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Socioeconomic, sociodemographic, and clinical variables associated with root caries in a group of persons age 60 years and older in Mexico

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Aim: To determine the prevalence of root caries and the root caries index in a population of older Mexicans, and its relationship to socioeconomic, sociodemographic and dental factors.

Methods: We carried out a cross-sectional study in 85 persons 60 years and older living either in long-term care facilities, or independently and attending an elder day-care group. Each subject underwent an oral examination, performed by a trained and standardized dentist, to determine the root caries index and other clinical variables. Questionnaires were administered to collect socioeconomic, sociodemographic and hygiene data. Statistical analyses were performed using non-parametric tests.

Results: The prevalence of root caries was 96.5%. The root caries index was $37.7\% \pm 21.7\%$. Statistically significant differences ($P < 0.05$) of root caries index were observed across residential arrangements and marital statuses, and were higher in publicly funded long-term care and among single subjects ($P < 0.05$). Those who had poor hygiene had more root caries ($P < 0.05$); persons with a low level of schooling and who brushed their teeth less frequently also showed a difference ($P < 0.05$).

Conclusions: The prevalence of root caries was very high. The type of long-term care, marital status, schooling and oral hygiene were associated with a higher root caries index. Oral health programs and preventive caries interventions are needed for this age group in general; targeted strategies may be better focused if sociodemographic profiles are used to characterize high need groups. *Geriatr Gerontol Int* 2012; 12: 271–276.

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Introduction

There are currently 8.5 million people in Mexico age 60 years and older and this number increases every year.¹ Improvements in oral health, along with the increase in life expectancy, ensure that many individuals

will retain more teeth during the later stages of life. While one of the major dental health problems in Mexico is dental caries,²⁻⁵ the increased likelihood of gingival recession in older age groups makes root caries more specific to them. Root caries can be either active or inactive,⁶ and it is frequently present at the junction of cement, enamel and root of the tooth.⁷ Just as the DMFT (decayed, missing and filled teeth) index summarizes the experience of carious, filled and missing teeth with regard to crowns, the root caries index (RCI) offers a similar measure for roots.⁸ Several studies have been performed to determine the prevalence and causes of root caries, and reports place prevalence figures between 18% and almost 90% in both the general and selected populations.⁹⁻¹¹ In Mexico, some studies have reported root caries prevalence between 34% and 49%. Overall, it is estimated that almost 40% of the population 60 years and older has root caries.¹²⁻¹⁴

Studies around the world have shown that the risk factors for the increasing incidence of root caries are the number of teeth with gingival recession, bleeding on probing, self-reported dry mouth,¹⁵ age, being an ethnic minority, smoking, non-tea drinkers and having a low annual household income.¹⁶ Beighton *et al.* observed that the factors significantly related to filled and decayed root surfaces were the number of exposed root surfaces, number of teeth present, sex, and salivary yeast levels.¹⁰ One variable that has been consistently shown to be linked to greater root caries experience is poor oral hygiene.¹⁷⁻¹⁹ Also, sociodemographic conditions (such as age and sex), being institutionalized,²⁰ decreased salivary flow,²¹⁻²³ and brushing teeth with reduced frequency have been identified as factors closely related to the presence of root caries.²⁴ Unlike in some industrialized countries, there is little information in Mexico about the oral health of older populations in general and about root caries in particular. There were two primary objectives of the present research: (i) to determine the prevalence of root caries according to the RCI and the relationship of root caries to sociodemographic, socioeconomic and dental factors in a population aged 60 years and older; and (ii) to compare this information across populations living in varying residential arrangements in Mexico.

Methods

This study was approved by the Ethics and Research Committee at Universidad Autónoma del Estado de Hidalgo (Pachuca, Hidalgo, Mexico).

