National survey on edentulism and its geographic distribution, among Mexicans 18 years of age and older (with emphasis in WHO age groups)

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SUMMARY To determine the prevalence of edentulism in adults aged 18 years and older in Mexico and to describe its distribution in 20 of the 32 States in Mexico, highlighting the experience in the WHO age groups. A secondary analysis of the National Performance Evaluation Survey 2002–2003 (representative at the state level and part of the Word Health Survey) was undertaken. The sample design was probabilistic, stratified and through conglomerates. Data on dental conditions were available only for 20 of the 32 states of Mexico, leading to a total of 24 159 households (*N* = 54 638 654). The percentage of edentulism was determined as the proportion of subjects that self-reported complete loss of teeth. Data were analyzed using the SVY module for complex surveys in STATA 8·2®. The mean age was 41·3 ± 17·0 years (range 18–99). An estimated 6·3% (*N* = 3 437 816) of the population ≥18 years was edentulous. Lowest prevalences were observed in the states of Tlaxcala, Puebla and the Estado de Mexico with 3·4%, 3·8% and 4·5%, respectively. Highest prevalences were observed in San Luis Potosí, Colima, and Michoacán with 10·3%, 10·2% and 10·1%, respectively. Following the WHO age groups, the prevalence ranged from 2·4% in the 35–44 group through 25·5% in the 65–74 group. No obvious association between socio-economic and socio-demographic indicators at the state level and prevalence of edentulism was found. The prevalence of complete tooth loss observed in the present study varied greatly across states, although no straightforward association was found with socio-economic and socio-demographic indicators at the state level. This study could serve as a baseline to enable future evaluations of the oral status of Mexican adults and elders, following WHO age groups.

KEYWORDS: national survey, edentulism, prevalence, adults, Mexico

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Introduction

The world population continues to grow older, especially in high-income countries. However, less-developed countries face especially acute problems because of the rapid increase in their elderly population. In Mexico, the largest increases will be observed between 2020 and 2050, placing considerable demands on the national health system to effectively address the needs flowing from such demographic trends (1). This demographic transition will have important implications for the health needs and status in the future, compounding

the challenges derived from the epidemiological transition already observed in many countries: a move toward morbidity/mortality predominantly due to chronic, degenerative diseases, from morbidity/mortality predominantly due to infectious and parasitic disease and maternal and pre-natal mortality (2). It still remains unclear how large the overlap might be between the two dominant burdens, although it is likely that a substantial overlap will continue for some time.

Of the public health problems derived from an aging and expanding population, oral health represents an important part of the total expenditure on health. The rise in life expectancy also leads to increased risks for the teeth remaining in the mouth for longer, because of tooth loss from caries and periodontal disease. An indicator of oral health is the percentage of persons who have retained their natural teeth. The World Dental Federation, the World Health Organization (WHO), and the International Association for Dental Research have proposed goals for tooth loss for the year 2020: (3) (i) reduction of X% in the number of teeth extracted in the age groups at 18, 35–44 and 65–74 years of age; (ii) reduction in the number of extractions because of periodontal disease by X% in the age groups at 18, 35–44 and 65–74, with a special emphasis on tobacco use, deficient oral hygiene, stress and systemic illnesses; (iii) fall in the number of persons without teeth by X% in the age groups 35–44 and 65–74 year; (iv) increment in the number of teeth present in the mouth by X% in the age groups at 18, 35–44, and 65–74 years; and (v) rise in the number of persons with a functional set of teeth (defined as 21 teeth or more) by X% in the age groups 35–44 and 65–74 years. Canada (4), the United States (5, 6), Finland (7, 8), Sweden (8, 9), the United Kingdom (8, 10), Japan (11), Thailand (12), Australia (13, 14) and China (15) have retained the prevailing rates of complete tooth loss ranging from 6% to 57% in adults over 65 years (16). Unlike other countries, the prevalence of edentulism at specific ages (hereby called WHO index age groups) is unknown in Mexico, thereby lacking reliable epidemiological data that would enable the measurement of changes in this important oral health indicator. The aim of the present study was to determine the prevalence of edentulism in adults 18 years of age and older in Mexico, and to describe its geographic distribution within the country, based on the WHO age groups.

Materials and methods

Design, population and sampling study

The National Performance Evaluation Survey 2002–2003 (ENED) was a part of the technical collaboration between the Ministry of Health of Mexico (SSA) and the WHO, following the survey instrument and sampling strategies developed by WHO for the World Health Survey (WHS). It was carried out between November 2002 and April 2003. The survey methods were already published (17, 18). ENED provides policy-makers with reliable and internationally comparable baseline information on a variety of health indicators, including general population health measures and the performance of health systems.

