosthodontic users and still present a prosthodontic need. Intra-examiner agreement was determined by re-examining 10 participants with an interval of 5 to 7 days between the two assessments. The Cohen's kappa coefficient showed substantial level of agreement (kappa=0.817).

For the statistical analysis, only data regarding number of teeth present, and use and need of dental prosthesis were considered. The total number of teeth was determined by the sum of dental elements present in the mouth, except third molars. All missing teeth due to caries or other reasons were considered as dental losses. Posterior occluding pairs (POPs) were defined as the presence of two opposing teeth. Sociodemographic data were collected using a structured questionnaire.

Participants were classified dichotomously in relation to the use of upper and lower dentures at the moment of the examination and need of some kind of upper and lower prosthesis.

The outcomes related to the presence of functional dentition were classified according to four different concepts:

1. Outcome 1 – WHO definition of Functional Dentition (FD_{WHO}): presence of 20 or more teeth[9];

2. Outcome 2 - Well Distributed Teeth (FD_{GROUP2}): presence of 10 or more teeth in each arch[13];

3. Outcome 3 - Aesthetic Functional Dentition (FD_{GROUP3}): presence of 12 anterior teeth;

4. Outcome 4 - Functional Dentition classified by aesthetics and occlusion (FD_{GROUP4}): presence of at least 10 teeth in each arch, all anterior teeth, three or four POPs between premolars, and at least one POP between molars bilaterally[14];

This set of concepts was adapted from a classification system previously tested in the Brazilian population by Chalub et al.[21].

Participants were classified according to sex, age, years of study, monthly household income, time of the last dental appointment, presence of periodontal pocket,

and municipality. Age was the only continuous variable analyzed. Education was classified as up to 4 years of formal education or more than 4 years of education. Regarding monthly household income, the amount corresponding to half of the Brazilian minimum wage in 2017 (US$147.00) was adopted as a cutoff point. It was primarily determined in the Brazilian currency and converted to the US dollars (mean exchange rate in August 2017: R$3.15 = US$1.00). Time of last dental appointment was categorized either as within the previous 2 years, or in 3 or more years. Considering the cultural, linguistic, and geographic barriers that Kaingang and Guarani peoples face to access regular dental treatment, we find reasonable to use a 2-year period to classify time of the last dental appointment, rather than adopting the normative recommendation of annual dental check-ups. Periodontal status was classified as the presence of at least one periodontal pocket (probing depth ≥4mm), or its absence. Municipality was classified as *Tenente Portela* or others. This division is due to the fact that the municipality of *Tenente Portela* provides a Dental Specialties Center (*CEO – Centro de Especialidades Odontológicas*) in the public health care network. On the other hand, individuals living in the villages located in *Redentora* and *Erval Seco* are referred for specialized dental treatment in a municipality located 116 km away from the Indigenous Reservation.

Initially, descriptive analyses were carried out in order to describe the sample. Prevalence of FD and respective 95% confidence interval were calculated for each of the four definitions used. Association between the dependent and independent variables was verified through Poisson regression with robust variance and presented through prevalence ratio (PR) and confidence interval (95% CI). For the multivariate analysis, FD definitions were incorporated separately into the Poisson regression models created. Associations were considered statistically significant at the 5% probability level ($p \leq 0.05$). Analysis was performed using STATA 12.0 software (StataCorp, College Station, Texas, USA).

Results

Of the 109 individuals examined, only 2 participants were from the ethnic group Guarani. Mean age was 39.4 (SD 3.3). The majority of the participants was female, with a monthly household income of less than US$147.00, and living in the villages situated in the municipalities of *Redentora* and *Erval Seco* (Table 1).

There were no participants fully edentulous, and only 3.7% presented complete dentition. Mean number of present teeth was 18.6 (SD 6.1; Min 2; Max 28). Nearly all dentures were inadequate due to cracks, fractures, or ill-fitting, requiring to be replaced. About 30% of the participants presented complete anterior dentition. Prevalence rates of the different definitions of FD ranged from 48.62% to 11.93% (Table 2).

Table 3 displays the univariate and multivariate analyses for the associations between prosthodontic status and independent variables. Age presented a statistically significant association with the use of upper (PR = 1.09, CI = 1.03-1.16) and lower dentures (PR = 1.27, CI = 1.06-1.53). Indigenous adults living in the villages located in *Tenente Portela* presented a significant difference regarding the need of upper dental prosthesis when compared to individuals from the other municipalities (RP = 0.74,

Table 1 – Sample distribution according to sociodemographic and clinical characteristics.

