The Role of Socioeconomic Position in Determining Tooth Loss in Elderly Costa Rican: Findings from the CRELES Cohort

El rol de la posición socioeconómica en la determinación de la pérdida de piezas dentales en personas adultas mayores costarricenses: Hallazgos de la cohorte de CRELES

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ABSTRACT

Objective: Differences in health status between socioeconomic groups continue to challenge epidemiological research. To evaluate health inequalities in tooth loss, using indicators of socioeconomic position (education level, occupation and subjective economic situation), in a large representative sample of elderly Costa Ricans, can contribute to conceive better adapted public health interventions. Methods: Data are from the Costa Rican Longevity and Healthy Aging Study (CRELES Pre-1945), a longitudinal study of a nationally representative sample of elders. 2827 participants were included in the study using data from the first wave conducted in 2005, and analyzed cross-sectionally. The sample was imputed for missing data using a multiple imputation model. Tooth loss was self-reported and informed about the quantity of missing teeth. Information on participant's socioeconomic factors was collected via a questionnaire, including three measures approaching socioeconomic position: education level, occupation and subjective economic situation. Additional variables were included in the multivariate analyses as potential confounders. Results: Tooth loss was found to be strongly socially patterned, using variables characterizing socioeconomic position, mainly education level, occupational status and subjective economic situation. Conclusions: To highlight how socioeconomic position relates to tooth loss, can allow a better understanding of the origins of the social gradient in oral health, to tackle the most common chronic diseases across the world.

KEYWORDS

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RESUMEN

Objetivo: Las diferencias en el estado de salud entre los grupos socioeconómicos continúan desafiando la investigación epidemiológica. El objetivo de este estudio es evaluar las inequidades sociales en salud con respecto a la pérdida de piezas dentales, utilizando distintos indicadores de la posición socioeconómica (nivel de educación, ocupación y situación económica subjetiva). Se utilizó un amplio estudio representativo de la población de adultos mayores costarricenses. Este trabajo podría contribuir a concebir intervenciones en salud pública más adaptadas para el país. Métodos: Los datos provienen del Estudio de Longevidad y Envejecimiento Saludable de Costa Rica (CRELES Pre-1945), un estudio longitudinal representativo de la población de personas adultas mayores. La muestra, analizada transversalmente, incluyó 2827 participantes usando datos de la primera ronda realizada en 2005. La muestra fue imputada para tomar en cuenta los datos faltantes usando un modelo de imputación múltiple. La pérdida de piezas dentales fue declarada como la cantidad de dientes perdidos en el momento de la entrevista. La información sobre los factores socioeconómicos de los participantes se recopiló a través de un cuestionario, incluyendo tres medidas que aproximaban la posición socioeconómica: nivel educativo, ocupación y situación económica subjetiva. Otras variables fueron incluídas en el modelo de regresión múltiple, como potenciales factores de confusión. Resultados: Se encontró que la pérdida de piezas dentales estaba fuertemente asociada a las todas las variables socioeconómicas analizadas, principalmente el nivel educativo, la ocupación y la situación económica subjetiva. Conclusiones: Mostrar cómo la posición socioeconómica se relaciona con la pérdida de piezas dentales podría permitir una mejor comprensión de los orígenes del gradiente social en la salud oral. Esto permitiría la concepción de mejores políticas en salud oral para hacer frente a estas enfermedades crónicas, reconocidas como las más comunes en el mundo.

PALABRAS CLAVE

Posición socioeconómica; Nivel de educación; Ocupación; Estatus social subjetivo; Inequidades sociales en salud; Pérdida de piezas dentales; Cohorte; Costa Rica; País en desarrollo.

INTRODUCTION

Differences in health status between socioeconomic groups continue to challenge epidemiological research. Recognized as systematic, socially produced, and unfair (1), the social gradient in health is observed for a wide range of health outcomes from risk factors, chronic diseases, mortality risk, among others (2). Social inequalities in health are often described using the gradient observed according to individual socioeconomic characteristics, principally, education, social class and income (3,4).

