

# Dental Prosthesis Needs and Associated Factors in Native Brazilian Kiriri Indians: a Cross-Sectional Study

## Necessidades de Próteses Dentárias e Fatores Associados em Índios Kiriri Nativos Brasileiros: um Estudo Transversal

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### Abstract

This study evaluated the dental prosthesis needs and associated factors in indigenous Brazilian adults from Northeastern Brazil. Dental prosthesis needs were assessed in a representative sample of 225 Indians. Edentulous area and current indication for tooth extraction according to periodontal status or non-restorable condition were registered in a clinical chart. Bivariate and logistic analyses were applied to assess associations of dental prosthesis needs and prosthesis type with age, sex, income, education, smoking, moderate or severe periodontitis, plaque index, dental caries experience, and previous dental visit. Prosthetic treatment was necessary in 83% of the participants. These individuals required 339 dental prostheses, including removable partial dentures (60.2%), fixed (33.6%), and complete dentures (6.2%). Regression analysis showed that age  $\geq 35$  years [odds ratio (OR) 5.95, 95% confidence interval (CI) 1.97–17.91,  $p=0.002$ ] and caries experience  $\geq 3$  [OR 4.01, 95%CI 1.78–9.02,  $p=0.001$ ] were significantly associated with prosthesis needs. The type of prosthesis required was associated with sex, age, educational level, periodontitis, caries experience, and plaque index ( $p \leq 0.03$ ). In conclusion, the need for prosthetic rehabilitation was high in this population, and sociodemographic factors, dental plaque level, caries experience, and periodontitis were associated with the required type of prosthesis. These data can be used to plan the allocation of resources to promote preventive and curative strategies in this population.

**Keywords:** Indians, South American. Dental Prosthesis. Oral Health. Cross-Sectional Studies.

### Resumo

*Este estudo avaliou as necessidades de prótese dentária e fatores associados em adultos indígenas brasileiros do Nordeste do Brasil. As necessidades de prótese dentária foram avaliadas em uma amostra representativa de 225 índios. A área edêntula e a indicação para extração dental, de acordo com o estado periodontal ou condição não restaurável, foram registradas em um prontuário clínico. Análises bivariadas e logísticas foram aplicadas para avaliar as associações das necessidades de prótese dentária e tipo de prótese com idade, sexo, renda, escolaridade, tabagismo, periodontite moderada ou grave, índice de placa, experiência de cárie dentária e consulta odontológica anterior. O tratamento protético foi necessário em 83% dos participantes. Esses indivíduos necessitaram de 339 próteses dentárias, incluindo próteses parciais removíveis (60,2%), fixas (33,6%) e próteses totais (6,2%). A análise de regressão mostrou que idade  $\geq 35$  anos [odds ratio (OR) 5,95, intervalo de confiança de 95% (IC) 1,97–17,91,  $p=0,002$ ] e experiência de cárie  $\geq 3$  [OR 4,01, IC 95% 1,78–9,02,  $p=0,001$ ] foram significativamente associados às necessidades de prótese. O tipo de prótese necessária foi associado ao sexo, idade, escolaridade, periodontite, experiência de cárie e índice de placa ( $p \leq 0,02$ ). Em conclusão, a necessidade de reabilitação protética foi alta nesta população e fatores sociodemográficos, nível de placa dentária, experiência de cárie e periodontite foram associados ao tipo de prótese necessária. Estes dados podem ser usados para planejar a alocação de recursos para promover estratégias preventivas e curativas nessa população.*

**Palavras-chave:** Índios Sul-Americanos. Prótese Dentária. Saúde Bucal. Estudos Transversais.

### 1 Introduction

Tooth loss and edentulism are considered a public health problem<sup>1,2</sup> and significantly influence the quality of life and general and oral health of affected patients as they impact masticatory function, speech, deglutition, dental and facial esthetics, self-esteem, and social relationships<sup>3</sup>. Within this context, prosthetic rehabilitation improves quality of life and reduces mortality<sup>4</sup>.