Factor	Category	N.	%
Sex	Male	26	23.85
	Female	83	76.15
Municipality	Tenente Portela	34	31.19
	Others	75	68.81
Education	Up to 4 years	52	47.71
	More than 4 years	57	52.29
Household monthly income	Up to US$147.00	46	52.27
	More than US$147.00	42	47.73
Last dental visit	Within last 2 years	80	73.39
	3 or more years	29	26.61
Periodontal pocket	Yes	35	32.11
	No	74	67.89

Table 2. Indigenous distribution regarding the use and need of prosthodontics and prevalence of functional dentition according to four different definitions.

Outcome	N.	%	95% CI
Prothodontics			
Upper denture user	50	45.87	36.63-55.41
Lower denture user	5	4.59	1.89-10.68
Upper denture need	82	75.23	66.13-82.53
Lower denture need	100	91.74	84.75-95.69
Functional Dentition			
DF_{WHO}	53	48.62	39.25-58.09
DF_{GROUP2}	43	39.45	30.60-49.05
DF_{GROUP3}	33	30.28	22.28-39.67
DF_{GROUP4}	13	11.93	6.99-19.60

DF_{WHO}: at least 20 teeth; DF_{GROUP2}: at least 10 teeth in each arch; DF_{GROUP3}: all anterior teeth; DF_{GROUP4}: at least 10 teeth in each arch, all anterior teeth, 3 or 4 POP between premolars, and at least one POP between molars bilaterally.

CI = 0.55-0.99). Need for a lower dental prosthesis was not associated with any independent variable.

Associations between the four FD outcomes and independent variables are shown in Table 4. After adjustments for the other variables, the prevalence of FD_{WHO} in the final model was 67% (95% CI 1.04-2.69) greater among men in comparison to women. When considering FD_{GROUP2}, prevalence of FD was twofold greater among men (PR 2.06; 95% CI 1.16-3.65). Indigenous adults who visited a dentist in the previous 2 years presented a significantly lower prevalence of FD_{GROUP4} (PR 0.27; 95% CI 0.08-0.91). There was no statistically significant association between the presence of a complete anterior dentition (FD_{GROUP3}) and independent variables.

Table 3. Unadjusted and adjusted analysis for prosthodontic use and need and associated factors according to multiple Poisson regression model with robust variance.

Outcome	Category	Univariate			Multivariate		
		PR_{un}	95% CI	p	PR_{ad}	95% CI	p
Upper denture use							
Sex	Male	0.43	0.20-0.90	0.026	0.45	0.20-1.01	0.052
Municipality	Tenente Portela	0.93	0.88-0.98	0.012	1.30	0.91-1.86	0.145
Education	Up to 4 years	0.91	0.60-1.37	0.660	1.38	0.95-2.03	0.088
Household monthly income	Up to US$147.00	1.14	0.75-1.72	0.518	1.07	0.74-1.56	0.712
Last dental visit	Within last 2 years	1.15	0.70-1.88	0.583	1.11	0.71-1.75	0.648
Periodontal Pocket	Yes	1.29	0.86-1.95	0.212	1.31	0.91-1.90	0.145
Age	In years	1.07	1.01-1.14	0.023	1.09	1.03-1.16	0.002
Lower denture use							
Sex	Male	0.79	0.09-6.89	0.838	0.78	0.09-6.99	0.823
Municipality	Tenente Portela	1.02	0.82-1.29	0.803	0.62	0.07-5.49	0.665
Education	Up to 4 years	0.22	0.02-1.99	0.182	4.41	0.52-37.02	0.172
Household monthly income	Up to US$147.00	0.73	0.12-4.20	0.725	0.71	0.17-2.99	0.646
Last dental visit	Within last 2 years	0.54	0.09-3.11	0.494	0.46	0.05-3.91	0.474
Periodontal Pocket	Yes	1.41	0.24-8.12	0.701	1.24	0.13-12.24	0.851
Age	In years	1.30	1.04-1.62	0.021	1.27	1.06-1.53	0.010
Upper denture need							
Sex	Male	0.96	0.73-1.25	0.778	0.92	0.71-1.21	0.566
Municipality	Tenente Portela	1.02	0.99-1.05	0.084	0.74	0.55-0.99	0.048
Education	Up to 4 years	0.91	0.73-1.13	0.404	1.02	0.82-1.28	0.843
Household monthly income	Up to US$147.00	0.81	0.64-1.03	0.091	0.79	0.62-1.00	0.056
Last dental visit	Within last 2 years	1.12	0.85-1.47	0.401	1.17	0.86-1.58	0.316
Periodontal Pocket	Yes	0.93	0.72-1.18	0.546	1.07	0.85-1.36	0.556
Age	In years	1.01	0.97-1.04	0.489	1.01	0.97-1.04	0.595
Lower denture need							
Sex	Male	1.00	0.88-1.14	0.903	1.06	0.92-1.22	0.395
Municipality	Tenente Portela	0.99	0.97-1.00	0.414	1.03	0.91-1.17	0.630
Education	Up to 4 years	1.02	0.91-1.15	0.627	0.98	0.86-1.13	0.813
Household monthly income	Up to US$147.00	1.04	0.91-1.18	0.543	1.05	0.91-1.20	0.507
Last dental visit	Within last 2 years	1.09	0.92-1.27	0.295	1.07	0.88-1.29	0.482
Periodontal Pocket	Yes	1.04	0.93-1.16	0.472	1.02	0.89-1.18	0.748
Age	In years	0.99	0.97-1.00	0.371	0.99	0.55-2.92	0.567

