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Tooth Loss Rates Over 13 Years in Remote Amazonian Indigenous Communities: Impact of the Belo Monte Dam

Alexander Paul Stevens[1]*, Michael Andrew Collins[1], Jonathan Robert Hayes[1]

[1]Department of Management, School of Business, University of Bristol, Bristol, United Kingdom.

***E-mail** ✉ a.p.stevens.bristol@gmail.com

Abstract

The prevalence of tooth loss in indigenous communities of the Amazon highlights the urgency of implementing oral health strategies that respect cultural contexts. This study aimed to determine the rate of tooth loss over a 13-year span in two remote indigenous populations. A prospective cohort followed 47 individuals with permanent dentition at baseline (T0) and 13 years later (T1) from the villages of Arara-Laranjal (n = 28; mean ages 16.1 and 29.9 years) and Assurini do Xingu (n = 19; mean ages 15.9 and 29.5 years), representing separate ethnic groups. Multilevel Poisson regression was used to examine the effect of sex, age, and village on tooth loss. At baseline, all participants had complete permanent dentition. By T1, 42 individuals (89%) had lost at least one tooth, totaling 172 teeth, with females showing a higher incidence (97%) than males (76%). Ethnic background did not influence tooth loss ($p = 1.000$). Males exhibited a significantly lower risk ($\beta = -0.50$, $p < 0.05$), whereas age showed no association. The highest frequency of tooth loss occurred in the lower second molars (females 22/46.8%, males 11/23.4%), and overall, molars were the teeth most affected. These results suggest that increased interaction with urban populations may be driving higher rates of tooth loss.

Keywords: Epidemiologic studies, Incidence, Tooth loss, Indigenous people

Introduction

Tooth loss remains a significant oral health concern in underdeveloped regions, reflecting disparities in social and healthcare access [1]. Its occurrence is strongly linked to inadequate oral hygiene and the adoption of processed, industrialized foods [2-4]. The Arara and Assurini communities of the Middle Xingu River Valley, Pará, Brazil, are semi-isolated populations whose traditional diets include cassava, nuts, fish, wild game, sweet potatoes, yams, and various fruits [5]. However, recent exposure to non-indigenous populations has increased access to sugar-sweetened beverages and processed foods, negatively affecting oral hygiene and raising the prevalence of dental caries [3, 6]. The construction of the Belo Monte Dam (2011–2019), approximately 200 km from these villages, and its subsequent operation in 2016 brought thousands of outsiders into the region, displacing local communities and introducing urban lifestyles [7, 8]. This led to social, economic, cultural, and environmental changes, including the provision of industrialized sugar-based foods by visitors [9].

Tooth loss serves as a key marker of oral health and reflects broader social inequalities, particularly in marginalized populations with limited access to care [10, 11]. In Brazil, indigenous populations experience high levels of tooth loss, dental caries, and periodontal disease, highlighting major oral health disparities across ethnic groups in the Amazon [12]. These oral health challenges negatively affect overall health and quality of life [3, 6]. In light of these factors, this study investigated

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the incidence of tooth loss in two indigenous populations over a 13-year period.

Materials and Methods

Ethics statement

The study was approved by the Research Ethics Committee of the Institute of Health Sciences, Federal University of Pará, and by Brazil's National Ethical Committee for Health Sciences (CONEP, 1.433.511), following the Declaration of Helsinki. Participants were informed about the study objectives and provided written consent; for those unable to read or sign, verbal consent was recorded. Authorization to access the villages and collect data was granted by FUNAI, after consultation with indigenous leaders.

Study design, participants, and eligibility criteria

This research employed a prospective cohort design with a 13-year follow-up, following STROBE guidelines for observational studies [13]. Convenience sampling replicated methods from previous 2009 studies in the Middle Xingu River Valley (Appendix A). At T0 (2009), before Belo Monte Dam construction, 66 individuals from Arara-Laranjal (n = 39) and Assurini do Xingu (n = 27) were examined. The second assessment (T1) occurred in November 2022, shortly after the dam's completion. Inclusion criteria required participants to have permanent dentition and be under 50 years old, with craniofacial anomalies or syndromes excluded. All individuals had full permanent dentition at baseline.

