



Marginalization and tooth loss in older Mexican adults

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Objective: To examine the association between the level of marginalization and tooth loss in adults aged ≥ 50 years in Mexico. **Methods:** A retrospective cross-sectional study was conducted on 2098 adults selected from communities presenting both high and medium levels of marginalization, with data obtained from the annual reports of the Epidemiological Surveillance System of Oral Pathologies 2019-2022. Analysis considered sociodemographic characteristics such as sex, age, and years of education. The prevalence of tooth loss was determined using the Decayed, Missing and Filled teeth (DMFT) index. Negative binomial regression was used to estimate rate ratio (RR) and 95% confidence intervals (CIs), using the presence of lost teeth as an outcome. **Results:** Most (62.4%) participants had lost at least one tooth, of whom 60.3% had a medium level of marginalization, 28.8% a high level, and 10.9% a very high level. More adults who lived in high or very high marginalization communities had lost teeth [RR=1.19 (95% CI 1.08 – 1.30)] than those living in communities with a medium level of marginalization. More males [RR=1.19 (95% CI 1.09 – 1.31)], adults ≥ 70 years [RR=1.77 (95% CI 1.57 – 1.99)], people who were illiterate [RR=1.60 (95% CI 1.35 – 1.88)] or who had poor oral hygiene [RR=1.26 (95% CI 1.15 – 1.38)] had also lost teeth. **Conclusion:** High and very high marginalization was associated with tooth loss in adults ≥ 50 years in Mexico. Effective oral health strategies are required to prevent tooth loss, as are interventions to improve access to and quality of dental services for marginalized communities.

Keywords: education, oral health, older adults, marginalization, tooth loss

Introduction

Aging is the result of the accumulation of a great variety of progressive cellular and molecular damage experienced over the course of a lifetime, which reduces physical and mental capacity and increases the risk of illness leading to death (WHO, 2022). Globally, aging represents one of the greatest challenges for healthcare systems, due to the diverse demands and specific health needs of older adults. While aging is not equivalent to disease, it is frequently related to various chronic conditions (Sayyed and Aron, 2020; Shimels *et al.*, 2022) and oral diseases that can impair quality of life (Ortiz-Barrios *et al.*, 2019). Similarly, oral diseases increase, mainly, due to complex economic situations, social inequality, lack of access to healthcare services, and marginalization.

Marginalization is a structural and multidimensional phenomenon related to the exclusion of people within a society, impeding access to progress and excluding various social groups, thus negatively impacting both the productive structure and the benefits of development within an economy (Baah *et al.*, 2019). Consequently, marginalized communities experience high levels of social vulnerability that are difficult to reduce via individual action, because they arise from an economic dynamic that fails to provide equality of opportunity (Aguilar, 2016). In older adults, marginalization and poverty are related phenomena which, combined, can impact access to healthcare services. The

oral diseases that present during aging carry greater need for preventive, restorative, and periodontal dental care (Raphael, 2017), with these diseases found to be related to socioeconomic inequality (Cardoso and Tenenbaum, 2020). This relationship is found in the most disadvantaged and socially marginalized population of older adults, who live in poverty as they age, and negatively impacts, in large part, oral health and quality of life for the people affected (Petersen *et al.*, 2010).

An important aim of dentistry is to keep the highest number of teeth possible in the oral cavity of adults as they age. Although tooth retention is an indicator of oral health, despite best efforts, tooth loss continues to present at high levels in various countries (Fatima Del Carmen *et al.*, 2021; Tiwari *et al.*, 2016; Islas-Granillo *et al.*, 2016; Imam, 2021). Tooth loss is a multifactorial process related to the presence of caries and periodontal disease (Northridge *et al.*, 2012). However, these conditions are related to social factors, access to healthcare services, smoking, diet, and general state of health (Tenani *et al.*, 2021). Additionally, lack of oral hygiene and some systemic conditions such as diabetes and hypertension have been associated with tooth loss (Maia *et al.*, 2018). Tooth loss limits the function of the oral cavity, thus affecting quality of life (Imam, 2021). Tooth loss also reflects the history of dental disease and is used as an indicator of general state of oral health since it indicates the effect of the individuals and professional attitude and behavior

toward dental hygiene, accessibility, and philosophy of dental services, and beliefs and cultural values about oral health (Silva Junior *et al.*, 2019).