Study population and recruitment design

The board of directors of each institution conducted a review and approved the informed consent forms and procedures. A description of the survey planning and

methods was previously published.²⁵ Subjects were invited to participate in the study after they were informed of its objectives and given a thorough explanation of informed consent, with an emphasis on the confidentiality of information being collected. Subjects were told that they could withdraw from the study at any time, and no monetary compensation was offered. A cross-sectional study was undertaken on people aged 60 and older who were either residents of the long-term care (LTC) facilities La Casa Hogar Para Ancianos de Gobierno del Estado (state funded) or Fundación Ma. Domínguez viuda de Álvarez (privately funded), or non-resident members of the federally funded elder day-care group En Busca de un Amigo. In total, there were 151 healthy subjects who either lived in an LTC or attended the day-care group. Twelve refused to take part in the study or failed to meet inclusion/exclusion criteria. After we obtained informed consent, 54 potential subjects were eliminated out of the remaining 139 because of complete edentulousness. The final study sample consisted of 68 LTC residents and 17 ambulatory members of the day-care group. Inclusion criteria were: (i) being age 60 years or older; (ii) having at least one existing natural tooth; (iii) a willingness to participate in the research; and (iv) being a member of the LTC facilities or a registered member of the day-care group. Exclusion criteria were: (i) being younger than 60 years; (ii) having auditory, cognitive or language disabilities that might interfere with the interview; (iii) having a physical disability severe enough to prevent an oral examination; and (iv) edentulism or complete tooth loss.

Data collection

Questionnaires were used to collect sociodemographic, socioeconomic information and dental health habits from the participants. Questionnaires were administered by two trained dental students. Age, sex, marital status, having health insurance, maximum level of schooling, and frequency of brushing teeth were included in the questionnaire.

Clinical exams were performed by one trained and standardized dentist ($\kappa > 0.85$) under artificial light, with a flat dental mirror and a WHO periodontal probe. Root caries encompassed a full mouth design, excluding third molars. Root caries was recorded when an area had a darkened appearance that was discolored and well-defined, and also allowed penetration with the probe. In addition, gingival recession was recorded to calculate the RCI when root surface apical to the cement-enamel junction was visible. The RCI was used to determine root caries and the Oral Hygiene Index was used to estimate the presence of plaque.^{8,26}

Salivary tests were performed using stimulated salivary flow rate to establish salivary pH and buffer capacity.²³ To stimulate salivary flow rate, subjects chewed a

piece of wax for 5 min and then spitting into a sterile collection cup 1 min after they stopped chewing. Specimens were processed and measured with a pH-meter. Afterwards, specimens were mixed with a reactive agent to analyze buffer capacity. Specimens from nine subjects had to be discarded from the analysis because a minimum amount of saliva could not be collected. Thus, we were able to analyze 76 of the 85 saliva specimens.

Data analysis

Root caries was expressed as the mean percentage of root surfaces with caries experience (RCI = [Number of root surfaces with caries / Number of surfaces with gingival recession] \times 100).⁸ Additionally, the prevalence of root caries was calculated and categorized as 0 (subjects with no root caries experience) and 1 (subjects with at least one tooth with root caries, decayed or filling).

A descriptive data analysis was first carried out according to the scale of the variables – for nominal variables, proportions and, for quantitative variables, central tendency measures and dispersion. Prevalence and RCI were subsequently calculated. Finally, a bivariate analysis was undertaken using the Mann–Whitney *U*-test, Spearman's rank correlation coefficient and non-parametric test for trend, according to the measurement scale of contrasted variables. For multiple comparisons, we used one-way ANOVA by ranks (Kruskal–Wallis test), with the null hypothesis that *k* samples came from the same population or from identical populations with the same median. When a significant value was found, this test determined which groups were different. Data were analyzed using Stata 9.0 (StataCorp, College Station, TX, USA).

Results

A total of 85 subjects were included: 60 women (70.6%) and 25 men (29.4%). Overall average age was 78.0 ± 10.9 years; only 10.6% ($n = 9$) were working; 38.8% ($n = 33$) were divorced or widowed; 21.2% ($n = 18$) could not read or write. Over half (56.5% or $n = 48$) did not have health insurance. Over half (55.3% or $n = 47$) resided in a publicly funded LTC. Table 1 shows oral conditions. The prevalence of root caries was 96.5% ($n = 82$); the mean percentage of surfaces affected (according to the RCI) was $37.7\% \pm 21.7$. Mean sound surfaces was 21.5 ± 17.7 . Table 2 shows the independent variables included in the study. No study participant could be classified as having good oral hygiene, and thus, we analyzed data incorporating only fair and poor oral hygiene categories.