The social gradient in health appears to be particularly strong when analyzing oral health. A large amount of evidence has shown the importance of socioeconomic position (SEP) all over the life course in determining oral health (5-7). SEP is defined here as "an aggregate concept that includes both resource-based and prestige based measures, as linked to both childhood and adult social class position. Resource-based measures refer to material and social resources and assets, including income, wealth, educational credentials (…). Prestige-based measures refer to individual's rank or status in a social hierarchy, typically

evaluated with reference to people's access to and consumption of goods, services, and knowledge as linked to their occupational prestige, income, and education level" (8). In epidemiological studies, SEP is usually approached using variables such as education (9,10), occupation (11) and income (12). These measures appear to be strong predictors of oral health in numerous studies (13,14).

Dental diseases are largely preventable, however they continue to challenge public health priorities and interventions (15). The loss of natural teeth, has been described as a good indicator of both population's health (16), as well as the quality and adequacy of a country's health care system (13). It has been suggested that the causes of tooth loss are complex, involving both disease-related mechanisms (e.g. inflammation and periodontal diseases) (14), history of previous dental diseases (17), as well as the access to medical care and treatment (16,18).

Tooth loss increases with age, being in elderly a common health problem (16). Worldwide it has been estimated that about 30% of people aged 65–74 have no natural teeth (19). A study conducted in 2014 reported than in 2010, 2.3% of the global population (158 million people), was edentate (16). However, it appears that substantial differences exist according to regional characteristics across the world. This variation may be explained by specific national characteristics (e.g. health care system) related to socioeconomic growth (17).

In Costa Rica, Brenes & Murillo conducted a study in 1990 showing that complete edentulism was present in 70.7% of the elderly population in a Costa Rican state (20). In 2011 a study conducted using 1566 people older than 60 years in six municipalities of the Costa Rican Metropolitan Area, reported complete edentulism in at least 45% of

elders (21). Tooth loss and edentulism negatively impact different dimensions of health, such as, quality of life and social functioning (22). Mainly because tooth loss cause functional problems that entails other troubles, like pain, infection, speaking difficulties, ultimately impacting nutritional status and self-esteem (23). Moreover, empirical evidence have shown correlations between oral diseases and several non-communicable diseases (e.g. diabetes (24), cardiovascular diseases (25)) and mortality risk (26,27).

Although an important amount of research suggests a link between socioeconomic position and oral health in industrialized counties, data from low and middle income countries are lacking (16). Furthermore, the relative importance of these relationships may differ across cultural and social contexts around the world. This is particularly important since studying the origins of oral pathologies and its distribution according to SEP is crucial in terms of public health interventions. In Costa Rica the social determinants of oral health have not been yet studied using a representative population of elderly.

In this study we aim to analyze the role of education level, occupation and subjective economic situation, as proxies of SEP, in determining severe tooth loss in a representative sample of elderly Costa Ricans. We hypothesize that oral health in elderly, approached using tooth loss, is socially patterned independently of health behaviors and psychosocial factors.

MATERIALS AND METHODS

PARTICIPANTS

Data are from the Costa Rican Longevity and Healthy Aging Study (CRELES Pre-1945) a longitudinal study of a nationally representative

sample including almost 3000 adults aged 60 years and over and residing in Costa Rica in 2000. For this study we analyzed the sample cross-sectionally using data from the first wave conducted in 2005. For this first wave, a subsample was selected systematically using 60 "health areas" out of a total of 102. The subsample included more than 2789 individuals, however the final sample included here was of 2705 subjects. The CRELES cohort has been described in detail elsewhere (28).

ETHICS AND DATA

Written informed consent was obtained directly from the participants, two additional witnesses signed the consent form. This observational study received ethical approval from the Scientific and Ethical Committee of the University of Costa Rica in the 63th session on March 17, 2004 (29).

MEASURES

OUTCOME VARIABLE

Tooth loss was self-reported and informed about the quantity of missing teeth: no teeth removed, up to 4 teeth missing, more than 4 and less than half, and half or more teeth missing. We dichotomized the variable as follows: Moderate tooth loss (no teeth removed, up to 4, and less than a half missing) / Severe tooth loss (half or more missing). The main criterion for this classification was based on the equilibrium of the quantity of subjects in each category (Table 1).

Table 1. Descriptive statistics on the sample (N= 2705).