Dental prosthesis needs vary among populations, however few studies have evaluated the needs for dental prostheses at the population level<sup>5-9</sup>. It is notorious that many factors associated with dental caries experience, periodontal disease,

and tooth loss are associated with the need for prosthesis<sup>10</sup>. These factors include sociodemographic conditions, dental plaque level, smoking habits, diabetes, and poor oral health care<sup>11</sup>. In elderly populations, the need of male individuals for complete dentures is mainly influenced by low family income, low educational level, self-perception of oral health and access to dental services<sup>12</sup>; whereas, in younger populations (24 years old), low family income was also an important factor, in addition to low maternal educational level, high caries experience, and lack of professional guidance on oral health<sup>13</sup>.

Indigenous populations, particularly Kiriri Indians, have preserved many of their traditional ethnic and sociocultural

characteristics despite external influences, including some characteristics of their traditional diet; however, consuming processed products containing high levels of sugar is a reality. Access to dental hygiene products is limited and poor oral hygiene practices and deficient oral health services have also been reported<sup>14,15</sup>. The prevalence of periodontitis and the number of decayed, missing, and filled teeth (DMFT index) are high in this population<sup>14</sup>.]

Officially implemented in 1999, with the responsibility of providing care to the entire population located in indigenous lands, the Subsystem for Indigenous Health Care, articulated with the Brazilian Unique Health System (SasiSUS) organized its action units according to the proposal of the 34 Special Indigenous Sanitary Districts (DSEI), which are characterized as an interconnected network of health services, capable of providing primary health care, adequate to the health needs of the majority of the population<sup>15</sup>. In 2011, special attention began through the National Indigenous Oral Health Policy; however, little is known about the oral epidemiological reality of these populations

In 2010, the National Epidemiological Survey collected data on the use of dental prostheses<sup>9</sup>, evaluating the capitals and interior of the Brazilian States, however, the indigenous population was not evaluated. So far there are no published data on the dental prosthesis needs of Kiriri population. Broader knowledge about the oral health conditions of different indigenous is necessary for developing action strategies and organizing health services according to the realities of each population. The current study aimed to evaluate dental prosthesis needs and associated factors in indigenous Kiriri adults from Northeastern Brazil.

## 2 Material and Methods

This study was conducted in accordance with the World Medical Association's Declaration of Helsinki and was approved by the Research Ethics Committee of the Brazilian Ministry of Health (registration 16455/Process No. 25000.066822/2011-45), Brasilia, Brazil. Authorization was provided by the National Health Foundation (FUNASA), the Special Indigenous Health District (DSEI), and the National Indian Foundation (FUNAI). Individuals who agreed to participate signed an informed consent form. At completion of the study, the Indian authorities and FUNASA received a written report of the study results.

### 2.1 Study design and sampling procedures

This study was part of a larger project, and some of the results related to periodontal diseases, tooth loss, and mucosal lesions have been published previously.<sup>2,14,16,17</sup> The current study had a cross-sectional design. The dependent variables were the need and the type of dental prosthesis. Sex, age, income, educational level, smoking, moderate/severe periodontitis, plaque index, dental caries experience, and

previous dentist visits were included as independent variables.

The target population were Kiriri Indians aged  $\geq 19$  years who were living in an isolated indigenous area in the state of Bahia, Northeastern Brazil. The study sample was designed to be representative of the target population and it was calculated based on information provided by FUNASA, about the age and gender of indigenous Kiriri adults, and the prevalence of periodontal disease in Brazil. Of the 2182 Kiriri Indians living in the isolated indigenous area in 2011, 1025 were 19 years or older. It was estimated that a sample size of 205 individuals would yield overall estimates with relative standard errors of 5% and a confidence level of 95%. Based on a predicted response rate of at least 90%, initially, 225 individuals were randomly selected from the list with the name of each adult and invited to participate. The response rate was 100%. Two hundred and twenty-five individuals aged 19–77 years were examined. Medical exclusion criteria included conditions that require the use of antibiotics before periodontal probing. However, none of the participants met the exclusion criteria.