Subjects who lived in a publicly funded LTC had a higher rate of caries (RCI = 43.7%, $P = 0.008$). Caries rates were lower for those who were married/

Table 1 Oral conditions of subjects included in the study

Variable	Mean \pm SD	Min–Max
Surfaces with gingival recession	32.56 ± 21.68	1–96
Sound surfaces	21.5 ± 17.7	0–80
Tooth present	13.05 ± 7.40	1–28
Tooth loss	14.95 ± 7.40	0–27
Root caries index	$37.7\% \pm 21.7$	0–100

cohabitating with a partner or divorced/widowed (RCI = 45.8%, $P = 0.0154$), compared to single subjects (Table 3). Statistically significant differences were found between various levels of schooling and root caries ($P = 0.0259$); when we applied the non-parametric test for this trend, we observed that RCI decreased when schooling increased. No age or sex differences were found for RCI ($P > 0.05$) (Table 2).

Using the Mann–Whitney *U*-test, we found that poor oral hygiene (estimated with dental plaque scores) in subjects was significantly associated ($P = 0.013$) with higher RCI readings (41.7% vs. 31.3%) for those with fair hygiene (Table 2). Subjects who reported not brushing their teeth at all had an RCI of 47.3% whereas the RCI of those who brushed their teeth was lower (RCI = 35.6%) ($P = 0.081$).

Discussion

Root caries can be considered an oral health problem for those aged 60 years and older, as shown by our findings in a mixture of independently living and institutionalized elders. With 96.5% of subjects presenting at least one root caries lesion, this is a very high prevalence, which highlights the poor oral health status of the individuals. Therefore, it may be hypothesized that they have received very limited preventive/restorative oral health services. From the perspective that caries data collection is one important piece of the epidemiological survey of oral diseases (with the ultimate goal of informing health policy and services planning),^{4,27,28} we cautiously contrast our findings from this small sample with the limited reports focused on the oral health of elders in Mexico. For example, in one study, 49% of an (institutionalized) population presented root caries.¹⁴ Another study showed that elders who were not LTC residents had a 40.0% caries prevalence.¹² Though those studies reported figures about half as large as our findings, Taboada *et al.* indicated the RCI for non-residents of LTC was 34.4% – which is similar to our study results (37.7%).¹³ Comparisons with groups of similar ages residing in other countries suggest that a few reports have figures almost as high as ours;

Table 2 Descriptive analysis and variable association between root caries index (RCI) and sociodemographic and socioeconomic independent variables

Variable	Mean ± SD	P-value	
Age (years)	78.0 ± 10.19	$r = 0.0246$, $P = 0.8234^{\ddagger}$	
Variable	n (%)	RCI	P-value
Sex			
Men	25 (29.4)	37.3	0.7649 [§]
Women	60 (70.6)	37.8	
Health insurance			
Yes	37 (43.5)	35.6	0.5407 [§]
No	48 (56.5)	39.2	
Type of residential arrangement			
Publicly funded LTC (1)	47 (55.3)	43.7	0.0087 [†]
Privately funded LTC (2)	20 (23.5)	26.8	
Lives independently, attends day care (3)	18 (21.2)	34.0	
			0.0017 [†]
			0.0381 [†]
			0.1872 [†]
Working status			
Not working	55 (64.7)	38.0	0.8960 [†]
Retired/pensioner	21 (24.7)	35.9	
Working	9 (10.6)	39.7	
Marital status			
Single (1)	32 (37.6)	45.8	0.0154 [†]
Married / cohabitating with partner (2)	20 (23.6)	32.6	
Divorced /widowed (3)	33 (38.8)	32.8	
			0.0110 [†]
			0.0047 [†]
			0.4871 [†]
Schooling			
Illiterate	18 (21.2)	50.0	0.0259 [†]
Literate, elementary school incomplete	37 (43.5)	35.3	
Completed elementary school and higher	30 (35.3)	33.1	$z = -2.22$ 0.026 ^{††}

[†]Multiple comparisons. [‡]Spearman's rank correlation coefficient, [§]Mann-Whitney *U*-test, [†]Kruskal-Wallis, ^{††}Non-parametric test for trend. LTC, long-term care.