Variables, data sources, and measurement

Demographic variables included age and sex. Oral examinations were conducted by a single orthodontist experienced in public health, using natural light supplemented with a flashlight and disposable tongue depressors. Tooth loss was defined as the outcome, while sex, age, and village were predictors. Clinical evaluation involved counting remaining teeth and identifying prosthetic spaces from upper and lower right second molars to left second molars (U7–U1, L7–L1).

Statistical analysis

Descriptive statistics were performed by village, age, and sex at T0 and T1. Tooth loss incidence, as a discrete outcome, was analyzed using multilevel Poisson regression with robust variance. Sex and age were treated as individual-level predictors, and village as a contextual variable. Variables with $p < 0.1$ in bivariate analyses were included in the final model. No formal sample size calculation was performed due to population constraints; a post hoc power analysis was conducted. Analyses were performed using Jamovi v2.3.22 and G*Power v3.1, with a 5% significance threshold.

Results and Discussion

Participants

From the initial cohort at T0 (Arara n = 39, Assurini n = 27), 19 participants were excluded according to eligibility criteria. The final cohort comprised 47 individuals (71.2 percent response rate): 28 (71.8 percent) from Arara and 19 (70.4 percent) from Assurini **(Figure 1).**

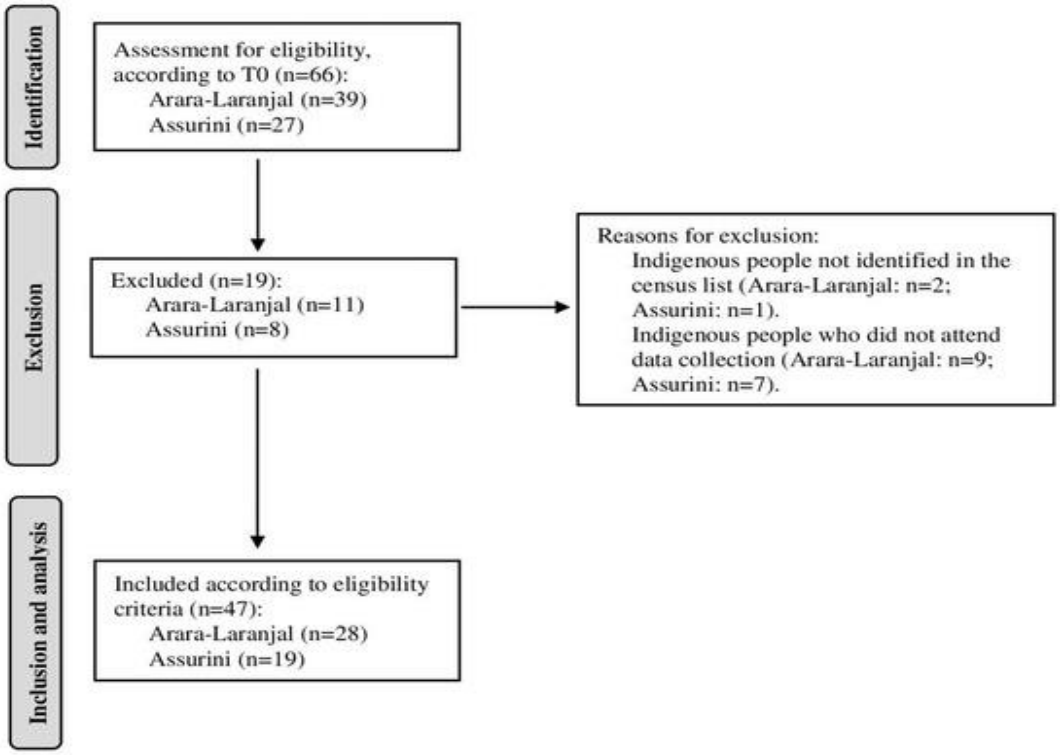


Figure 1. Flowchart illustrating the selection of participants from Arara-Laranjal (Arara ethnicity) and Koatinemo (Assurini do Xingu ethnicity).