### 2.2 Operational procedure

The study was presented to the local indigenous authorities that first invited the community to participate. A few days before the clinical examinations, the community dentist and two nurses visited the selected subjects to explain the study's aims and encourage participation. Data collection was performed between December 2011 and December 2014, without intervals among assessments. Before the clinical examination, in-person interviews were conducted by two trained nurses to collect standard data on demographic and socioeconomic status, as well as other health-related data using a structured written questionnaire.

### 2.3 Oral evaluation and rehabilitation planning

Four calibrated dentists assisted by four trained undergraduate students from the School of Dentistry, Federal University of Bahia (UFBA), Brazil, performed the clinical examinations. Before the study, examiners were calibrated for accuracy and repeatability using 10 subjects not included in the study. The intraclass and interclass correlation coefficients were  $\geq 0.75$  for intraexaminer and interexaminer reproducibility.

Clinical examinations were performed using a headlight (Turboled, Nautika, São Paulo, Brazil), a sterilized mouth mirror (Golgran Ind. E Com. Ltda., São Paulo, SP, Brazil) and a manual periodontal probe (PCP-UNC 15, Hu-Friedy, Chicago, IL, USA), with the subject seated on a normal chair, at 10 locations including schools and health facilities. For periodontal evaluation, all permanent fully erupted teeth excluding third molars were examined. Probing depth (PD) and the distance between the cemento-enamel junction and the free gingival margin (CEJ-GM) were measured at six sites per tooth: mesiobuccal, midbuccal, distobuccal, distolingual,

midlingual, and mesiolingual. Measurements in millimeter were rounded to the nearest whole number. The clinical attachment level (CAL) was calculated as the sum of PD and CEJ-GM measurements.

A tooth was classified as decayed if cavitation of the enamel or dentinal involvement or both were observed, or if visible caries contiguous with a restoration was present, as well as in the presence of total or partial coronal destruction resulting from disease progression. Missing teeth were teeth that had been extracted due to decay. In the case of uncertainty about the dental caries diagnosis, the tooth was classified as sound<sup>18</sup>.

The necessity of dental prosthesis was measured in the upper and lower arch<sup>18</sup>, and teeth with a CAL  $\geq 50\%$  or with more than three surfaces affected by caries and residual roots were indicated for extraction.<sup>19</sup> Using a tooth chart, tooth loss and extraction-indicated teeth were identified and prosthetic rehabilitation was planned by a single prosthodontist.

Prosthesis planning was based on the following criteria:

1. Fixed prosthesis: loss or indication of extraction of  $\leq 2$  non-adjacent teeth.
2. Removable partial denture: loss or indication of extraction of  $\geq 3$  teeth or 2 adjacent teeth.
3. Complete denture: indication for extraction of all remaining teeth or totally edentulous.

The designated examiner underwent accuracy and repeatability calibrations for dental prosthesis needs evaluation. Ten subjects were examined twice, observing an interval of more than 30 minutes among examinations and in the same study settings. The kappa coefficient was 1.00.

When dental prosthesis needs were found, clinical descriptions of the needs were recorded. The study was performed following a stepwise protocol that included clinical examination, review of clinical records, statistical analysis, and the findings notification to the community dentist and to the DSEI Bahia.

#### 2.4 Data analysis

The statistical analysis included 225 individuals. Of these, only 10 had incomplete data, which were handled by omitting the missing values in the analysis.

The participants were categorized as requiring prosthetic rehabilitation or no need. In addition, the type of prosthesis was categorized into three groups: 1) fixed prosthesis: when the participant required only fixed prosthesis; 2) removable partial prosthesis: when the participant required a removable partial denture associated or not with single crowns or fixed prosthesis, and 3) removable prosthesis: when the participant required a complete denture associated or not with a removable partial prosthesis or fixed prosthesis. Demographic, socioeconomic and health-related data were categorized. Age was categorized as 19–34 or  $\geq 35$  years based on the subjects' median age. According to the International standard education classification educational level was categorized as  $< 9$  years

or  $\geq 9$  years of schooling<sup>20</sup>. Economic status was categorized as a monthly income  $< \text{US}\$259.00$  (less than the federal minimum wage) or  $\geq \text{US}\$259.00$  (equal to or greater than the federal minimum wage) using the minimum wage in Brazil as a threshold. In addition, the participants were classified as current nonsmokers or smokers