Variables	N	%
Tooth loss		
Moderate	358	13.2%
Severe	2347	86.8%
Sex		
Men	1237	45.7%
Women	1468	54.3%
Place of birth		
Costa Rica	2553	94.4%
Other	146	5.4%
Missing	3	0.2%
Education level		
None	509	18.8%
Elementary	1826	67.5%
Secondary	201	7.4%
Post-Secondary	148	5.5%
Missing	21	0.8%
Occupation		
Professional, Office, Vendor	326	12.1%
Specialized & Non-specialized worker	368	13.6%
Domestic worker & services	482	17.8%
Farmer, agricultural worker	800	29.6%
Other	245	9.1%
Never worked	467	17.3%
Missing	17	0.6%

Variables	N	%
Subjective economic situation		
Rather good	1054	39.0%
Average	1238	45.8%
Poor	404	14.9%
Missing	9	0.3%
Alcohol consumption		
Abstainers	1950	72.1%
Moderate	688	25.4%
Heavy drinker	54	2.0%
Missing	13	0.5%
Smoking status		
Non- smoker	1532	56.6%
Former smoker	943	34.9%
Current smoker	218	8.1%
Missing	12	0.4%
Sugar consumption		
Less	1157	42.8%
Same	1421	52.5%
More	127	4.7%
Depression		
No	2186	80.8%
Yes	508	18.8%
Missing	11	0.4%
Marital status		
Married	1344	49.7%
Divorced or separated	257	9.5%
Widowed	868	32.1%
Never married	230	8.5%
Missing	6	0.2%
Self-rated health		
Excellent	192	7.1%
Very good	305	11.3%
Good	844	31.2%
Fair	1110	41.0%
Poor	245	9.1%
Missing	9	0.3%
	Mean	**SD**
Age	76.3	10.2

EXPOSURE VARIABLES

Information on participant's socioeconomic factors was collected via a self-reported questionnaire. The following measures were selected: education level (None / Elementary / Secondary / Post-Secondary), occupation (Professional, Office, Vendor / Specialized & Non-specialized worker / Domestic worker & services / Farmer, agricultural worker / Other / Never worked). To take into account the perception of the current economic situation, the variable subjective economic situation was also added in the models (Rather good / Average / Poor).

Confounders: age, sex, place of birth, health behaviors, and psychosocial factors.

Some variables that may partly account for the association between SEP and tooth loss acting as confounders were considered in this study. First, we took into account potential differences according to some general variables such as, sex, age (continuous variable), and place of birth. Place of birth (Costa Rica or other countries – mainly Nicaragua) was added to consider potential cultural variations, specific national characteristics and differences in access to social security and health care between groups. With regard to risky oral health behaviors we considered in the models alcohol consumption (Abstainers (does not drink) / Moderate (drinks occasionally) / Heavy drinker (drinks daily) and the smoking status (Non-smoker / Former smoker / Current smoker). Furthermore, behaviors related to diet such as sugar consumption, was taking into account. This variable investigated the variations in sugar consumption in the last 10 years, including the habit of eating coke, sugar, and sweets and informing if there was a decrease (Less), if the consumption remained stable (Same) or if the consumption increased (More).

To take into account the potential role of psychosocial factors, a depression variable was added to the models, which identified symptoms of depression and/or anxiety. The individual was considered as having a depression if the participant answered "Yes" to the question "¿Has a doctor ever told you that you have a nervous or psychiatric problem such as depression?". Marital status was used to capture social support, the variable was grouped into the following categories: Married / Divorced or separated / Widowed / Never married. Self-rated health (Excellent / Very good / Good / Fair / Poor) was as well added to control in the models for the potential influence of subjective health status in reporting tooth loss.

DATA ANALYSIS

To control for possible bias due to missing data, we imputed data for covariates with missing data using the multiple imputation program ICE in STATA V11. Twenty imputations were conducted taking the missing-at-random (MAR) assumption. Each covariable with missing values was imputed including all the variables considered in the models.

We performed a multivariate linear (logistic regression) analysis presenting three different models. Model one adjusted only for general variables related to age, sex, place of birth and also included the socioeconomic factors (education level, occupation, and subjective economic situation). Subsequently, we adjusted the multivariate linear regression resulting in three models to observe the potential modifying role of subsequent confounders:

Model 2: Model 1 + health behaviors
Model 3: Model 2 + psychosocial factors

All analyses were performed using STATA V13 taking a statistical significance level of 0.05.