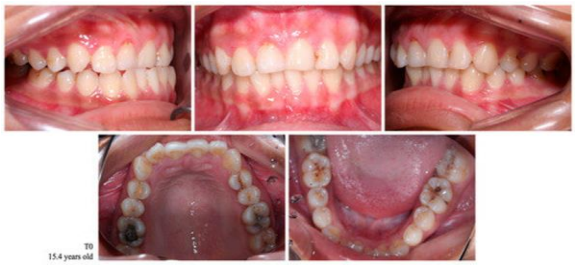
Descriptive data

The study's final cohort consisted of 47 indigenous individuals, including 17 males (36.2 percent) and 30 females (63.8 percent). Mean ages were comparable between the two villages at both evaluation points: in Assurini, 15.9 ± 5.67 years at T0 and 29.5 ± 5.75 years at T1; in Arara, 16.1 ± 4.90 years at T0 and 29.9 ± 4.83 years at T1 **(Table 1).**

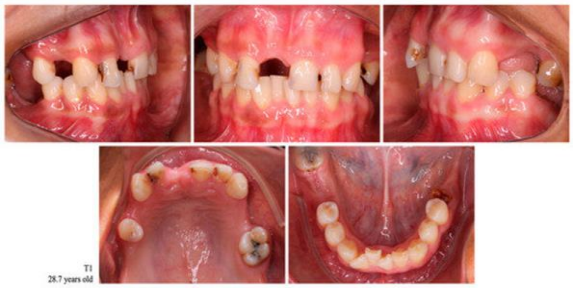
Table 1. Descriptive statistics of participants by village, including sex distribution (male M/female F), mean age (X ± SD) at T0 and T1, and tooth loss (median, Q1–Q3) in the upper, lower, and total arches.

Variables	Assurini (n = 19)	Arara-Laranjal (n = 28)	Total (n = 47)
Sex (M/F)	8 / 11	9 / 19	—
Age T0 X (±SD)	15.9 ± 5.67	16.1 ± 4.90	—
Age T1 X (±SD)	29.5 ± 5.75	29.9 ± 4.83	—
Total tooth loss T1–T0 (median / Q1–Q3)			
Upper arch	34 (1 / 0.5–2.5)	63 (2 / 0–3)	97 (2 / 0–3)
Lower arch	32 (2 / 1–2)	43 (1 / 1–2.25)	75 (2 / 1–2)
Total	66 (3 / 2–4.5)	106 (4 / 1–5.25)	172 (3 / 2–5)

Between T0 and T1, 42 of the 47 indigenous participants (89%) experienced the loss of at least 1 tooth. Tooth loss incidence was notably higher in females (97%) than in males (76 percent). The total number of teeth lost was 106 in the Arara village (median = 4) and sisxty six in the Assurini village (median = 3). Across both arches, 97 teeth were lost in the upper arch and seventy five in the lower arch, summing to a total of one hundred and seventy two teeth lost at T1 (median = 3) **(Table 1).** When considering both arches, 11 females (23.4 percent) and 7 males (14.9%) lost 3 to 4 teeth. Additionally, five female participants (10.6%) lost more than 6 teeth **(Figures 2 and 3).** Participants with no tooth loss were predominantly male, representing 4 individuals (8.5%).



a)



b)

Figure 2. Intraoral views illustrating the bite alignment in a female Indigenous resident of the Assurini community. Image (a) captures the initial state with a full set of permanent teeth and no missing ones, whereas image (b) shows the later stage after the removal of ten teeth, namely 1.7, 1.6, 1.4, 1.1, 2.4, 2.5, 2.7, 3.7, 3.6, and 4.6.

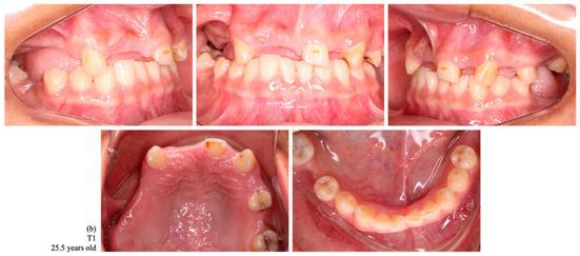


Figure 3. Intraoral images displaying the bite relationship in a female Indigenous resident from the Arara village. Panel (a) presents the baseline condition with a complete set of permanent teeth and no absences, while panel (b) documents the follow-up stage after the extraction of twelve permanent teeth (specifically 1.7, 1.6, 1.5, 1.4, 1.2, 1.1, 2.2, 2.4, 2.6, 3.7, 3.6, and 4.6).