Caries experience was classified as low ( $< 3$  decayed teeth) or high ( $\geq 3$  decayed teeth) based on the median. The chi-square test was used to assess the association between the outcomes (prosthetic needs and type of prosthesis) and independent variables (Table 1 and 2), followed by backward stepwise logistic regression. Independent variables with a  $p$ -value  $\leq 0.1$  in the bivariate models were included in the multivariate models. The odds ratio (OR) and 95% confidence interval (CI) were calculated. A level of significance of 5% was adopted. All the statistical analyses were performed using a software program (SPSS 13.0, SPSS Inc., Chicago, IL, USA).

### 3 Results and Discussion

The general characteristics of the sample are shown in Table 1. Most subjects were female and younger than 35 years. More than half of the subjects reported  $< 9$  years of formal education and a monthly income  $< \text{US}\$237.00$ . Fifty percent were smokers and the plaque index was  $< 40\%$  in 62.3% of the participants. Three or more decayed teeth with caries were observed in 58.2% of the subjects, and 40% exhibited moderate or severe periodontitis. Furthermore, 89.3% of the subjects had previously visited a dentist.

Regression analysis showed that age  $\geq 35$  years (OR 5.95, CI 1.97–17.91,  $p = .02$ ) and caries experience (OR 4.01, CI 1.78–9.02,  $p = .001$ ) were significantly associated with a need for dental prostheses (Table 2). Dental prostheses were required by 83.1% of the sample, most of participants (56.9%) required prostheses in both the arches and 13.3% required in upper arch. A total of 339 prostheses were required: 204 removable partial dentures (60.1%), 114 fixed prostheses (33.6%), and 21 complete dentures (6.2%) (Table 3). The need for fixed prostheses was significantly and positively associated with the male sex (OR 2.1, CI 1.10–4.24,  $p = .02$ ) and negatively associated with age  $< 35$  years (OR 0.21, CI 0.08–0.49,  $p < .001$ ). The need for a removable partial denture was negatively associated with a lower educational level (OR 0.45, CI 0.21–0.92,  $p = 0.03$ ). The need for a complete denture was significantly associated with older age (OR 4.29, CI 2.22–8.25,  $p < .001$ ), periodontitis (OR 2.17, CI 1.14–4.13,  $p = .02$ ), caries experience  $\geq 3$  (OR 2.31, CI 1.23–4.36,  $p = .009$ ), and a plaque index  $\geq 40\%$  (OR 2.08, CI 1.10–3.95,  $p = 0.02$ ) (Table 4).

The overall results of this study show a high prevalence of dental prosthesis needs in indigenous people from Northeastern Brazil; whereas the required type of prosthesis was positively associated with older age, more severe periodontitis, greater caries experience, and a higher plaque index. Few studies have

reported the need for prostheses in indigenous Brazilians<sup>22-24</sup>, but none in the Kiriri population. In the Xavante population, few individuals required a prosthesis and a partial denture was the main type. The prevalence of partial denture need was higher among females when compared to males (22.5% and 8.4% in the upper arch, respectively; 18.3% and 11.1% in the lower arch, respectively)<sup>22</sup>. The same trend was identified for the Baniwa people. Among the individuals requiring a prosthesis, a partial denture was the most common (84.2% in the upper arch and 90.7% in the lower arch). Females also more frequently required a prosthesis than males (9.8% and 2.7% in the upper arch, respectively; 5.7% and 1% in the lower arch, respectively)<sup>23</sup>.