PR_{un} – Unadjusted Prevalence Ratio
PR_{ad} – Adjusted Prevalence Ratio
CI – Confidence Interval

Table 4. Unadjusted and adjusted analysis for functional dentition and associated factors according to multiple Poisson regression model with robust variance.

Outcome	Category	Univariate			Multivariate		
		PR_{un}	95% CI	p	PR_{ad}	95% CI	p
FD_{WHO}							
Sex	Male	1.64	1.14-2.35	0.007	1.67	1.04-2.69	0.035
Municipality	Tenente Portela	0.99	0.94-1.04	0.736	1.44	0.91-2.30	0.117
Education	Up to 4 years	1.18	0.80-1.76	0.387	0.65	0.40-1.05	0.80
Household monthly income	Up to US$147.00	0.89	0.56-1.42	0.643	0.98	0.62-1.56	0.939
Last dental visit	Within last 2 years	0.92	0.60-1.40	0.693	1.02	0.60-1.74	0.926
Periodontal Pocket	Yes	0.76	0.48-1.20	0.242	0.79	0.48-1.31	0.365
Age	In years	0.95	0.89-1.01	0.128	0.95	0.88-1.02	0.134
FD_{GROUP2}							
Sex	Male	2.08	1.36-3.19	0.001	2.06	1.16-3.65	0.013
Municipality	Tenente Portela	0.97	0.92-1.04	0.511	1.60	0.90-2.85	0.109
Education	Up to 4 years	1.26	0.78-2.04	0.331	0.62	0.34-1.12	0.116
Household monthly income	Up to US$147.00	0.90	0.50-1.60	0.724	1.00	0.57-1.75	0.990
Last dental visit	Within last 2 years	0.68	0.42-1.07	0.099	0.72	0.40-1.29	0.272
Periodontal Pocket	Yes	0.82	0.48-1.39	0.462	0.81	0.43-1.53	0.525
Age	In years	0.97	0.90-1.04	0.432	0.96	0.87-1.05	0.346
FD_{GROUP3}							
Sex	Male	1.59	0.89-2.84	0.112	1.56	0.70-3.47	0.275
Municipality	Tenente Portela	1.06	0.98-1.15	0.114	0.75	0.33-1.70	0.487
Education	Up to 4 years	0.85	0.48-1.52	0.602	1.21	0.60-2.42	0.594
Household monthly income	Up to US$147.00	0.73	0.36-1.44	0.369	0.80	0.40-1.61	0.538
Last dental visit	Within last 2 years	0.83	0.45-1.54	0.560	0.82	0.39-1.70	0.588
Periodontal Pocket	Yes	0.68	0.34-1.35	0.267	0.58	0.25-1.34	0.204
Age	In years	0.96	0.88-1.06	0.497	0.98	0.89-1.07	0.747
FD_{GROUP4}							
Sex	Male	2.73	1.00-7.45	0.049	0.95	0.22-4.02	0.947
Municipality	Tenente Portela	1.11	0.97-1.26	0.107	0.78	0.16-3.77	0.761
Education	Up to 4 years	1.06	0.38-2.97	0.905	1.18	0.31-4.43	0.806
Household monthly income	Up to US$147.00	0.31	0.06-1.43	0.135	0.38	0.07-1.89	0.236
Last dental visit	Within last 2 years	0.42	0.15-1.16	0.095	0.27	0.08-0.91	0.034
Periodontal Pocket	Yes	0.63	0.18-2.17	0.469	0.71	0.80-2.70	0.613
Age	In years	0.89	0.76-1.05	0.195	0.91	0.74-1.13	0.409