Analysis of the absolute and relative frequencies of missing teeth across groups—calculated by directly tallying the absences in each tooth category—revealed the following patterns: in females, the lower second molars were most commonly lost (22 teeth, representing 46.8%), followed by the upper and lower first molars (17 teeth, 36.2%). In males, the lower second molars showed the highest frequency of loss (11 teeth, 23.4%), with the upper first and second molars next (6 teeth each, 12.8%) **(Table 2).**

Table 2. Absolute and relative frequencies of tooth loss by tooth type, village, and sex (male M/female F).

Tooth	Sex	Assurini (n = 19)	Arara-Laranjal (n = 28)	Both Villages (n = 47)	Tooth	Sex	Assurini (n = 19)	Arara-Laranjal (n = 28)	Both Villages (n = 47)
U7	M	3 (15.8%)	3 (10.7%)	6 (12.8%)	**L7**	M	6 (31.6%)	5 (17.9%)	11 (23.4%)
	F	4 (21.1%)	6 (21.4%)	10 (21.3%)		F	8 (42.1%)	14 (50.0%)	22 (46.8%)
U6	M	2 (10.5%)	4 (14.3%)	6 (12.8%)	**L6**	M	1 (5.3%)	2 (7.1%)	3 (6.4%)
	F	6 (31.6%)	11 (39.3%)	17 (36.2%)		F	8 (42.1%)	9 (32.1%)	17 (36.2%)
U5	M	1 (5.3%)	1 (3.6%)	2 (4.3%)	**L5**	M	0 (0.0%)	1 (3.6%)	1 (2.1%)
	F	4 (21.1%)	7 (25.0%)	11 (23.4%)		F	0 (0.0%)	1 (3.6%)	1 (2.1%)
U4	M	2 (10.5%)	0 (0.0%)	2 (4.3%)	**L4**	M	0 (0.0%)	0 (0.0%)	0 (0.0%)
	F	5 (26.3%)	8 (28.6%)	13 (27.7%)		F	0 (0.0%)	0 (0.0%)	0 (0.0%)
U3	M	0 (0.0%)	0 (0.0%)	0 (0.0%)	**L3**	M	0 (0.0%)	0 (0.0%)	0 (0.0%)
	F	0 (0.0%)	0 (0.0%)	0 (0.0%)		F	0 (0.0%)	0 (0.0%)	0 (0.0%)
U2	M	1 (5.3%)	1 (3.6%)	2 (4.3%)	**L2**	M	0 (0.0%)	0 (0.0%)	0 (0.0%)
	F	0 (0.0%)	3 (10.7%)	3 (6.4%)		F	0 (0.0%)	0 (0.0%)	0 (0.0%)
U1	M	0 (0.0%)	0 (0.0%)	0 (0.0%)	**L1**	M	0 (0.0%)	0 (0.0%)	0 (0.0%)
	F	1 (5.3%)	3 (10.7%)	4 (8.5%)		F	0 (0.0%)	0 (0.0%)	0 (0.0%)

U7= upper second molar; U6= upper first molar; U5= upper second premolar; U4= upper first premolar; U3= upper canine; U2= upper lateral incisor; U1= upper central incisor; L7= lower second molar; L6= lower first molar; L5= lower second premolar; L4= lower first premolar; L3= lower canine; L2= lower lateral incisor; L1= lower central incisor.

Main results

To analyze tooth loss, treated as a discrete outcome, a multilevel Poisson regression model was applied. Model assumptions included: tooth loss as a positive count variable with a quasi-Poisson distribution, robust variance to account for overdispersion, independence of observations, and linearity between the outcome and predictors ($p < 0.1$). No significant differences in total tooth loss were observed between the two villages, as indicated by an intraclass correlation coefficient of zero (ICC = 0.00), reflecting minimal clustering effect. Additionally, the likelihood ratio test (LRT) from a multilevel linear regression model showed no significance (p = 1.00), suggesting that it was unnecessary to treat villages as separate clusters **(Table 3).**

Table 3. Multilevel Poisson regression (level 1 individuals, level 2 villages) for the association between the predictor variable sex and the increase in total tooth loss in the upper and lower arches (dependent variable). R2 = 0.087.