Beighton *et al.* and Kularatne *et al.* found root caries prevalence to be 88.4% and 89.7%, respectively.^{10,11} However, findings from other studies differ. For example, Du's *et al.* showed that subjects aged 65 years

Table 3 Descriptive analysis and variable association between root caries index (RCI) and dental independent variables

Variable	n (%)	RCI	P-value
Oral hygiene			
Fair (0.0 to 1.9)	33 (38.8)	31.3	0.0136 [‡]
Poor (2.0 to 3.0)	52 (61.2)	41.7	
Salivary pH [†]			
Acidic < 6.5	2 (2.6)	28.6	0.2994 [§]
Normal 6.5 to 7.5	16 (21.1)	29.8	
Alkaline > 7.5	58 (76.3)	39.0	
Salivary buffer capacity [†]			
Low < 5.0	52 (68.4)	37.1	0.2184 [§]
Normal 5.0 to 7.0	22 (29.0)	37.9	
High > 7.0	2 (2.6)	16.2	
Salivary flow			
Low < 1.0	60 (70.6)	37.3	0.8592 [§]
Normal 1.0 to 2.0	18 (21.2)	41.1	
High > 2.0	7 (8.2)	32.1	
Brush teeth			
No	15 (17.6)	47.3	0.0816 [‡]
Yes	70 (82.4)	35.6	
Mouth rinse			
Yes	13 (15.3)	30.8	0.1444 [‡]
No	72 (84.7)	38.9	
Dental floss			
Yes	3 (3.5)	24.4	0.2578 [‡]
No	82 (96.5)	38.1	

[†]Missing data for nine subjects, [‡]Mann-Whitney *U*-test, [§]Kruskal-Wallis.

and older had a prevalence of 43.9%.¹⁶ Studies from other parts of the world (none of them representative of national profiles) have reported a root caries prevalence of 31.8% in subjects aged 65 to 74 in Brazil,²⁹ an average of 6.3% affected surfaces in the Netherlands,³⁰ an RCI of 27% in Germany,³¹ and an RCI of 66.7% in India.³² The severity and extension of root caries appears to vary widely across population groups.

Fure *et al.* and Borges-Yañez *et al.* found significant differences across sex and age groups, which was not the case of our study.^{17,33} Although small samples are common in studies of root caries – not surprisingly considering the distribution of the age pyramid, the salience of oral health for many older people in the larger scheme of health problems, and the highly diverse living arrangements for this age subgroup – the lack of age-related differences may have been influenced by the small number of subjects studied. Perhaps the size of the population group lacked enough power to detect significant differences between sociodemographic variables.

More telling was the fact that RCI was different across LTC and day care group. Root caries, as well as

periodontal disease, dental health services utilization, frequency of brushing teeth and coronal caries seem to follow a health gradient along social disadvantage.^{2,3,34-37} Using different indicators of socioeconomic status in an elderly population, some authors have found differences between publicly and privately funded LTC.^{38,39} The general assumption is that a privately funded LTC reflects the higher socioeconomic status of residents or their families, who have more selective standards of living. This assumption is substantiated by the fact that, in our study, higher educational attainment was associated with lower experience of root caries – a gradient identified in the past.^{38,40} While the multidimensionality of health status and socioeconomic status makes it very difficult to completely tease out the nature of these associations, there is ample evidence that social position is a strong predictor of both morbidity and mortality.⁴¹

Subjects who lived without a partner had a higher RCI (45.8%); just as in the case of marital quality of life and (primarily male) survival, living alone seems to have an influence on disease. It is known that elders who live with a partner have better overall health status than those living alone or with no partner.⁴²

Oral hygiene is related to RCI, and it is often a key factor in maintaining appropriate oral health. Whether it is adequate plaque control to reduce the experience of dental caries and periodontal diseases or it is a variable that acts as a proxy of more competent cognitive/manual dexterity/overall health status,^{2,3,34,37} it is impossible to know with certainty from our data.

The present research has some limitations that ought to be considered while interpreting the results. This study did not attempt to be a national representation of the country. Because of its cross-sectional study design, it was not possible to establish causal relationships. Another limitation relates to the type of population who, as in other studies, was institutionalized. Therefore, the results might differ from findings ascribable to the open population. Finally, the sample size precluded a more sophisticated statistical analysis.

Given the sparse data for the Mexican environment, the limitations of the study do not deter from the value of our findings. This is one of the first studies contrasting root caries data across elders living in different residential arrangements; the prevalence of root caries was very high (96.5%), though it appeared to vary depending on residential arrangement, marital status and appropriateness of oral hygiene. Based on these limited findings, it is feasible to emphasize the need to develop and implement oral health programs focused on improving elders' oral health and to make use of our profiling to ensure that staggered levels of effort account for those at higher risk of oral health challenges.