RESULTS

Descriptive statistics are presented in Table 1 and were carried out on nonimputed data. These results provided information on whether the

participants presented moderate or severe tooth loss. Among respondents, 13.2% reported having moderate tooth loos and 86.8% reported having severe tooth loss. In total, 2347 participants reported severe tooth loss in this first sweep of the CRELES study. Regarding the distribution of socioeconomic factors, the majority of the participants had an education level correspondent to elementary (67.5%), were mainly farmer or agricultural worker (29.6%), and 45.8% reported having an average subjective economic situation.

Bivariate statistics were carried out on imputed data, Table 2 shows the results of the logistic regressions between socioeconomic factors, covariates and tooth loss. Age, sex, place of birth, education level, occupation, subjective economic situation, alcohol consumption, sugar consumption, marital status and self-rated health, were significantly associated with tooth loss. Smoking status was not significantly associated with tooth loss (p>0.05), and neither was depression (p=0.29).

Multivariate analyses are presented in Table 3, and were carried out on the imputed data using logistic regression. Model 1 shows that, after controlling for age (OR=1.07, p<0.01), sex (OR=1.52, p<0.01) and place of birth (OR=0.42, p<0.001), education level had a protective effect against tooth loos: those with a secondary education had an odds ratio of 0.47 (p<0.01). Moreover, having a post-secondary education also reduced the odds of reporting tooth loss (OR=0.22, p<0.01), compared with those having no education. Regarding occupation, having worked as a domestic worker or as a farmer/agricultural worker had a 1.56 and 1.68 increase in the odds of reporting tooth loss (p=0.06 and 0.02) respectively compared to the professional category. Those who "never worked" had a 2.06 increase in the odds of reporting tooth loss and therefore, was strongly associated (OR=2.06, p<0.01), relatively to the professional category.

Finally, the subjective economic situation was also linked to tooth loss. Having an "average" or "poor" perception of the current economic situation increased the odds (OR=1.54, p<0.01 and 1.60=0.02 respectively) of reporting tooth loss versus those reporting having a "rather good" economic situation.

When information on health behaviors was added in Model 2, the association between education level and tooth loss remained stable (secondary education: OR=0.46, p<0.01 / post secondary education: 0.23, p<0.01). The link between occupation and tooth loss remained significant, so that participants who had a domestic job or a farmer/agricultural work had an odds ratio of 1.57 (p=0.06) and 1.71 (p=0.02) respectively compared to the professional category. Furthermore, "never worked" was still significantly associated with tooth loss (OR=1.95, p=0.01) versus the professional category. The subjective economic situation remained significantly associated with tooth loss (Average: OR=1.49, p<0.01). However the link between having a "poor" subjective economic situation and tooth loss disappeared. Being a moderate drinker was protective in regards of tooth loss (OR=0.71, p=0.01) compared to abstainers. Being a current smoker was strongly associated with tooth loss (OR=2.17, p<0.01) compared to non-smokers. Finally, having the same sugar consumption in the last 10 years was statistically associated with a decreased risk of tooth loss compared to those who reported having less quantities of sugar (OR=0.59, p<0.01).

The full model (model 3) showed the stable link between education level and tooth loss: after adjusting for all confounders, education remained a strong protective factor against tooth loss (Secondary: OR=0.47, p<0.01 / Post-Secondary: OR=0.24, p<0.01). Moreover, occupation continued to be linked to tooth loss, even if the association was slightly weakened (Farmer, agricultural worker: OR=1.65, p=0.03 / Never worked: OR=1.89,

p=0.02) and the link between domestic workers and tooth loss was no longer significant (OR=1.54, p=0.07). Having an "average" subjective economic situation remained significantly associated with tooth loss after taking into account all confounders (OR=1.46, p=0.01). Regarding health behaviors, alcohol consumption (Moderate: OR=0.73, p=0.03), smoking status (Current: OR=2.354, p<0.01) and sugar consumption (Same: OR=0.61, p<0.01) remained linked to tooth loss. Regarding the psychosocial variables, having symptoms of depression slightly increased the odds of having a tooth loss (OR=1.05), however this result was not significant at the 5% level (p=0.77). Being married appears to be a protective factor against tooth loss (OR=0.69), however this result was not significant at the 5% level (p=0.07). Finally, participants who rated their health as "good" had a 1.77 increase in the odds of reporting tooth loss relatively to the "excellent" category.