Independent Variables	Bivariate Model			Multilevel Poisson Regression							Sample Power
	p-Value	CI (95%)		*p*-Value	Estimate	Exp(β)	CI (95%)		ICC	*p*-Value (LRT)	
		Lower	Upper				Lower	Upper			
(Village)									0.00	1.00	0.54 (54%)
Sex (M-F)	0.046 *	0.37	0.96	0.004 **	−0.50	0.60	0.43	0.85			
Age in T1	0.590	0.94	1.03								

M= male; F= female; CI= confidence interval; ICC= intraclass correlation coefficient; LRT= likelihood test. * Statistically significant at $p < 0.10$; ** Statistically significant at $p < 0.05$.

In the bivariate regression analysis, sex demonstrated a statistically significant association with tooth loss incidence (p = 0.046), whereas age at T1 did not show a notable effect and was therefore excluded from the final model. Given the threshold of $p < 0.1$, sex was the sole variable incorporated into the multilevel Poisson regression, with individuals and villages treated as first- and second-level units, respectively. The effect of sex on total tooth loss was confirmed as significant (p = 0.004, 95% CI: 0.43–0.85). The β coefficient indicated that, using females as the reference, males had approximately half the risk of experiencing tooth loss compared to females. Since this is an incidence study, the exponentiated β represents the relative risk, showing that males had a 0.60-fold lower incidence of tooth loss than females **(Table 3)**.

A post hoc power calculation, based on multiple regression, used an R^2 of 0.087, $\alpha = 0.05$, a sample size of 47, and one predictor (sex), yielding a power estimate of 54% **(Table 3)**.

Oral health is strongly influenced by geographic context and social isolation, with more remote populations generally exhibiting poorer hygiene practices [14]. In the Amazon, these factors are compounded by critical socioeconomic limitations, including inadequate water fluoridation, insufficient sewage systems, suboptimal oral hygiene, restricted access to dental care, and the recent adoption of highly cariogenic foods following increased contact with urban communities [9, 15].

The construction of the Belo Monte Hydroelectric Dam generated profound social and environmental inequalities, displacing over 20,000 people, including indigenous communities [8, 16]. The influx of thousands of workers during the dam's construction likely affected remote indigenous groups by exposing them to urban influences. These socioeconomic shifts may have contributed to dietary changes observed over recent years [2-4] and could explain why 16 indigenous individuals did not participate in the follow-up examination due to displacement and fission of villages into smaller groups [7, 8].

The primary aim of this 13-year prospective cohort was to evaluate tooth loss incidence and associated factors in semi-isolated populations of the Middle Xingu River. In 2009, among 102 participants from both villages, 38 individuals (37%) had lost a total of 84 teeth. As expected, tooth loss increased over the follow-up, with 89% of the 47 analyzed participants experiencing at least one tooth loss. While age is often linked to higher incidence of dental caries and subsequent tooth loss [9, 17-19], other contextual factors also play important roles. In a study of indigenous populations in Northeast Brazil, 4.98% of teeth were indicated for extraction due to caries, averaging 1.24 teeth per individual [19]. Globally, indigenous groups exhibit higher prevalence and severity

of dental decay compared to non-indigenous populations, independent of age, sex, or country, likely reflecting poorer oral hygiene practices [20, 21]. Rural indigenous communities generally present with more missing teeth than urban groups [22], and the highest rates are seen among those with untreated caries or previously lost teeth [20, 21]. Additionally, in Amazonian indigenous populations, tooth loss may also arise from injuries or manual work activities [23].

The multilevel Poisson analysis revealed that males had a lower incidence and risk of tooth loss than females, a reversal from the 2009 baseline, where 27% of females and 47% of males had lost at least one tooth. Hormonal fluctuations in women may increase cariogenic conditions in the oral cavity [24]. Cultural factors, including social roles, differential access to health information, services, and education, also likely contribute [25]. Similar to other studies [11, 26], females demonstrated a higher risk of tooth loss due to greater caries prevalence, potentially influenced by more frequent dental care and overtreatment. In contrast, men's involvement in subsistence activities such as hunting, fishing, or defense reduces their exposure to food resources [27, 28]. However, some reports indicate that males are more prone to tooth loss [29, 30], illustrating ongoing controversy regarding sex differences in oral health outcomes.