PR_{un} – Unadjusted Prevalence Ratio
PR_{ad} – Adjusted Prevalence Ratio
CI – Confidence Interval

Discussion

This study presents the first evaluation of FD in an Indigenous population. The employment of such measures represents an important shift in the paradigm of dental research from a disease-focused approach to positive outcomes of health. For instance, it was presented herein the mean number of teeth present rather than number of losses, which is a modest yet significant modification. This change is particularly relevant for the scientific literature covering the oral health of Indigenous peoples, which is typically restricted to the epidemiological analysis of dental caries

Findings of this study might be useful for clinicians when deciding which criteria of functionality are suitable to guide prosthodontic rehabilitation. For vulnerable populations with high prosthodontic need, this information could lead to more appropriate therapeutic decisions and reduction of oral health inequalities. For instance, employing purely quantitative criteria (e.g., number of missing teeth) for prosthodontic treatment in an Indigenous population may reify existing inequalities by not identifying a significant proportion of individuals in need of oral rehabilitation. Understanding the burden of tooth loss for the aesthetics and functionality in a population is essential in order to plan effective and adequate oral health programs.

The employment of traditional sampling strategies to conduct research among hard-to-reach populations such as Indigenous peoples imposes important methodological challenges. It is likely that the high dispersion of the studied population throughout the territory and the difficulty to locate eligible participants prevented the accomplishment of a greater sample size. Missing data for household monthly income was substantial due to the number of participants who did not know or declined to provide this information (19,3%). The comparison of results between Kaingang and Guarani individuals was not possible due to the low number of participants of the latter. This study also presented limitations inherent to the cross-sectional design regarding the impossibility of establishing causal conclusions. Cultural and social characteristics of Indigenous peoples prevent the generalizability to other native communities and might be explored in further studies. Subjective perception of functionality was not assessed.

In this study, prevalence rates of FD ranged considerably according to the definition assessed. Nevertheless, our findings contrast with national data, suggesting that disparities between Indigenous and non-Indigenous adults persist regardless of the definition investigated. Data from the 2010 National Oral Health Survey (NOHS) for Brazilians in the age group of 35-44 years present prevalence rates of FD_{WHO}, FD_{GROUP2} and FD_{GROUP4} of 77.9%; 72.9%; and 42,6%, respectively[21]. Frequencies of FD among Vietnamese and Chinese non-indigenous populations are similarly high and contrast with the findings reported in this study[14,22]. Such differences are most likely resulting from health inequalities related to ethnicity and structural determinants of health. A study with Indigenous peoples from the Xingu Park found that tooth losses accounted for 80% of the DMFT score of mother in the 35-44 age bracket[23]. Lack of access to fluoridated water seems to be an important explanatory factor to the FD prevalence rates observed in this study as it has been associated with lower frequencies of FD_{WHO}, FD_{GROUP2}, and FD_{GROUP4}[10,21].

In the final model, age was statistically associated with use of upper and lower prosthodontics. Greater prevalence of dental replacements among individuals of higher age was also described in a study with Chinese adults[22]. Although it is likely to be a result of the cumulative effect of dental caries and periodontal disease over time, such association in a well-delimited age group might indicate a trend of rapid and premature deterioration of the oral status. The lower need of upper dental prosthesis among Indigenous adults from the villages of *Tenente Portela (PR:* 0.74; CI: 0.55-0.99) seems to be an effect of the dental specialties offered in the local secondary care system. Indigenous residents of the other municipalities might experience financial restraints related to the costs of travelling to a distant location in order to receive the same level of health care.