Marginalized populations present unfavorable oral health, wherein those with a lower level of education have fewer teeth and a higher likelihood of edentulousness for the rest of their life. Ascertaining the role played by the level of marginalization in tooth loss in the Mexican population will inform effective social programs and strategies to promote oral health and improve healthcare for older adults. Therefore, this study aimed to examine the association between the level of marginalization and tooth loss in adults aged ≥ 50 years in Mexico. We hypothesized that older adults who live in locations with high or very high marginalization would be more likely to have experienced loss than those living in locations with a medium marginalization.

Methods

The research protocol was reviewed and approved by the Ethics Committee of the Faculty of Higher Studies Iztacala at the National Autonomous University of Mexico (CE/FESI/032023/1587).

Tooth loss was determined using data from the annual reports (2019-2022) produced by the *Sistema de Vigilancia Epidemiológica de Patologías Bucales* (SIVEPAB or Epidemiological Monitoring System for Oral Pathologies) administered by the General Epidemiology Directorate of the Secretariat for Health. SIVEPAB is responsible for compiling information on patients seeking dental treatment, mainly via primary care services, from the 442 sentinel units located in the 32 states of the Mexican Republic.

The inclusion criteria were patients over 50 years of age, of either sex with complete data in the database. The exclusion criteria were patients with third molars because it is unknown if they were extracted or did not erupt.

In Mexico, the *Consejo Nacional de Población* (CONAPO or National Population Council, 2015) calculates the level of marginalization as an area-based measure, aggregating scores for nine forms of exclusion across four dimensions. For each dimension, an indicator records the proportion of the population that lacks education, housing (drinking water, lack of sanitary service, electricity), income level, and distribution of population in localities with less than five thousand inhabitants. Higher scores indicate fewer opportunities to access the benefits of development and reveal the relative deprivation of the population in each federal entity or municipality (García-Pérez *et al.*, 2020). Information is first obtained at a family level, then used to establish the degree of marginalization in the community. The level of marginalization was classified as *very low*, *low*, *medium*, *high*, and *very high*. This study considered communities with *medium*, *high*, and *very high* marginalization.

The number of missing teeth was obtained from the tooth loss count carried out by the dentist at the sentinel unit, according to the DMFT index. The following sociodemographic variables were considered as potential confounders: age, categorized into three groups (50-59 years, 60-69 years, and ≥ 70 years); sex (male/female); and smoking status, categorized into three groups (never/current/former smoker). Oral hygiene was recorded using

the Simplified Oral Hygiene Index (OHI-S). The index comprises scores for debris and calculus on selected tooth surfaces. The buccal and lingual surfaces for six permanent teeth on the index were examined. Oral hygiene was classified as either poor (OHI-S ≥ 2 score) or good hygiene (OHI-S < 2 score) (WHO, 2013). Years of education was compared adults who had completed nine or more years of formal education with those who had completed less than nine years (corresponding, in Mexico, to primary and secondary school combined). Participants were categorized into three groups (No education, 1-9 years and ≥ 10 years).

Sample size was calculated using the formula for two independent proportions with a power of 80%, deriving a difference of 0.17 in proportions between the two groups with a two-sided p-value of 0.05. Assuming that 49% of participants in the reference population had lost tooth, the study would require 139 in each group (i.e. a total sample size of 278, assuming equal group sizes) (Dhand and Khatkar, 2014).

All analyses were conducted using Stata 15 software (Stata Corp, College Station, TX, USA). As data were not normally distributed, nonparametric tests (Kruskal-Wallis or Mann-Whitney tests) were used in bivariate analyses for Decayed, Missing and Filled teeth by the following variables: age; sex; oral hygiene; years of education; marginalization level; and smoking status. Cross-tabulations generated via Pearson's Chi-square test were used to describe the associations between covariates by tooth loss prevalence. The marginalization level variable was grouped into medium vs. high and very high marginalization as the two latter categories share similar characteristics. The tooth loss data were non-normally distributed (Shapiro-Wilk test = 0.90, $p < 0.001$). The rate ratio (RR) was estimated with 95% confidence intervals (CIs) for the association between marginalization level and tooth loss. The negative binomial regression model for non-normally distributed count data was used to obtain the RR. Variables where $p < 0.20$ in bivariate analyses were tested in a negative binomial regression model where $p < 0.05$ was used as the threshold for statistical significance.