Regarding the affected dental arches, 97 teeth were lost in the maxilla and 75 in the mandible, totaling 172 over 13 years. Comparatively, a four-year urban cohort reported greater baseline loss in the maxilla (53.7%) with similar incidence between upper (50.8%) and lower (49.2%) arches, totaling 130 teeth lost among 51 adults. Differences between these findings and the present study should be interpreted cautiously, considering the older age and urban context of the reference population, and the use of 32 teeth for cumulative incidence calculations [17].

The teeth most commonly lost were the first and second molars, consistent with findings from other studies identifying first molars as the most frequently missing teeth [17, 26, 31, 32]. The multilevel Poisson regression analysis revealed no significant association between total tooth loss and village, likely because these semi-isolated Amazonian indigenous populations share similar environmental exposures and traditional dietary practices [5]. Beyond environmental influences, individual susceptibility to dental caries is also modulated by preventive factors such as genetic traits, including saliva composition and flow rate, which can mitigate the impact of cariogenic diets [24, 33].

In this context, dental caries and periodontal disease act as indicators of dietary imbalances, with the ultimate outcome reflecting the interplay between oral health promotion and protective factors [34]. Parental capacity to maintain traditional cultural and dietary practices may be crucial in preventing caries and reducing tooth loss, particularly in children and adolescents within some indigenous communities [35]. Both indigenous groups generally have comparable access to oral health services, which often prioritize curative care over preventive measures. Individual motivations and behaviors may therefore determine oral health outcomes, making tooth loss a frequent endpoint of oral disease.

Limitations

Several limitations should be noted. Females comprised the majority of participants, and over the 13-year follow-up, 19 individuals were lost to follow-up, reducing the cohort by 28.8% (n = 19/66), consistent with challenges in longitudinal indigenous studies. Multiple factors, including education, cultural practices, psychological influences, and nutrition—particularly increased sugar consumption after the Belo Monte Dam construction—likely contributed to tooth loss, although their specific impact was not fully examined, warranting cautious extrapolation regarding urbanization effects.

Although the post hoc power analysis indicated 54% power, the study sample was limited due to convenience sampling; nevertheless, this did not materially affect the regression model results. Despite these constraints, the study provides valuable insights into tooth loss in traditional populations. Future research is needed to further elucidate the etiology of tooth loss among indigenous communities and to inform the development of culturally tailored oral health programs aimed at preventing dental disease, preserving teeth, and improving oral health and quality of life.

Conclusion

This study demonstrated a high incidence of tooth loss among remote indigenous populations in the Amazon. Incidence did not differ between the villages and occurred across both younger and older age groups. Females exhibited approximately twice the tooth loss compared to males, with first and second permanent molars being the most affected. These findings suggest

that the Belo Monte Dam construction may have contributed to this elevated incidence of tooth loss. Immediate public health interventions are essential to provide oral care and protect traditional populations, particularly women, from the functional and aesthetic consequences of tooth loss.