The sample design was probabilistic, multistage, stratified, through conglomerates and was calculated to provide representative information at the State level, and across urban and rural areas. Three strata were considered: (i) Cities or metropolitan areas (locales with >100 000 inhabitants); (ii) urban settings (locales from 2500 to 99 999 inhabitants), and c) rural areas (locales with fewer than 2500 inhabitants). The sample size considered 9% as the smaller proportion to estimate; state estimations with a maximum relative error of 25%; a confidence level of 95%; non-response rate of 15%; and a design effect of 1·7. The complete WHS instrument was not used in every state, and in some cases the dental items were omitted. Data on dental conditions are only available for 20 of the 32 states of Mexico, leading to a total of 24 159 households included in this study. The national non-response rate was 3·1%.

Variables included in data collection and data collection process

The survey comprised household and individual face-to-face questionnaires. The household survey included general topics, such as the physical characteristics of the household and the ownership of consumable goods. The individual questionnaire aimed at individuals at least 18 years of age and collected information on health status, risk factors, health care expenditures and coverage for specific interventions and conditions. Questionnaires were read out by trained personnel. In the present study, the dependent variable was self-reported edentulism, defined as a subject that reported

having no teeth (complete loss of all natural teeth). The question asked was: *Have you lost all of your natural teeth?* Other independent variables such as state of residence, age, sex, and geographical region were included. Due to the small number of states in the Northern region, the Northern and Central regions were merged in one category.

Statistical analysis

For the statistical analysis, we adapted the sample design strategy to make our analysis more robust, using the statistical package STATA 9® (module for complex samples). First, a univariate analysis was conducted to report the summary measures per case (for nominal and ordinal variables, frequencies and percentages; for continuous variables, dispersion and central tendency measures). In the bivariate analysis, χ^2 and Student's *t*-test were used. The Pearson χ^2 statistic was corrected for the survey design using the second-order correction of Rao and Scott (19) and converted into an F-statistic. Correlation was evaluated at the ecological level to assess linear associations between the prevalence of edentulism across states, and various standard socio-economic indicators, such as the marginalization index, the human development index (including each one of the nine disaggregated components), and socio-demographic indicators, such as median age at the state level and the masculinity index. Finally, we created a map of edentulism across all states.

Results

Aiming to facilitate international comparisons on oral health status, the results will largely be presented for age groups specified by WHO as index age groups. We included 24 159 subjects ≥ 18 years old, which represented 54 638 654 individuals. (All results are subsequently presented as weighted population). Table 1 shows the general characteristics of the subjects included in the analysis. The mean age was 39·6 ± 16·1 (95% CI: 38·8–40·4) years old (ranging from 18 through 99 years), and 58·2% (*n* = 31 816 359) were women. Most subjects (73·5%; *n* = 40 184 757) lived in urban areas, and 43·8% (*n* = 23 920 970) of the study population resided in the southern states of Mexico.

It was estimated that 6·3% (*N* = 3 437 816) of the study population ≥ 18 years old in the 20 states of Mexico were edentulous. In Table 2 the distribution of

Table 1. General characteristics of the sample included in the study (N = 54 638 654)

Variable	*n*	*n* weighted	% estimated
Age groups (years)			
18–29	7121	16 968 955	32·0
30–34	3072	6 961 576	13·3
35–39	2777	6 465 175	11·8
40–44	2318	5 587 972	10·2
45–49	1730	4 158 122	7·6
50–54	1667	3 580 980	6·6
55–59	1261	2 485 301	4·5
60–64	1181	2 429 510	4·4
65–69	1046	1 765 375	3·2
70–74	848	1 505 852	2·8
75–79	542	873 271	1·6
80–84	375	622 724	1·1
85<	221	379 325	0·7
Sex			
Female	14057	31 816 359	58·2
Male	10102	22 822 295	41·8
Country region			
Northern and Central	14459	30 717 684	56·2
Southern	9700	23 920 970	43·8