Disclosure statement

The authors declare no conflict of interest.

References

- 1 Shamah-Levy T, Cuevas-Nasu L, Mundo-Rosas V, Morales-Ruán C, Cervantes-Turrubiates L, Villalpando-Hernández S. [Health and nutrition status of older adults in Mexico: results of a national probabilistic survey]. *Salud Publica Mex* 2008; **50**: 383–389.
- 2 Medina-Solis CE, Maupomé G, Pelcastre-Villafuerte B, Avila-Burgos L, Vallejos-Sánchez AA, Casanova-Rosado AJ. [Socioeconomic inequalities in oral health: dental caries in 6 to 12 year-old children]. *Rev Invest Clin* 2006; **58**: 296–304.
- 3 Villalobos-Rodelo JJ, Medina-Solis CE, Maupomé G, Pontigo-Loyola AP, Lau-Rojo L, Verdugo-Barraza L. [Dental caries in schoolchildren from a northwestern community of Mexico with mixed dentition, and some associated clinical, socioeconomic and socio-demographic variables]. *Rev Invest Clin* 2007; **59**: 256–267.
- 4 Martínez-Pérez KM, Monjarás-Ávila AJ, Patiño-Marín N *et al.* Epidemiologic study on dental caries and treatment needs in schoolchildren aged six to twelve years from San Luis Potosí. *Rev Invest Clin* 2010; **62**: 206–213.
- 5 Juárez-López ML, Villa-Ramos A. Caries prevalence in preschool children with overweight and obesity. *Rev Invest Clin* 2010; **62**: 115–120.
- 6 Guivante-Nabet C, Tavernier JC, Trevoix M, Berenholz C, Berdal A. Active and inactive caries lesions in a selected elderly institutionalised French population. *Int Dent J* 1998; **48**: 111–122.
- 7 Peplassi E, Tsami A, Komboli M. Root caries in periodontally treated patients in relation to their compliance with suggested periodontal maintenance intervals. *Compend Contin Educ Dent* 2005; **26**: 835–844.
- 8 Katz RV. Assessing root caries in populations: the evolution of the root caries index. *J Public Health Dent* 1980; **40**: 7–16.
- 9 Unlüer S, Gökalp S, Doğan BG. Oral health status of the elderly in a residential home in Turkey. *Gerodontology* 2007; **24**: 22–29.
- 10 Bighton D, Hellyer PH, Lynch EJ, Heath MR. Salivary levels of mutans streptococci, lactobacilli, yeasts, and root caries prevalence in non-institutionalized in elderly dental patients. *Community Dent Oral Epidemiol* 1991; **19**: 302–307.
- 11 Kularatne S, Ekanayake L. Root surface caries in older individuals from Sri Lanka. *Caries Res* 2007; **41**: 252–256.
- 12 Borges-Yañez SA. [Prevalence of coronal and root caries in an elderly population of Mexico City]. *Rev Div Estudios de Posgrado Invest UNAM* 1999; **9**: 25–32.
- 13 Taboada AO, Mendoza-Núñez VM, Hernández-Palacios D, Martínez-Zambrabo IA. [Prevalence of dental caries in third age patients]. *Rev ADM* 2000; **57**: 188–192.
- 14 Heredia-Ponce E, Sánchez-García S, Borges-Yañez SA. [Prevalence of coronal and root caries in older people in a long-term care in Mexico City]. *Rev Div Estudios de Posgrado Invest UNAM* 2001; **5**: 54–64.
- 15 Sugihara N, Maki Y, Okawa Y, Hosaka M, Matsukubo T, Takaesu Y. Factors associated with root surface caries in elderly. *Bull Tokyo Dent Coll* 2010; **51**: 23–30.