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Ethics Statement: None

References

1. Peres, M.A.; Barbato, P.R.; Reis, S.C.G.B.; Freitas, C.H.S.D.M.; Antunes, J.L.F. Perdas dentárias no Brasil: Análise da Pesquisa Nacional de Saúde Bucal 2010. *Rev. Saúde Pública* 2013, *47*, 78–89.
2. Luo, H.; Wu, B.; Kamer, A.R.; Adhikari, S.; Sloan, F.; Plassman, B.L.; Tan, C.; Qi, X.; Schwartz, M.D. Oral health, diabetes, and inflammation: Effects of oral hygiene behaviour. *Int. Dent. J.* 2022, *72*, 484–490.
3. Martin-Iverson, N.; Pacza, T.; Phatouros, A.; Tennant, M. Indigenous Australian dental health: A brief review of caries experience. *Aust. Dent. J.* 2000, *45*, 17–20.
4. Begg, R. Stone age man's dentition: With reference to anatomically correct occlusion, the etiology of malocclusion, and a technique for its treatment. *Am. J. Orthod.* 1954, *40*, 462–475.
5. Carvalho, J.J.; Baruzzi, R.G.; Howard, P.F.; Poulter, N.; Alpers, M.P.; Franco, L.J.; Marcopito, L.F.; Spooner, V.J.; Dyer, A.R.; Elliott, P. Blood pressure in four remote populations in the INTERSALT Study. *Hypertension* 1989, *14*, 238–246.
6. Maia, C.V.R.; Mendes, F.M.; Normando, D. The impact of oral health on quality of life of urban and riverine populations of the Amazon: A multilevel analysis. *PLoS ONE* 2018, *13*, e0208096.
7. Oliveira, J.P.; Cohn, C. *Belo Monte e a Questão Indígena*; ABA: Brasília, Brazil, 2014.
8. Randell, H. The short-term impacts of development-induced displacement on wealth and subjective well-being in the Brazilian Amazon. *World Dev.* 2016, *87*, 385–400.
9. Gonçalves, É.M.; Cavalcanti, L.C.; Firmino, R.T.; Ribeiro, G.L.; Granville-Garcia, A.F.; Menezes, V.A. Dental caries experience among indigenous children and adolescents. *J. Oral Sci.* 2015, *57*, 123–129.
10. Peres, M.A.; Macpherson, L.M.D.; Weyant, R.J.; Daly, B.; Venturelli, R.; Mathur, M.R.; Listl, S.; Celeste, R.K.; Guarnizo-Herreño, C.C.; Kearns, C.; et al. Oral diseases: A global public health challenge. *Lancet* 2019, *394*, 249–260.
11. Roberto, L.L.; Silveira, M.F.; de Paula, A.M.B.; Ferreira E Ferreira, E.; Martins, A.M.E.B.L.; Haikal, D.S. Contextual and individual determinants of tooth loss in adults: A multilevel study. *BMC Oral Health* 2020, *20*, 73.
12. Brasil Fundação Nacional de Saúde. *Diretrizes Para a Atenção à Saúde Bucal nos Distritos Sanitários Especiais Indígenas: Manual Técnico*; Fundação Nacional de Saúde FUNASA: Brasília, Brazil, 2007.
13. von Elm, E.; Altman, D.G.; Egger, M.; Pocock, S.J.; Gøtzsche, P.C.; Vandenbroucke, J.P.; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for reporting observational studies. *Int. J. Surg.* 2014, *12*, 1495–1499.
14. Hajek, A.; Kretzler, B.; König, H.H. Oral health, loneliness and social isolation. A systematic review and meta-analysis. *J. Nutr. Health Aging* 2022, *26*, 675–680.
15. Rigonatto, D.D.; Antunes, J.L.; Frazão, P. Dental caries experience in Indians of the Upper Xingu, Brazil. *Rev. Inst. Med. Trop. Sao Paulo* 2001, *43*, 93–98.
16. Calvi, M.F.; Moran, E.F.; Bicudo da Silva, R.F.; Batistella, M. The construction of the Belo Monte Dam in the Brazilian Amazon and its consequences on regional rural labor. *Land Use Policy* 2020, *90*, 104327.
17. Silva-Junior, M.F.; Batista, M.J.; de Sousa, M.D.L.R. Incidence of tooth loss in adults: A 4-year population-based prospective cohort study. *Int. J. Dent.* 2017, *2017*, 6074703.
18. Alves Filho, P.; Santos, R.V.; Vettore, M.V. Fatores associados a cárie dental e doença periodontal em indígenas na América Latina:

Revisão sistemática [Factors associated with dental caries and periodontal diseases in Latin American indigenous peoples: A systematic review]. *Rev. Panam. Salud Publica* 2014, *35*, 67–77. (In Portuguese)