edentulism throughout the states is presented; including all subjects the lowest prevalence was observed in Tlaxcala with 3·4%, while the highest was in San Luis Potosí with 10·1% (Fig. 1; *P* < 0·0001). Results for each age group indicated that in subjects under 35 years of age, the state with the highest prevalence was Guanajuato (4·9%; *n* = 58 941) and the lowest was observed in Veracruz with 0·2% (Table 2; *P* < 0·0001). Using the WHO index age groups, in Table 2, we can see that the 35–44 year old group had an overall prevalence of edentulism of 2·4%; the lowest prevalence of edentulism was in Veracruz (0·6%; *n* = 9357), and the highest in Tabasco (7·0%; *n* = 15 580; *P* < 0·001). In the same group, the prevalence in males was 2·0% and in females 2·7%, and this difference was not statistically significant (*P* > 0·05). In the 45 to 64 years age group, the highest prevalence was found in Chiapas with 16·1%, and the lowest in Morelos, with 4·3% (Table 2; *P* < 0·05). Using another WHO index age group, the subjects (65–74 years of age) had an overall prevalence of edentulism of 25·5%. The state with highest prevalence was Veracruz (40·9%; 106 054) and the lowest was observed in Hidalgo, with 8·0% (*n* = 6525; *P* < 0·0001; Table 2). In the same group, the prevalence in males was 20·6% and in females 29·4%, and such difference was statistically

Table 2. Distribution of edentulism according to Mexican States by WHO index age group (35–44 years, and 65–74 years) and other age groups, as well as sex by each age group

	Edentulism in different age groups in Mexico (percentages and *n* are weighted)					
	All – 18 and more (*n*)	18–34 years (*n*)	35–44 years (*n*)	45–64 years (*n*)	65–74 years (*n*)	≥65 years (*n*)
Aguascalientes	4·7 (44 718)	0·3 (1422)	1·4 (3716)	8·1 (14 896)	29·1 (12 288)	38·0 (24 684)
Colima	10·2 (36 913)	1·4 (2144)	5·5 (3816)	13·0 (13 539)	40·4 (11 441)	43·3 (17 414) (+)
Chiapas	9·5 (203 655)	4·0 (38 544)	3·0 (13 368)	16·1 (84 162) (+)	35·4 (44 660)	33·9 (67 581)
D.F.	10·0 (600 371)	0·7 (14 694)	2·6 (25 767)	11·6 (186 491)	24·3 (190 968)	29·2 (373 419)
Durango	9·4 (78 069)	2·7 (9330)	4·9 (7217)	11·1 (27 576)	27·0 (18 555)	34·4 (33 946)
Estado de Mexico	4·5 (570 180)	0·9 (57 880)	1·7 (47 012)	8·5 (243 164)	24·8 (134 042)	28·6 (222 124)
Guanajuato	8·2 (211 258)	4·9 (58 941) (+)	5·2 (27 043)	8·9 (53 764)	26·2 (46 108)	26·7 (71 510)
Guerrero	5·7 (171 435)	1·4 (19 242)	3·6 (27 737)	9·9 (63 043)	19·1 (29 570)	24·9 (61 413)
Hidalgo	6·4 (133 223)	4·4 (43 990)	1·8 (9127)	11·8 (53 960)	8·0 (6525) (−)	20·6 (26 146)
Michoacán	10·1 (224 677)	1·6 (15 921)	4·5 (18 162)	13·4 (72 745)	33·5 (63 824)	39·7 (117 849)
Morelos	5·0 (75 469)	3·0 (20 133)	1·3 (4412)	4·3 (15 431) (−)	16·2 (14 090)	24·9 (35 493)
Nayarit	8·7 (47 478)	2·5 (5895)	3·8 (3750)	10·0 (14 330)	27·9 (12 025)	32·5 (23 503)
Oaxaca	4·7 (151 507)	1·2 (17 172)	4·5 (33 337)	7·0 (51 396)	9·8 (19 312)	17·9 (49 602) (−)
Puebla	3·8 (186 557)	0·3 (6540)	0·8 (8990)	5·4 (55 607)	24·7 (48 044)	34·1 (115 420)
Querétaro	5·6 (46 797)	2·9 (11 000)	1·6 (2791)	6·3 (12 135)	22·1 (10 400)	24·5 (20 871)
San Luis Potosí	10·3 (136 643) (+)	4·8 (25 867)	6·9 (21 857)	10·9 (34 130)	28·1 (25 539)	36·4 (54 789)
Tabasco	9·3 (103 701)	3·8 (20 793)	7·0 (15 580) (+)	14·4 (35 688)	27·2 (16 548)	35·3 (31 640)
Tlaxcala	3·4 (30 145) (−)	1·6 (6741)	0·9 (1984)	4·6 (8637)	20·9 (6522)	24·5 (12 783)
Veracruz	5·0 (325 209)	0·2 (5056) (−)	0·6 (9357) (−)	9·1 (132 931)	40·9 (106 054) (+)	40·4 (177 865)
Zacatecas	7·7 (59 811)	1·4 (4248)	2·2 (3424)	7·0 (15 446)	30·2 (19 275)	36·5 (36 693)
X^2 corrected †	F = 5·44;	F = 4·35;	F = 3·50;	F = 1·93;	F = 2·05;	F = 1·86;
	P = 0·0000	*P* = 0·0000	*P* = 0·0001	*P* = 0·0394	*P* = 0·0508	*P* = 0·0573
Male	5·0 (1 148 112)	1·2 (118 593)	2·0 (102 847)	6·8 (354 631)	20·6 (297 245)	25·3 (572 041)
Female	7·2 (2 289 704)	1·8 (266 960)	2·7 (185 600)	11·2 (834 440)	29·4 (538 545)	34·7 (1 002 704)
X^2 corrected†	F = 23·08;	F = 5·81;	F = 1·29;	F = 12·68;	F = 6·92;	F = 14·00;
	P = 0·0000	*P* = 0·0169	*P* = 0·2577	*P* = 0·0005	*P* = 0·0092	*P* = 0·0002
Total	6·3 (3 437 816)	1·6 (385 553)	2·4 (288 447)	9·4 (1 189 071)	25·5 (835 790)	30·6 (1 574 745)