Table 2. Bivariate statistics on imputed data for the sample (N=2705).

	OR	CI (95%)	p
Age	1.07	1.06 - 1.09	<0.01
Sex			
Men	Ref		
Women	1.56	1.25 - 1.95	<0.01
Place of birth			
Costa Rica	Ref		
Other	0.42	0.28 - 0.62	<0.01
Education level			
None	Ref		
Elementary	0.80	0.57 - 1.14	0.22
Secondary	0.23	0.15 - 0.36	<0.01
Post-Secondary	0.09	0.06 - 0.14	<0.01
Occupation			
Professional, Office, Vendor	Ref		
Specialized & Non-specialized worker	2.18	1.52 - 3.13	<0.01
Domestic worker & services	3.91	2.68 - 5.70	<0.01
Farmer, agricultural worker	4.34	3.10 - 6.07	<0.01
Other	2.08	1.39 - 3.12	<0.01
Never worked	6.68	4.29 - 10.41	<0.01
Subjective economic situation			
Rather good	Ref		
Average	2.04	1.60 - 2.60	<0.01
Poor	2.19	1.51 - 3.16	<0.01
Alcohol consumption			
Abstainers	Ref		
Moderate	0.49	0.39 - 0.62	<0.01
Heavy drinker	0.38	0.20 - 0.72	<0.01

	OR	CI (95%)	p
Smoking status			
Non- smoker	Ref		
Former smoker	1.02	0.81 - 1.30	0.86
Current smoker	1.15	0.75 - 1.78	0.52
Sugar consumption			
Less	Ref		
Same	0.65	0.52 - 0.83	<0.01
More	1.28	0.67 - 2.44	0.46
Depression			
No	Ref		
Yes	1.17	0.87 - 1.58	0.29
Marital status			
Married	Ref		
Divorced or separated	0.87	0.61 - 1.24	0.43
Widowed	1.98	1.49 - 2.16	<0.01
Never married	1.28	0.84 - 1.94	0.25
Self-rated health			
Excellent	Ref		
Very good	1.07	0.69 - 1.64	0.77
Good	2.20	1.49 - 3.26	<0.01
Fair	2.43	1.66 - 3.57	<0.01
Poor	3.86	2.15 - 6.93	<0.01

Table 3. Multivariate logistic regression using data obtained from multiple imputation (N=2705).

Variables	Model 1		Model 2		Model 3	
	OR (CI 95%)	p	OR (CI 95%)	p	OR (CI 95%)	p
Age	1.07 (1.05-1.08)	<0.01	1.07 (1.05-1.08)	<0.01	1.07 (1.06-1.09)	<0.01
Sex						
Men	Ref		Ref		Ref	
Women	1.49 (1.13-1.97)	<0.01	1.63 (1.20-2.22)	<0.01	1.77 (1.27-2.46)	<0.01
Education level						
None	Ref		Ref		Ref	
Elementary	0.96 (0.67-1.40)	0.85	1.02 (0.70-1.49)	0.92	1.02 (0.70-1.50)	0.90
Secondary	0.45 (0.27-0.74)	<0.01	0.46 (0.28-0.76)	<0.01	0.47 (0.28-0.78)	<0.01
Post-Secondary	0.21 (0.12-0.37)	<0.01	0.23 (0.13-0.41)	<0.01	0.24 (0.14-0.44)	<0.01
Occupation						
Professional, Office, Vendor	Ref		Ref		Ref	
Specialized & Non-specialized worker	1.11 (0.71-1.72)	0.66	1.14 (0.73-1.79)	0.56	1.14 (0.72-1.78)	0.58
Domestic worker & services	1.51 (0.95-2.39)	0.08	1.57 (0.98-2.49)	0.06	1.54 (0.96-2.46)	0.07
Farmer, agricultural worker	1.64 (1.05-2.56)	0.03	1.71 (1.09-2.69)	0.02	1.65 (1.04-2.60)	0.03
Other	1.24 (0.77-1.97)	0.38	1.30 (0.81-2.10)	0.28	1.26 (0.78-2.04)	0.34
Never worked	1.99 (1.17-3.38)	0.01	1.95 (1.15-3.32)	0.01	1.89 (1.11-3.22)	0.02
Subjective economic situation						
Rather good	Ref		Ref		Ref	
Average	1.54 (1.17-2.03)	<0.01	1.49 (1.13-1.97)	<0.01	1.46 (1.10-1.94)	0.01
Poor	1.60 (1.07-2.40)	0.02	1.47 (0.97-2.21)	0.07	1.41 (0.92-2.16)	0.11
Place of birth						
Costa Rica	Ref		Ref		Ref	
Other	0.42 (0.27-0.65)	<0.01	0.39 (0.25-0.62)	<0.01	0.38 (0.24-0.61)	<0.01
Alcohol consumption						
Abstainers			Ref		Ref	
Moderate			0.71 (0.54-0.93)	0.01	0.73 (0.56-0.96)	0.03
Heavy drinker			0.60 (0.28-1.27)	0.18	0.66 (0.31-1.39)	0.27