Results

Among the 2200 participants, 102 did not meet the inclusion criteria and were excluded, leaving 2098 adults ≥ 50 years (95.3% participation rate). The mean age of participants was 62.0 (s.d. 9.4) years and 59.5% were female (Table 1). Two thirds (67.8%) had 1-10 years of education. Most (60.3%) were classified as presenting medium, 28.8% high, and 10.9% very high marginalization. Most adult (62.4%) had lost at least one tooth, with a mean of 7.0 (s.d. 6.8) missing teeth. More men than women had lost teeth (64.2% vs. 59.7% respectively; $p = 0.037$). Age, oral hygiene, years of education, and marginalization level were also related, while tooth loss in adults increased with age (Figure 1).

The bivariate analyses revealed differences in both the average number of tooth lost in men and women, years of education, age groups, oral hygiene and the marginalization level (Table 2). Differences were also observed in terms of carious and filled teeth.

The negative binomial regression model showed that 19% more adults living in locations with high or very high marginalization areas had tooth loss than those living

Table 1. Demographic and oral health characteristics among 2098 Mexican adults aged ≥ 50 years with and without Tooth Loss.

	No Tooth Loss n=789 %	Tooth Loss ≥ 1 n=1309 %	p (Chi sq)
Age			
50-59 years	47.9	52.1	<0.001
60-69 years	31.6	68.4	
≥ 70 years	23.4	76.6	
Sex			
Male	35.8	64.2	0.037
Female	40.3	59.7	
Oral hygiene (OHI-S)			
Good hygiene	41.9	58.1	<0.001
Poor hygiene	33.7	66.3	
Years of education			
No education	29.6	70.4	<0.001
1-9 years	34.3	65.7	
≥ 10 years	58.0	42.0	
Marginalization level			
Medium	39.4	60.6	<0.001
High	38.4	61.6	
Very High	25.4	74.6	
Smoking Status			
Never	38.2	61.8	0.227
Current	31.5	68.5	
Former Smoker	32.8	67.2	

in a medium marginalization area. Tooth loss was 19% more common in men than women, 77% more common in adults ≥ 70 years old than those younger and 60% more common among adults who were illiterate compared to those with ≥ 10 years of education (Table 3). Tooth loss was also more common amongst those with poor oral hygiene but negatively associated with the number of carious and filled teeth.

Discussion

We found that high or very high marginalization level is associated with tooth loss in adults ≥ 50 years. Marginalized populations more frequently experience transmitted and non-transmitted diseases, with worse health outcomes due to economic, political, social, cultural, and health-related factors that present in most developing countries (Di Cesare *et al.*, 2013).

In Mexico, despite the development of various programs alongside the creation of large health institutions, marginalization causes economic, professional, political or social disadvantage. This is particularly observed in southern and southeastern regions of the country, where the highest levels of marginalization, poverty, and inequality are found (García-Pérez *et al.*, 2020). Few studies have investigated marginalization and oral health in older adults. However, previous studies among children have associated the presence of caries, dental fluorosis, and poor oral hygiene with marginalization (García-Pérez *et al.*, 2020; Burnett *et al.*, 2016; Singh *et al.*, 2017).

The higher prevalence of lost teeth found could result from the limited access to oral healthcare related to marginalization and poverty. Inequalities in healthcare are an obstacle to overcoming poverty and achieving sustainable development. For example, older people are at higher risk of poverty (Crimmins *et al.*, 2009). Furthermore, this age group is also more likely to present precarious states of health, experiencing less healthy life conditions and access to fewer economic resources with which to cover their basic needs (Juárez-Ramírez *et al.*, 2014). Older adults are more likely to have poor oral health if they live in a low-income household, have no healthcare coverage, and/or pertain to racial/ethnic minorities, are immigrants, or live in rural areas with limited access to quality oral healthcare (Northridge *et al.*, 2020). Therefore, marginalized populations may benefit from greater access, not only to healthcare, including oral health services, but also to other opportunities.