In the present population, 83.1% of the participants required a prosthesis. The populations in previous studies mainly consisted of individuals younger than 19 years<sup>22,24</sup>, which explains the differences compared to the Kiriri population since only individuals older than 19 years were included in the present sample. In the present study, subjects  $\geq 35$  years were 7 times more likely to require a dental prosthesis than younger participants, in agreement with previous studies<sup>9,10,25</sup>. Since tooth loss is more common in older individuals<sup>5,6,8,11,26</sup>, it is logical to assume that the need for prosthetic rehabilitation will be greater in this group. Regarding the Kiriri population, the high for prosthetic treatment can be explained by the high prevalence of tooth loss in this population, which is likely due to the limited access to oral health services and low socioeconomic conditions<sup>2</sup>, in agreement with previous studies<sup>5,27</sup>.

Considering that tooth loss was associated with dental caries experience in a previous study involving this population<sup>2</sup>, the association between the need for prosthetic treatment and dental caries found here was expected. The need for prosthetic treatment was 4 times greater in individuals with higher dental caries experience. This finding might be explained by the fact that, due to the limited access to oral health services, dental caries was not treated and its progression resulted in tooth extraction<sup>10,28</sup> and in the consequent need for prosthetic rehabilitation. Although periodontitis was not associated with prosthetic need in general, it was associated with the need for a complete denture. Periodontitis is also associated with tooth loss<sup>27,29</sup>, which explains this association. All the other factors that were related to complete denture requirement in this study, namely older age<sup>30</sup>, greater caries experience<sup>31</sup>, and a higher dental plaque index<sup>32</sup> have been previously associated with tooth loss<sup>2</sup>. The reasons for this association between complete denture need and periodontal disease are the high prevalence of periodontitis in Kiriri Indians, the insufficient health care for periodontal disease control, and poor access to dental services (mainly focused on tooth extraction)<sup>14</sup>. Thus, tooth extraction is the main treatment and disease progression is influenced by aging, which explains the association of periodontal disease with complete prosthetic needs.

Although the greater prosthetic need was expected to be

associated with lower education and income levels, this was not demonstrated in the present study. This finding may be related to the generally low level of formal education and low income of the entire population, as demonstrated previously<sup>13</sup>. On the other hand, the prosthetic need has been associated with low formal education level and low income in non-Indian populations<sup>33</sup>. In contrast, the need for a removable partial denture was negatively associated with a lower educational level. This finding may be related to the fact that people with lower education required more complex prosthetic rehabilitation.

The need for fixed prostheses, for example, was associated with age  $< 35$  years and male sex. The association with age might be related to the higher frequency of tooth loss in older individuals<sup>2</sup> who would need removable partial or complete dentures. The association with the male sex can be explained by the fact that female sex has been described to be a risk factor for tooth loss and the need for a removable prosthesis<sup>24</sup>. Among the 339 prostheses required, 60.1% were removable partial dentures and a low rate, 6%, were complete dentures, in agreement with previous studies that showed a higher need for removable partial dentures in adults<sup>9,22,24</sup>.

Kiriri Indians comprise a typically non-nomadic population, whose main economic activities are based on subsistence agriculture, and handicraft production provides a basis for the sustenance of some families. Kiriri Indigenous Land has public education institutions that offer elementary and secondary education, and educational projects have been implemented in the communities, with the aim of promoting literacy, respecting the political demands and cultural and linguistic specificities of the population.<sup>34</sup> Their location is in an area where external influences are limited, coupled with lack of help with transportation, limited public dental care, and the high cost of private care, which restrict access to dental services. Cultural habits in relation to health care, such as the use of herbal medicines and prayers, are traditions maintained. The diet is basically composed of foods from local family farming, such as pulses, vegetables, in addition to locally produced fruits; however, steaks are not conquering at all. Industrial products are consumed by a small but growing portion of the population<sup>35</sup>. Their drinking water is obtained from deep artesian wells, where the fluoride concentration varied from 0.01 to 0.07 mg/L<sup>36</sup>.

Kiriri population is covered for dental care through the support of DSEI Bahia, responsible for planning, offering health services, and visiting communities. However, at the time of the research, transport limitations and cultural differences were considered factors that reduced the demand for dental care. In this context, although the levels of significance regarding income and education are similar in indigenous populations that live in isolation, there is a deficit in terms of instruction in oral hygiene and access to dental treatment, that emphasizes the need to establish culturally sensitive health services, at different levels of health care, in order to maintain

respect for culture at the center of the relationship between patients and health services.