Variables	Model 1		Model 2		Model 3	
	OR (CI 95%)	p	OR (CI 95%)	p	OR (CI 95%)	p
Smoking status						
Non- smoker			Ref		Ref	
Former smoker			1.26 (0.94-1.69)	0.12	1.30 (0.97-1.74)	0.08
Current smoker			2.17 (1.32-3.57)	<0.01	2.34 (1.42-3.87)	<0.01
Sugar consumption						
Less			Ref		Ref	
Same			0.59 (0.45-0.76)	<0.01	0.61 (0.47-0.79)	<0.01
More			1.25 (0.63-2.48)	0.53	1.29 (0.64-2.58)	0.47
Depression						
No					Ref	
Yes					1.05 (0.75-1.46)	0.77
Marital status						
Married					Ref	
Divorced or separated					0.69 (0.46-1.03)	0.07
Widowed					0.82 (0.58-1.16)	0.26
Never married					0.72 (0.45-1.16)	0.17
Self-rated health						
Excellent					Ref	
Very good					1.12 (0.68-1.85)	0.64
Good					1.77 (1.13-2.79)	0.01
Fair					1.48 (0.94-2.34)	0.09
Poor					1.89 (0.98-3.66)	0.06

DISCUSSION

In this study, tooth loss was found to be strongly associated with variables characterizing socioeconomic position, mainly education level, occupational status and subjective economic situation. This association was independent of health behaviors, including alcohol consumption, smoking status, cariogenic diet and psychosocial factors, such as depression or marital status.

In this study we described the main social determinants of oral health, as measured by severe tooth loss. The social gradient in health results from the accumulation over the life course of three main determinants: those related to the biomedical background (e.g. health care, preventive medicine) (30), those related to socioeconomic determinants classified into material circumstances (e.g. income, physical, chemical factors), psychosocial factors (e.g. social support, organizational work, stress, adverse experiences, etc.) (31) and those related to life styles (e.g. smoking, alcohol consumption, diet) (32). Our findings add to this literature by testing the role of several measures approaching socioeconomic economic position (SEP) (e.g. education level, occupation and subjective economic situation), on tooth loss in a middle income country. These results are suggestive of a strong, stable link between SEP and oral health in elderly Costa Ricans, that is not fully explained by demographic characteristics, health behaviors or psychosocial factors.

An important amount of literature has shown that oral health is socially patterned. Nevertheless, it appears that between 1990 and 2010, the global prevalence of severe tooth loss decreased from 4.4% (16). However, in regards of educational attainment, studies continue to consistently show the important role of education on tooth loss. A work conducted in 2017 in Switzerland showed that not having a school diploma increased by 300% the odds of having tooth loss for both men and women

(9). This study took into account other variables not included here, such as gingival inflammation and oral hygiene (9). But why education appears to be so important? Galobardes mentioned that education "captures the long term influences of both early life circumstances on adult health, as well as the influence of adult resources. The knowledge and skills attained through education may affect a person's cognitive functioning, make them more receptive to health education messages, or more able to communicate with and access appropriate health services" (4).