All percentages presented are weighted (*N* = 54 638 654).

−, lower prevalence; +, higher prevalence.

[†]The Pearson χ^2 statistic was corrected for the survey design using the second-order correction of Rao and Scott (19) and converted into an F-statistic.

significant (*P* < 0·05). Finally, for the ≥65-year-old age group, in Oaxaca the prevalence of edentulism was 17·9% (*n* = 49 602), and in Colima, 43·3% (Table 3; *P* = 0·0573).

The mean age in edentate subjects was 60·0 ± 17·8 years, and 38·2 ± 15·0 years among the non-edentate group (*P* < 0·001). In the test for trends, a clear tendency was observed between edentulism and age (*P* < 0·0001). The prevalence of edentulism was higher in women than in men (*P* < 0·0001). According to the regions within the country, edentulism prevailed marginally lower (*P* = 0·0501) in the Southern region (5·5% vs. 6·9%) than in the Northern and Central regions (Table 3). Analysis of the socio-economic and socio-demographic indicators and the prevalence of edentulism by age group showed no statistically significant differences (*P* > 0·05) – except for the masculinity index (number of men for 100 women), whereby a slightly positive association was found for subjects 45–64 years old, indicating that a higher masculinity index was associated with a higher prevalence of edentulism (*P* = 0·0851).

Discussion

Having natural teeth is a positive health status. Edentulism is generally considered to have a negative impact on oral health, and is a commonly used indicator in
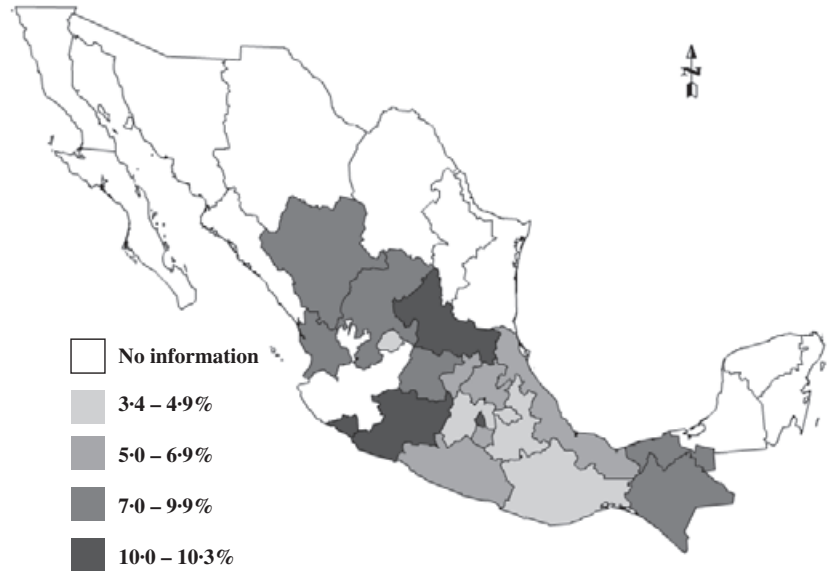
Fig. 1. Distribution of edentulism in 20 of 32 states, including all subjects ≥18 years old.

Legend:
- No information
- 3·4 – 4·9%
- 5·0 – 6·9%
- 7·0 – 9·9%
- 10·0 – 10·3%

The prevalence ranged between 3·4 and 10·3.