Substantial differences in relation to sex were observed for FD_{WHO} and FD_{GROUP2}, with higher prevalence rates among men. Similar results were previously described for FD_{GROUP4} in Brazilian adults[21]. A study with Sudanese tribes found that women were twice as likely to present less than 20 teeth when compared to men[24]. Greater risks of dental caries, tooth loss, and oral health impairment have also been reported for Indigenous women of Brazil and Australia[25-27]. This phenomenon may possibly be explained by the social positions attributed to gender as well as biological markers.

Researchers have incorporated periodontal status as an additional level in the classificatory system of functional dentition, even though it did not seem to significantly affect the results[14,15]. In this study, periodontal status was included as an independent variable and was not statistically associated with functional dentition nor prosthodontic status. Additionally, income and years of education have been reported as associated factors for FD in Brazilian adults[10,21]. It is likely that these associations have not been observed in this study due to the similar socioeconomic characteristics of the participants and the modest sample size.

Time of the last dental visit was the only factor associated with FD_{GROUP4}. Indigenous adults who had not seen a dentist for an interval higher than 2 years presented better outcomes of FD in comparison to those who had a recent dental appointment. Sudanese adults who visited a dentist more frequently presented significantly fewer teeth than those who did not visit a dentist at all[24]. On the other hand, higher prevalence rates of FD_{WHO} and FD_{GROUP2} have been reported to Brazilian individuals who attended a dental appointment in the previous 12 months[21]. Dental care may affect tooth loss in opposing directions according to the type of service offered. Restrictive and mutilating dental practices have historically promoted edentulousness as a health practice in the field of oral health in Brazil[7]. Dental health teams in both developed and developing countries seem to operate mainly by reinforcing the curative praxis of care, and often perform clinical practices that are biased by characteristics such as ethnicity and social class[4,28].

Health inequities resulting from this complex interplay of social determinants tend to be expressed as extremely high demands for health treatments among Indigenous groups. Nearly all individuals observed in this study presented need for prosthodontic rehabilitation. The scant frequency of denture users and the general unsuitable conditions of the prostheses worn seem to aggravate the situation. Meanwhile, approxi-

mately 69% of Brazilian adults in the same age group present need for some type of dental prosthesis[29].

A strategic goal set by the WHO stipulates that 96% of all adults aged 35-44 years should present a FD comprising at least 20 teeth[30.] While Brazilian and Vietnamese adults have not reached so far the goal for FD set by the WHO[12,14], the situation of Indigenous from the Guarita Reservation is far worse. In fact, the prevalence of FD_{WHO} observed in this study is similar to the frequency reported to the Brazilian adult population in 2003 (54%)[31]. Improvements in the oral health status of Brazilian adults, with a significant reduction in the number of missing teeth, resulted in a 44% increase in the prevalence rate of FD_{WHO} in the 2010 NOHS[15,32]. Longitudinal data regarding Indigenous oral health is needed in order to assess whether the gap between Indigenous and non-Indigenous is narrowing or widening.

Nevertheless, the WHO's classification of FD might not guarantee a sufficient number of occlusal contacts for adequate functionality due to the multiple possible configurations of the teeth[14]. Chalub et al.[21] (2016) questions whether aiming at a FD based purely on quantitative criteria without considering teeth distribution and condition might lead to increasing oral health inequities. Conversely, the classification proposed by Nguyen et al.[14] (2011) (here referred as FD_{GROUP4}) offers a qualitative system that is more compatible with functional and perceived demands[21,33].

The low prevalence of FD_{GROUP3} indicates the magnitude of the aesthetic impairment affecting this population. Exploring subjective perceptions related to the low frequency of intact anterior dentition might provide a better understanding of its implications to social life. Despite limitations of the FD_{WHO} definition, it may still represent an important instrument for comparison across populations and for the establishment of health goals. On the other hand, more demanding concepts such as FD_{GROUP4} might be appropriate to both planning of individualized treatments and formulation of public policies[34].

The findings of this study suggest that tooth loss is an eloquent marker of social and health inequalities between Indigenous and non-Indigenous populations. Public policies targeting the health of Indigenous populations should address structural factors through viable measures, such as considering local fluoridation water systems, and improving the health care network of referrals to a closer Dental Specialties Center in order to facilitate the access to oral rehabilitation.