Occupation can represent different pathways influencing health. Galobardes mentioned that it can relate to health through some privileges (e.g. health care, better access to education, better housing and salubrious residential facilities). Moreover, it could be linked to the social standing which includes social networks, work based stress, control, and autonomy in the place of work, and so, be associated to general health outcomes through psychosocial processes. Finally, the author explains that it can also influence health through the potential work toxic environmental exposures (4). Regarding oral health, stress-related work exposure may increase the odds of dental attrition, oral and mucosal lesions, or the exposure of the air borne dust particles in the mining workers which could lead to cancerous lesions (33).

Subjective economic situation, defined as "the individual's perception of his own position in the social hierarchy" (34) was a strong predictor of tooth loss. Singh-Manoux claims that "subjective status reflects an individual's sociocultural circumstance more fully than any of the other objective measures of social class" (35). In this study it has been shown that subjective economic situation remained an important predictor of tooth loss even after adjustment for the conventional measures of socioeconomic position. This may suggest that this indicator is measuring a different dimension of social standing in the social

hierarchy, which relates to oral health and could be a good proxy of the overall material, financial circumstances, and its influence on psychosocial factors (36).

The findings also showed the link between age and tooth loss. This could be explained by several reasons, for instance, the age-related changes in the periodontium or the lack of bacterial control in elderly, associated with physical capacity to disorganize dental biofilm (37). Regarding the additional contributing factors added in this work, literature shows, that women appear to have higher prevalence and incidence of severe tooth loss compared to men, consistently with this work (16). Regarding place of birth, this variable can approach geographical differences in low and middle income countries. It was found that to be born abroad is a protective factor against tooth loss. This could be partially explained by the diet differences in sugar consumption in low income countries such as Nicaragua compared to Costa Rica. However we do not have data available to study this hypothesis. Health behaviors, such as smoking status, alcohol consumption, and sugar intake, are well known risk factors of oral health (22,34-36). In this work we showed a protective effect of moderate drinkers compared to abstainers. There are different types of abstainers, and may be, in this cultural context, abstainers include persons who have diseases that prevent alcohol consumption. Regarding other health outcomes, moderated drinking appears to have a protective effect (41). However, in this work heavy drinking was not found statistically significant in regards to tooth loss. Being a current smoker was strongly linked to tooth loss, consistently with the literature (42-44). Diet habits and sugar consumption are difficult variables to measure. In these results, having the same sugar consumption in the last 10 years appears to be protective against tooth loss. However, this could also represent a measurement error, indicating that we were not able to better approximate cariogenic diet. Our findings also

showed a link between self-rated health and tooth loss. This result is in accordance with the literature, since self-rated health appears to be a good proxy of overall health, is socially patterned and is linked, for instance to mortality risk (45).

One of the weaknesses of this study relates to attrition and missing data. We decided to impute the missing data in the sample taking the Missing at Random assumption, to preserve important aspects of the distribution, variability, and relationships between variables. However, in any case, we cannot rule out the possibility that the missing data was not at random. An important weakness relates to the measure of tooth loss. Being self-reported, it is likely that the results in this study are underestimated. The better way to count tooth loss is via a dental examination. Another limitation is the number of additional confounders not taking into account here, such as, dental hygiene behaviors, frequency of dental visits, better measures of cariogenic diet, access to dental public health care, which could partially account for the relationships shown here.

Despite these limitations, this study has a number of strength. Is a population-based study, collecting a diverse numbers of social and health data in Costa Rican elders. Another important strength is the sample size included, which allowed to have a good power and to control for a number of potential confounding factors. Finally, this is the first study in Costa Rica that could evaluate health inequalities in oral health in a nationally representative study in elders.

CONCLUSIONS

Redressing the social stratification in oral health is a major concern in public health priorities. Despite the general improvements in oral health approaches, oral diseases appear to be persistently socially patterned across the world. This work intents to show that to tackle oral diseases, dentist

and health personal should not underestimate the role of social status. Oral diseases are multicausal, integrating not only bacterial infections or risky health behaviors, but also the social and economic dimensions. Taking into account socioeconomic position is crucial to understand the social gradient in oral health, where groups in the bottom of the social hierarchy have worse oral health than those in the middle, and they in turn, have worse health than those in the top.

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