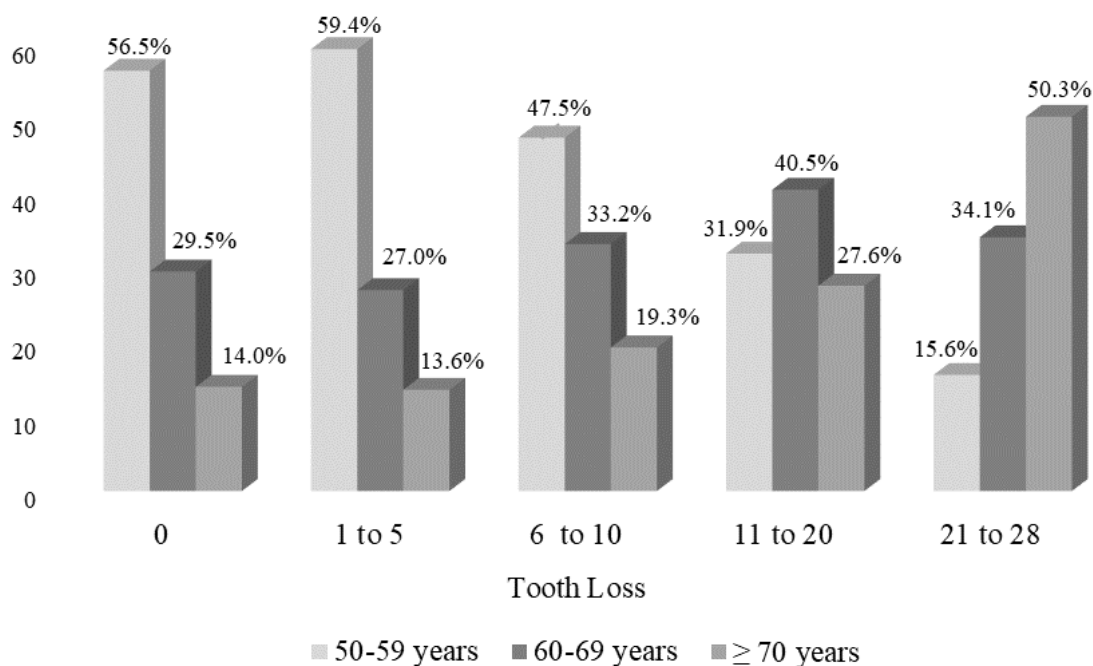


Figure 1. Number of teeth lost by age among 2098 older Mexican adults.

Table 2. Decayed, Missing and Filled teeth according to demographic characteristics, and oral hygiene among 2098 older Mexican adults.

	DMFT					
	Decayed Mean (sd)	<i>p</i> *	Missing Mean (sd)	<i>p</i> *	Filled Mean (sd)	<i>p</i> *
Age						
50-59 years	7.3 (5.5)	0.001	5.5 (5.9)	0.001	2.0 (3.6)	0.001
60-69 years	6.5 (5.5)		8.6 (7.8)		1.5 (2.9)	
≥ 70 years	6.2 (5.5)		11.7 (9.5)		1.1 (2.7)	
Sex						
Female	7.1 (5.7)	0.132	7.1 (7.4)	0.001	1.4 (3.0)	<0.001
Male	6.7 (5.4)		8.2 (±8.0)		1.9 (3.4)	
Oral hygiene (OHI-S)						
Good hygiene	6.1 (4.9)	<0.001	6.5 (6.6)	<0.001	2.2 (3.7)	<0.001
Poor hygiene	7.5 (5.9)		8.9 (8.6)		1.2 (2.7)	
Years of education						
No education	7.6 (5.9)	0.048	10.2 (8.7)	0.001	0.6 (1.7)	0.001
1-9 years	6.7 (5.4)		8.1 (7.8)		1.6 (3.1)	
≥ 10 years	6.7 (5.7)		4.2 (±.2)		3.1 (4.2)	
Marginalization level						
Medium	6.6 (5.6)	0.001	7.6 (8.0)	0.001	1.7 (3.2)	0.001
High	6.9 (5.0)		7.7 (7.4)		1.9 (3.4)	
Very High	8.1 (6.0)		9.4 (6.7)		1.0 (2.9)	
Smoking Status						
Never	7.1 (5.5)	0.048	7.6 (7.6)	0.001	1.6 (3.2)	0.849
Current	2.3 (4.4)		10.7 (10.6)		1.8 (3.8)	
Former Smoker	8.2 (4.5)		6.7 (5.7)		1.7 (2.7)	

* Kruskal-Wallis or Mann-Whitney tests as appropriate.