Advances in health care provided to the indigenous population have taken place, after the implementation of the Indigenous Smiling Brazil policy, in 2011, which had the purpose of expanding and qualifying the services provided to indigenous people by the Dental Specialty Centers and Regional Laboratories of Dental Prosthesis. Therefore, an analysis of the need for prostheses in the Kiriri population allows the proposal of a rehabilitation program for the community based on their particular needs. Although the fieldwork was carried out between 2011 and 2014, the results of this study reflect the importance of periodic surveys, as part of a strategy inserted in the Indigenous Health Policy, with the perspective of building a historical series of oral health data, in order to verify trends, plan and evaluate services. Thus, it is recommended surveys to verify possible changes over the years and evaluate the possible impacts of the SARS-CoV-2 pandemic on access to health services by this population.

A strength of this study was its original purpose since it is the first study that evaluated the dental prosthesis needs of the Kiriri population and their association with socioeconomic, demographic, systemic, and oral characteristics. Information on this topic is scarce even for other populations. However, the study has some limitations. The cross-sectional study design does not allow to determine cause-effect relationships between dental prosthesis needs and the independent variables. Besides, other important factors were not considered in the planning of the prosthesis type, such as tooth extrusion and occlusal plane inclination, which can modify the treatment plan.

The results of the present study suggest that action planning and oral health services should be designed to promote, prevent, and restore the oral health of the Kiriri population. Studies involving other populations are necessary since this is a unique population and prosthetic requirements may differ in other groups.

#### 4 Conclusions

In conclusion, the need for prosthetic rehabilitation was high in the Kiriri population and removable partial dentures were the most frequently required type of prosthesis. Sociodemographic factors, dental plaque level, caries experience, and periodontitis were associated with prosthesis needs. The results of this study can be used to plan the allocation of resources to promote preventive and curative strategies in this population.

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#### References

1. Marcenes W, Kassebaum NJ, Bernabé E, Flaxman A, Naghavi M, Lopez A, et al. Global burden of oral conditions in 1990-2010: a systematic analysis. *J Dent Res* 2013;92(7):592-7. doi: <https://doi.org/10.1177/0022034513490168>
2. Ribeiro LS, dos Santos JN, Ramalho LM, Chaves S, Figueiredo AL, Cury PR. Risk indicators for tooth loss in Kiriri Adult Indians: a cross-sectional study. *Int Dent J* 2015;65(6):316-321. doi: <https://doi.org/10.1111/idj.12187>
3. Gil-Montoya JA, de Mello AL, Barrios R, Gonzalez-Moles MA, Bravo M. Oral health in the elderly patient and its impact on general well-being: a nonsystematic review. *Clin Interv Aging* 2015;10:461-7. doi: <https://doi.org/10.2147/CIA.S54630>
4. Gupta A, Felton DA, Jemt T, Koka S. Rehabilitation of Edentulism and Mortality: A Systematic Review. *J Prosthodont* 2019;28(5):526-35. doi: <https://doi.org/10.1111/jopr.12792>
5. Ramraj C, Azarpazhooh A, Dempster L, Ravaghi V, Quiñonez C. Dental treatment needs in the Canadian population: analysis of a nationwide cross-sectional survey. *BMC Oral Health* 2012;12:46. doi: <https://doi.org/10.1186/1472-6831-12-46>
6. Davis M, Hilton TJ, Benson S, Schott J, Howard A, McGinnis P, et al. Unmet dental needs in rural primary care: a clinic community and practice-based research network collaborative. *J Am Board Fam Med* 2010;23(4):514-522. doi: <https://doi.org/10.3122/jabfm.2010.04.090080>
7. Bansal V, Veerasha KL, Soji GM, Kumar A, Bansal S. Assessment of dental prosthetic status and needs among prisoners of Haryana, India. *J of Indian Prosthodontics Soc* 2013;13(3):303-307. doi: <https://doi.org/10.1007/s13191-013-0268-4>. Epub 2013
8. Cocco F, Campus G, Strohmeier L, Ardizzone VC, Cagetti MG. The burden of tooth loss in Italian elderly population living in nursing homes. *BMC Geriatr* 2018;18(1):76. doi: <https://doi.org/10.1007/s13191-013-0268-4>
9. Brasil. Ministério da Saúde (MS). Secretaria de Atenção à Saúde. Departamento de Atenção Básica. Projeto SB Brasil 2010: Pesquisa Nacional de Saúde Bucal - Resultados Principais. Brasília: MS; 2012.
10. 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;54(4):303-12. doi: <https://doi.org/10.2334/josnusd.54.303>
11. Silva-Junior MF, Sousa ACC, Batista MJ, Sousa MDLR. Oral health condition and reasons for tooth extraction among an adult population (20-64 years old). *Cien Saude Colet* 2017;22(8):2693-702. doi: <https://doi.org/10.1590/1413-81232017228.22212015>.
12. Gomes Filho VV, Moreira RS, Silva Junior MF, Gondinho BVC, Cavalcante DFB, Bulgareli JV, et al. Factors associated with the need for a complete denture in one arch or both arches among the elderly population. *Braz. Oral Res* 2020;34:e040. doi: <https://doi.org/10.1590/1807-3107bor-2020.vol34.0040>.
13. Correa MB, Peres MA, Peres KG, Horta BL, Gigante DP, Demarco FF. Life-course determinants of need for dental prostheses at age 24. *J Dent Res* 2010;89(7):733-8. doi:

<https://doi.org/10.1177/0022034510366681>

14. Figueiredo A, Soares S, Lopes H, dos Santos JN, Ramalho LM, Cangussu MC, et al. Destructive periodontal disease in adult Indians from Northeast Brazil: cross-sectional study of prevalence and risk indicators. *J Clin Periodontol* 2013;40(11):1001-6. doi: <https://doi.org/10.1111/jcpe.12147>
15. Garnelo L. Política de Saúde Indígena no Brasil: notas sobre as tendências atuais do processo de implantação do subsistema de atenção à saúde. In: Garnelo L, Pontes AL, organizadores. *Saúde indígena: uma introdução ao tema*. Brasília: MEC-SECADI; 2012.
16. Coelho TRC, Sampaio HBC, Araujo NS, Cury PR. [Tooth extraction indication and associated factors: cross-sectional study in Kiriri indigenous population]. *Cienc Saude Colet* 2019
17. Cury PR, Porto LPA, dos Santos JN, Ribeiro LSF, Xavier FCA, Figueiredo AL, et al. Oral Mucosal Lesions in Indians From Northeast Brazil 2014;93(27):e140. doi: <https://doi.org/10.1097/MD.0000000000000140>
18. World Health Organization. *Oral Health Surveys: basic methods*. Geneva: WHO; 1997.
19. Zitzmann NU, Krastl G, Hecker H, Walter C, Waltimo T, Weiger R. Strategic considerations in treatment planning: Deciding when to treat, extract, or replace a questionable tooth. *J Prosthet Dent* 2010;104(2):80-91. doi: [https://doi.org/10.1016/S0022-3913\(10\)60096-0](https://doi.org/10.1016/S0022-3913(10)60096-0)
20. UNESCO Institute for Statistics. *International standard classification of education: ISCED 2011*. Montreal: UNESCO; 2012.
21. Page RC, Eke PI. Case definitions for use in population-based surveillance of periodontitis. *J Periodontol* 2007;78:1387-99. doi: <https://doi.org/10.1902/jop.2007.060264>
22. Arantes R, Santos VR, Coimbra CEA. [Oral health among the Xavante Indians in Pimentel Barbosa, Mato Grosso, Brazil]. *Cad Saúde Pública* 2001;17(2):375-84. doi: <https://doi.org/10.1590/S0102-311X2001000200012>. Portuguese.
23. Carneiro MCG, Santos RV, Garnelo L, Bessa MAR, Coimbra Jr CEA. Dental caries and need for dental care among the Baniwa Indians, Rio Negro, Amazonas. *Cienc Saude Coletiva* 2008;13(6):1985-19. doi: <https://doi.org/10.1590/S1413-81232008000600034>. Portuguese.
24. Maia FB, de Sousa ET, de Sousa JP, Scudine KG, Freitas CM, Sampaio FC, et al. Influence of the dental prosthetic status on self-perceptions of health and treatment needs: A cross-sectional study of middle-aged adults with chronic disease. *J Clin Exp Dent* 2018;10(6):567-73. doi: <https://doi.org/10.4317/jced.54783>
25. Azevedo MS, Correa MB, Azevedo JS, Demarco FF. Dental prosthesis use and/or need impacting the oral health-related quality of life in Brazilian adults and elders: results from a National Survey. *J Dent* 2015;43(12):1436-41. doi: <https://doi.org/10.1016/j.jdent.2015.10.016>