Table 3. Prevalence of edentulism by age groups, sex, and regions in the country

Variable	Percentage of Edentulous	P-value*
Age groups (years)		
18–29	1·5	
30–34	1·8	
35–39	2·2	
40–44	2·6	F = 133·69
45–49	5·7	P = 0·0000
50–54	6·8	
55–59	11·7	
60–64	17·2	
65–69	20·5	
70–74	31·5	Z = 53·02[†]
75–79	36·0	P = 0·0000
80–84	37·4	
85<	50·5	
Sex		
Female	7·2	F = 23·09
Male	5·0	P = 0·0000
Country region		
Northern and Central	6·9	F = 3·89
Southern	5·5	P = 0·0501

*The Pearson χ^2 statistic was corrected for the survey design using the second-order correction of Rao and Scott (19) and converted into an F-statistic.
[†]Test for trends.

high-income countries (13). The importance of preserving teeth in good functional condition lay in being linked to a good health-related quality of life (5, 20–26), while edentulism has been consistently associated with chronic disorders such as cancers in the digestive tract (27), cardiovascular disease (28) including hypertension (29) and poor nutritional status (30–33) or changes in food choices because of inherent dental/mastication limitations (34).

The present study used an epidemiological approach to describe the prevalence of edentulism rates in people other than those living in nursing homes or other institutional settings, finding that complete tooth loss in adults over 18 years of age varied by age group, sex and geographic region in Mexico. While dental caries (35–39) and periodontal diseases (40) are considered public health problems in Mexico and are often considered the principal causes of tooth loss, information is not available for establishing edentulism trends over time. Only a few studies have looked at oral health in adults and senior citizens. Comparisons of our results with the international (7–16) scene are complicated, as many of these studies were carried out in persons 65 or older, and did not include other WHO index age populations (mainly the 35–44 years age group). For the 65–74 age group, the prevalence of edentulism found (25·6%) was significantly higher than figures from China (between 5·6% and 11%); lower than Slovakia (44%); and about the same compared to Poland and Madagascar (25%), Romania (26%), Denmark, and Hungary (27%). In the case of the very low prevalence found in the 35–44 age group (2·4%), a contrast with both Chinese (15) and British (10) data reports (0% and 1%) suggests that disease experience, availability of dental services and

existing treatment patterns may render tooth extraction infrequent as the therapeutic method of choice (e.g. see discussion in 41).

The present study corroborated observations made in various reports (5, 13) in which age increases in the population studies were accompanied by increases in the proportion of subjects with complete tooth loss. This is to be expected, as oral diseases in general, and dental caries in particular, tend to have a cumulative nature. Also sharing trends derived from reports originating in other countries, Mexican women had a higher prevalence of edentulism than men (6, 13). The reason for this sex bias is not clear (42), although it is generally accepted that women have more dental caries in their permanent teeth and men have more periodontal diseases. It is interesting to point out that no edentulism differences were found between those living in rural and urban areas, as reported in southern China (15) but ,in contrast to countries like Australia (13), where total tooth loss was more likely in rural areas. Other studies carried out in Mexico (30, 31) reported that the oral health status seemed to be more favourable in rural populations, despite their more restricted access to dental care. This apparent paradox could be explained by the fact that spontaneous tooth loss is rare; intervention by a dentist is necessary for extracting tooth, regardless of dental caries and periodontal disease being the underlying reason for tooth loss (43, 44).

Generally, there are two ways to determine the oral health status of an individual. A normative method uses a clinical oral examination and a subjective method relies on the self-reporting of oral health status. Self-reporting methods are inexpensive approaches for epidemiological studies and have been employed in various health-related subjects (45–47), including indicators of oral health (48–50). Although self-reporting has been shown to have certain limitations, it is a valid and reliable measure for self-reporting remaining teeth, restorations, root-canal therapy, and the use of fixed or removable dental prostheses (48). Maupome *et al.* (51) found that when asked about their oral health, patients are capable of making a fairly accurate approximation of oral health needs regarding restorative and preventive work, as well as relating this perception with the degree of satisfaction they have with their level of oral health. Despite the fact that survey participants could not supply accurate details about their clinical conditions, the present study offered a nationally representative, cross-sectional assessment of edentulism.

We conclude that the prevalence of total tooth loss observed in the present study varies across states, and it is closely related to age, sex and country region, although showed no association with socio-economic and socio-demographics indicators at the state level. This study could serve as a baseline to enable future evaluations of the oral health of Mexican adults and elders. Additionally, this study can be used as a reference to gauge the impact of programs aiming at improving access to dental and oral health care, especially in those states that are afflicted by high levels of edentulism.

Acknowledgment

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