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References

1.   Schuch HS, Haag DG, Kapellas K, Arantes R, Peres MA, Thomson WM, et al. The magnitude of Indigenous and non-Indigenous oral health inequalities in Brazil, New Zealand and Australia. Community Dent Oral Epidemiol. 2017 Oct;45(5):434-41. doi: 10.1111/cdoe.12307

2.   Gomes MS, Chagas P, Padilha DMP, Caramori P, Hugo FN, Schwanke CHA, et al. Association between self-reported oral health, tooth loss and atherosclerotic burden. Braz Oral Res. 2012 Sep-Oct;26:436-42.

3.   Gerritsen AE, Allen PF, Witter DJ, Bronkhorst EM, Creugers NH. Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. Health Qual Life Outcomes. 2010 Nov 5;8:126. doi: 10.1186/1477-7525-8-126.

4.   Mendonça TC. [Dental mutilation: rural workers' concepts of responsibility for tooth loss]. Cad Saude Publica. 2001 Nov-Dec;17(6):1545-7. doi: 10.1590/S0102-311X2001000600027. Portuguese

5.   Gilbert GH, Duncan RP, Shelton BJ. Social determinants of tooth loss. Health Serv Res. 2003 Dec;38(6 Pt 2):1843-62.

6.   Silveira Neto JM, Nadanovsky P. Social inequality in tooth extraction in a Brazilian insured working population. Community Dent Oral Epidemiol. 2007 Oct;35(5):331-6. doi: 10.1111/j.1600-0528.2006.00335.x

7.   Saliba NA, Moimaz SA, Saliba O, Tiano AV. [Dental loss in a rural population and the goals established for the World Health Organization]. Cien Saude Colet. 2010 Jun;15(Suppl 1):1857-64. doi: 10.1590/S1413-81232010000700099. Portuguese.

8.   Bernabé E, Sheiham A. Tooth loss in the United Kingdom--trends in social inequalities: an age-period-and-cohort analysis. PLoS One. 2014 Aug 8;9(8):e104808. doi: 10.1371/journal.pone.0104808.

9.   Recent advances in oral health. Report of a WHO Expert Committee. World Health Organ Tech Rep Ser. 1992;826:1-37.

10. Koltermann AP, Giordani JMdA, Pattussi MP. The association between individual and contextual factors and functional dentition status among adults in Rio Grande do Sul State, Brazil: a multilevel study. Cad Saude Publica. 2011 Jan;27(1):173-82. doi: 10.1590/S0102-311X2011000100018.

11. Ueno M, Ohara S, Inoue M, Tsugane S, Kawaguchi Y. Association between education level and dentition status in Japanese adults: Japan public health center-based oral health study. Community Dent Oral Epidemiol. 2012 Dec;40(6):481-7. doi: 10.1111/j.1600-0528.2012.00697.x..

12. Chalub LL, Borges CM, Ferreira RC, Haddad JP, Ferreira e Ferreira E, Vargas AM. Association between social determinants of health and functional dentition in 35-year-old to 44-year-old Brazilian adults: a population-based analytical study. Community Dent Oral Epidemiol. 2014 Dec;42(6):503-16. doi: 10.1111/cdoe.12112.

13. Gotfredsen K, Walls AW. What dentition assures oral function? Clin Oral Implants Res. 2007 Jun;18(Suppl 3):34-45. doi: 10.1111/j.1600-0501.2007.01436.x.

14. Nguyen TC, Witter DJ, Bronkhorst EM, Pham LH, Creugers NH. Dental functional status in a southern vietnamese adult population-a combined quantitative and qualitative classification system analysis. Int J Prosthodont. 2011 Jan-Feb;24(1):30-7.

15. Chalub LL, Ferreira RC, Vargas AM. Functional, esthetical, and periodontal determination of the dentition in 35- to 44-year-old Brazilian adults. Clin Oral Investig. 2016 Sep;20(7):1567-75. doi: 10.1007/s00784-015-1637-7.

16. Damyanov ND, Witter DJ, Bronkhorst EM, Creugers NH. Satisfaction with the dentition related to dental functional status and tooth replacement in an adult Bulgarian population: a cross-sectional study. Clin Oral Investig. 2013 Dec;17(9):2139-50. doi: 10.1007/s00784-013-0925-3.

17. Kosaka T, Ono T, Kida M, Kikui M, Yamamoto M, Yasui S, et al. A multifactorial model of masticatory performance: the Suita study. J Oral Rehabil. 2016 May;43(5):340-7. doi: 10.1111/joor.12371.