19. Coelho, T.D.R.C.; Sampaio, H.B.C.; Araujo, N.S.; Cury, P.R. Indicação de exodontias e fatores associados: Estudo transversal na população indígena Kiriri [Recommendation of tooth extraction and associated factors: Cross-sectional study in the Kiriri indigenous population]. *Cien Saude Colet.* 2021, *26*, 5223–5232.
20. Nath, S.; Poirier, B.F.; Ju, X.; Kapellas, K.; Haag, D.G.; Ribeiro Santiago, P.H.; Jamieson, L.M. Dental Health Inequalities among Indigenous Populations: A Systematic Review and Meta-Analysis. *Caries Res.* 2021, *55*, 268–287.
21. Schuch, H.S.; Haag, D.G.; Kapellas, K.; Arantes, R.; Peres, M.A.; Thomson, W.M.; Jamieson, L.M. The magnitude of Indigenous and non-Indigenous oral health inequalities in Brazil, New Zealand and Australia. *Community Dent. Oral Epidemiol.* 2017, *45*, 434–441.
22. Wiener, R.C. Tooth loss and dental visits by Indigenous American Indian/Alaska Native adults in the USA. *Rural Remote Health* 2023, *23*, 7679.
23. Pereira, C.B.; Evans, H. Occlusion and attrition of the primitive Yanomami Indians of Brazil. *Dent. Clin. N. Am.* 1975, *19*, 485–498.
24. Lukacs, J.R.; Largaespada, L.L. Explaining sex differences in dental caries prevalence: Saliva, hormones, and "life-history" etiologies. *Am. J. Hum. Biol.* 2006, *18*, 540–555.
25. Arantes, R.; Santos, R.V.; Frazão, P. Oral health in transition: The case of Indigenous peoples from Brazil. *Int. Dent. J.* 2010, *60*, 235–240.
26. Susin, C.; Oppermann, R.V.; Haugejorden, O.; Albandar, J.M. Tooth loss and associated risk indicators in an adult urban population from south Brazil. *Acta Odontol. Scand.* 2005, *63*, 85–93.
27. Silva, F.A. Mito e arqueologia: A interpretação dos Asurini do Xingu sobre os vestígios arqueológicos encontrados no parque indígena Kuatinemu—Pará. *Horiz. Antropol.* 2002, *8*, 175–187.
28. Lukacs, J.R. Gender differences in oral health in South Asia: Metadata imply multifactorial biological and cultural causes. *Am. J. Hum. Biol.* 2011, *23*, 398–411.
29. Suominen-Taipale, A.L.; Alanen, P.; Helenius, H.; Nordblad, A.; Uutela, A. Edentulism among Finnish adults of working age, 1978–1997. *Community Dent. Oral Epidemiol.* 1999, *27*, 353–365.
30. Roohafza, H.; Afghari, P.; Keshteli, A.H.; Vali, A.; Shirani, M.; Adibi, P.; Afshar, H. The relationship between tooth loss and psychological factors. *Community Dent. Health* 2015, *32*, 16–19.
31. Soares, G.H.; Aragão, A.S.; Frias, A.C.; Werneck, R.I.; Biazevic, M.G.H.; Michel-Crosato, E. Epidemiological profile of caries and need for dental extraction in a Kaingang adult Indigenous population. *Rev. Bras. Epidemiol.* 2019, *22*, e190042.
32. Sharif, R.A.; Chaturvedi, S.; Suleman, G.; Elmahdi, A.E.; Elagib, M.F.A. Analysis of tooth extraction causes and patterns. *Open Access Maced. J. Med. Sci.* 2020, *8*, 36–41. Available online: https://oamjms.eu/index.php/mjms/article/view/3784 (accessed on 10 March 2024).
33. Bretz, W.A.; Corby, P.M.; Melo, M.R.; Coelho, M.Q.; Costa, S.M.; Robinson, M.; Schork, N.J.; Drewnowski, A.; Hart, T.C. Heritability estimates for dental caries and sucrose sweetness preference. *Arch. Oral Biol.* 2006, *51*, 1156–1160.
34. Hujoel, P.P.; Lingström, P. Nutrition, dental caries and periodontal disease: A narrative review. *J. Clin. Periodontol.* 2017, *44*, S79–S84.
35. Levin, A.; Sokal-Gutierrez, K.; Hargrave, A.; Funsch, E.; Hoeft, K.S. Maintaining Traditions: A Qualitative Study of Early Childhood Caries Risk and Protective Factors in an Indigenous Community. *Int. J. Environ. Res. Public Health* 2017, *14*, 907.