Table 3. Negative binomial regression analysis for having lost teeth among Mexican adults aged ≥50 years (n=2098).

Variables	Unadjusted RR (95% CI)	<i>p</i>	Adjusted RR (95% CI)	<i>p</i>
Age (Reference 50 – 59 years)				
60 – 69 years	1.55 (1.40, 1.73)	<0.001	1.38 (1.25, 1.53)	<0.001
≥ 70 years	2.12 (1.87, 2.39)	<0.001	1.77 (1.57, 1.99)	<0.001
Sex (Reference Female)				
Male	1.16 (1.05, 1.28)	0.003	1.19 (1.09, 1.31)	<0.001
Oral hygiene (OHI-S) (Reference Good Hygiene)				
Poor Hygiene	1.37 (1.25, 1.51)	0.001	1.26 (1.15, 1.38)	<0.001
Years of education (Reference ≥ 10 years)				
1-9 years	1.92 (1.68, 2.19)	<0.001	1.45 (1.28, 1.65)	<0.001
No formal education	2.41 (2.04, 2.85)	<0.001	1.60 (1.35, 1.88)	<0.001
Marginalization level (Reference Medium)				
High/Very High	1.06 (0.96, 1.17)	0.186	1.19 (1.08, 1.30)	<0.001
Smoking Status (Reference Never)				
Current	1.09 (0.97, 1.23)	0.141	1.06 (0.96, 1.18)	0.214
Decayed	0.94 (0.93, 0.95)	<0.001	0.94 (0.93, 0.96)	<0.001
Filled	0.93 (0.92, 0.95)	<0.001	0.93 (0.93, 0.96)	<0.001
Constant	–	–	4.64 (3.92, 5.48)	<0.001

Less educated older adults were more likely to be missing teeth. The same relationship has been shown in adults with a broader age range (Barbato *et al.*, 2015; Goulart and Vettore, 2016). Those with a lower level of education and living in poverty are also more likely to experience earlier onset of tooth loss (Crimmins *et al.*, 2009). Education is a mobilizing process and is considered fundamental to delaying the effects of aging and maintaining optimal health in older adults (González, 2018). Similarly, education brings knowledge and abilities to foster healthy behavior (Ferreira *et al.*, 2020). It may therefore affect older adults' access to oral healthcare services (Andrade *et al.*, 2020). Consequently, oral healthcare services could eliminate education-based barriers to access, which may reduce oral health inequalities allow them to respond to the demands of marginalized communities.

Poor oral hygiene was related to tooth loss. Plaque is a risk factor for gingivitis and its progression to periodontitis (Trombelli and Farina, 2013). Periodontitis is a significant cause of tooth loss (Siow *et al.*, 2023). Other factors are associated with tooth loss, such as sociodemographic factors as well as those related to sex, ethnic origin, educational level, income, dental caries, smoking, lack of access to healthcare services, and diseases such as diabetes (Northridge *et al.*, 2012; Silva *et al.*, 2019; Barbato and Peres, 2015). Therefore, the study of tooth loss helps to ascertain the risk factors related to the condition, while the social determinants that may be related to a higher level of tooth loss in the marginalized population should also be considered.

More males had missing teeth than females. This may be due to the supposition that females take better care of their oral health and, therefore, undertake more dental visits than males (Meisel *et al.*, 2008). Adults may also request that their dentist extract teeth if they cannot pay for their treatment due to their low income (Fatima Del Carmen *et al.*, 2021).

The present investigation is one of the few to have examined tooth loss in older adults in an environment with high and very high marginalization. None the less it has some limitations. The cross-sectional data do not allow causal inference. Second, the data may not be representative of the general population with respect to prevalence of tooth loss in Mexico. However, the relationships between marginalization and tooth loss are likely to be generalizable.

In conclusion, high and very high marginalization was associated with tooth loss among older adults in Mexico. Effective interventions for improving access to services for marginalized communities may improve oral healthcare and oral health in older adults.

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Declaration of Conflicting Interests

The authors declare no conflict of interest.

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