18. Coimbra Junior CEA, Santos RV. [Health, minorities and inequality: some webs of inter-relations, emphasizing indigenous peoples in Brazil]. Cienc Saude Colet. 2000;5(1):125-32. doi: 10.1590/S1413-81232000000100011. Portuguese.

19. Ricardo B, Ricardo F. [Indigenous peoples in Brazil: 2011/2016]. São Paulo: Social and Environmental Institute; 2017. 827 p. Portuguese.

20. World Health Organization. Oral health surveys: basic methods. 5 ed. Geneva: ORH/EPID; 2013. 125 p.

21. Chalub LL, Martins CC, Ferreira RC, Vargas AM. Functional Dentition in Brazilian Adults: An Investigation of Social Determinants of Health (SDH) Using a Multilevel Approach. PLoS One. 2016 Feb 10;11(2):e0148859. doi: 10.1371/journal.pone.0148859.

22. Zhang Q, Witter DJ, Bronkhorst EM, Creugers NH. Dental and prosthodontic status of an over 40 year-old population in Shandong Province, China. BMC Public Health. 2011 Jun 1;11:420. doi: 10.1186/1471-2458-11-420.

23. Hirooka LB, Mestriner-Junior W, Mestriner SF, Nunes SAC, Lemos PN, Franco LJ. Dental caries in mother-child pairs from Xingu. Braz J Oral Sci. 2014 Jan-Mar;13(1):43-6. doi: 10.20396/bjos. v13i1.8640931.

24. Khalifa N, Allen PF, Abu-bakr NH, Abdel-Rahman ME. Factors associated with tooth loss and prosthodontic status among Sudanese adults. J Oral Sci. 2012 Dec;54(4):303-12. doi: 10.2334/josnusd.54.303.

25. Arantes R, Santos RV, Frazao P, Coimbra Jr CE. Caries, gender and socio-economic change in the Xavante Indians from Central Brazil. Ann Hum Biol. 2009 Mar-Apr;36(2):162-75. doi: 10.1080/03014460802672844.

26. Carneiro MC, Santos RV, Garnelo L, Rebelo MA, Coimbra CE, Jr. [Dental caries and need for dental care among the Baniwa Indians, Rio Negro, Amazonas]. Cien Saude Colet. 2008 Nov-Dec;13(6):1985-92. doi: 10.1590/S1413-81232008000600034. Portuguese.

27. Jamieson LM, Roberts-Thomson KF, Sayers SM. Risk indicators for severe impaired oral health among indigenous Australian young adults. BMC Oral Health. 2010 Jan 27;10:1. doi: 10.1186/1472-6831-10-1.

28. Dolan TA, Gilbert GH, Duncan RP, Foerster U. Risk indicators of edentulism, partial tooth loss and prosthetic status among black and white middle-aged and older adults. Community Dent Oral Epidemiol. 2001 Oct;29(5):329-40. doi: 10.1111/j.1600-0528.2001.290502.x.

29. Brazil. Ministry of Health of Brazil. [SB BRAZIL 2010: national research on oral health: main results]. Brasília: Ministry of Health; 2012. 116p. Portuguese.

30. World Health Organization IAfDR. 4th World Congress on Preventive Dentistry, "Trends in Prevention — Promotion of Oral Health within General Health Care. Possibilities and Limitations in Preventive Dentistry". Sweden: University of Umed; 1993.

31. Ministry of Health of Brazil. [SB Brasil 2003 Project: oral health conditions of Brazilian population 2002–2003: principal results]. Brasília: Ministry of Health; 2004. Portuguese.

32. Nascimento S, Frazão P, Bousquat A, Antunes JL. [Dental health in Brazilian adults between 1986 and 2010]. Rev Saude Publica. 2013 Dec;47(Suppl 3):69-77. Portuguese.

33. Nguyen TC, Witter DJ, Bronkhorst EM, Gerritsen AE, Creugers NH. Chewing ability and dental functional status. Int J Prosthodont. 2011 Sep-Oct;24(5):428-36.

34. Chalub LLFH, Ferreira RC, Vargas AMD. Influence of functional dentition on satisfaction with oral health and impacts on daily performance among Brazilian adults: a population-based cross-sectional study. BMC Oral Health. 2017 Jul 11;17(1):112. doi: 10.1186/s12903-017-0402-5.