26. Phipps KR, Reifel N, Bothwell E. The oral health status, treatment needs, and dental utilization patterns of Native American elders. *J Public Health Dent* 1991;51(4):228-33. doi: <https://doi.org/10.1111/j.1752-7325.1991.tb02220.x>
27. Ramseier CA, Anerud A, Dulac M, Lulic M, Cullinan MP, Seymour GJ, et al. Natural history of periodontitis: Disease progression and tooth loss over 40 years. *J Clin Periodontol* 2017; 44(12):1182-91. doi: <https://doi.org/10.1111/jcpe.12782>
28. Nath S, Poirier BF, Ju X, Kapellas K, Haag DG, Ribeiro Santiago PH, Jamieson LM. Dental Health inequalities among indigenous populations: a systematic review and meta-analysis. *Caries Res* 2021;55(4):268-87. doi: <https://doi.org/10.1159/000516137>.
29. Nath S, Poirier B, Ju X, Kapellas K, Haag D, Jamieson L. Prevalence of periodontal disease among Indigenous and non-Indigenous populations: protocol for systematic review and meta-analysis. *Syst Rev* 2022;11(1):43. doi: <https://doi.org/10.1186/s13643-022-01913-8>.
30. Chrysanthakopoulos NA. Periodontal Reasons for tooth extraction in a group of greek army personnel, *Journal of Dental Research, Dental Clinics, Dental Prospects* 2011;5(2):55-60. doi: <https://doi.org/10.5681/joddd.2011.012>
31. Urzua I, Mendoza C, Arteaga O, Rodríguez G, Cabello R, Faleiros S, et al. Dental caries prevalence and tooth loss in Chilean adult population: first national dental examination survey. *Int J Dent* 2012;2012:810170. doi: <https://doi.org/10.1155/2012/810170>
32. Broadbent JM, Thomson WM, Boyens JV, Poulton R. Dental plaque and oral health during the first 32 years of life. *J Am Dent Assoc* 2011;142(4):415-26. doi: <https://doi.org/10.14219/jada.archive.2011.0197>
33. Zitzmann NU, Haggmann E, Weiger R. What is the prevalence of various types of prosthetic dental restorations in Europe? *Clin Oral Implants Res* 2008;19(3):326-8. doi: <https://doi.org/10.1111/j.1600-0501.2007.01435.x>
34. Ministério da Educação. *Indigenous School Education: Indigenous Sociocultural Diversity, resignifying the school*. Brasília: MEC; 2007.
35. Pacheco SSM. Food interdictions in liminality situations among the Kiriri Indians of the Brazilian caatinga. *Espaço Ameríndio* 2011;5(1):57-68. doi: <https://doi.org/10.22456/1982-6524.18718>
36. Montanha-Andrade K, Maia W, Pimentel ACP, Arsati YBOL, Santos JND, Cury PR. Dental health status and its indicators in adult Brazilian Indians without exposition to drinking water fluoridation: a cross-sectional study. *Environ Sci Pollut Res Int* 2019;26(33):34440-7. doi: <https://doi.org/10.1007/s11356-019-06571-3>