- 16 Du M, Jiang H, Tai B, Zhou Y, Wu B, Bian Z. Root caries patterns and risk factors of middle-aged and elderly people in China. *Community Dent Oral Epidemiol* 2009; **37**: 260–266.
- 17 Fure S. Ten-year cross-sectional and incidence study of coronal and root caries and some related factors in elderly Swedish individuals. *Gerodontology* 2004; **21**: 130–140.
- 18 Ritter AV, Shugars DA, Bader JD. Root caries risk indicators: a systematic review of risk models. *Community Dent Oral Epidemiol* 2010; **38**: 383–397.
- 19 Vehkalahti MM, Vrbic VL, Peric LM, Matvoz ES. Oral hygiene and root caries occurrence in Slovenian adults. *Int Dent J* 1997; **47**: 26–31.
- 20 Tan HP, Lo EC, Dyson JE, Luo Y, Corbet EF. A randomized trial on root caries prevention in elders. *J Dent Res* 2010; **89**: 1086–1090.
- 21 Mungia R, Cano SM, Johnson DA, Dang H, Brown JP. Interaction of age and specific saliva component output on caries. *Aging Clin Exp Res* 2008; **20**: 503–508.
- 22 Flink H. Studies on the prevalence of reduced salivary flow rate in relation to general health and dental caries, and effect of iron supplementation. *Swed Dent J Suppl* 2007; **192**: 3–50.
- 23 Närhi TO, Vehkalahti MM, Siukosaari P, Ainamo A. Salivary findings, daily medication and root caries in the old elderly. *Caries Res* 1998; **32**: 5–9.
- 24 Galan D, Brecx M, Heath MR. Oral health status of a population of community-dwelling older Canadians. *Gerodontology* 1995; **12**: 41–48.
- 25 Islas-Granillo H, Borges-Yañez SA, Lucas-Rincón SE *et al.* Edentulism risk indicators among Mexican elders 60-year-old and older. *Arch Gerontol Geriatr* 2011; **53**: 258–262.
- 26 Greene JC, Vermillion JR. The simplified oral hygiene index. *J Am Dent Assoc* 1964; **68**: 7–13.
- 27 Hahn P, Reinhardt D, Schaller HG, Hellwig E. Root lesions in a group of 50–60 year-old Germans related to clinical and social factors. *Clin Oral Investig* 1999; **3**: 168–174.
- 28 Minaya-Sánchez M, Vallejos-Sánchez AA, Casanova-Rosado AJ *et al.* Symmetrical occurrence of periodontitis and tooth loss in Mexican male adults: a pilot study. *J Dent Sci* 2010; **5**: 126–130.
- 29 Rihs LB, de Sousa ML, Wada RS. Root caries in areas with and without fluoridated water at the Southeast region of São Paulo State, Brazil. *J Appl Oral Sci* 2008; **16**: 70–74.
- 30 Keltjens H, Schaecken T, van der Hoeven H, Hendriks J. Epidemiology of root surface caries in patients treated for periodontal diseases. *Community Dent Oral Epidemiol* 1988; **16**: 171–174.
- 31 Mack F, Mojon P, Budtz-Jorgensen E *et al.* Caries and periodontal disease of the elderly in Pomerania, Germany: results of the study of health in Pomerania. *Gerodontology* 2004; **21**: 27–36.
- 32 Shah N, Sundaram KR. Impact of sociodemographic variables, oral hygiene practices, oral habits and diet on dental experience of Indian elderly: a community-based study. *Gerodontology* 2004; **21**: 43–50.
- 33 Borges-Yañez SA, Maupomé G, Martínez-Gonzalez M, Cervantez-Turrubiate L, Gutiérrez-Robledo LM. Dietary fiber intake and dental health status in urban-marginal, and rural communities in central Mexico. *J Nutr Health Aging* 2004; **85**: 333–339.
- 34 Villalobos-Rodelo JJ, Medina-Solís CE, Maupomé G, Vallejos-Sánchez AA, Lau-Rojo L, Ponce de León-Viedas MV. Socioeconomic and sociodemographic variables associated with oral hygiene status in Mexican schoolchildren aged 6 to 12 years. *J Periodontol* 2007; **78**: 816–822.
- 35 Villalobos-Rodelo JJ, Medina-Solís CE, Maupomé G *et al.* Dental needs and socio-economic status associated with dental services' utilization taking place in the presence of dental pain: a case control study. *J Orofac Pain* 2010; **24**: 279–286.
- 36 Medina-Solís CE, Villalobos-Rodelo JJ, Márquez-Corona ML, Vallejos-Sánchez AA, López Portillo-Núñez C, Casanova-Rosado AJ. [Socioeconomic inequalities in the use of dental services: a study of Mexican schoolchildren aged 6 to 12 years]. *Cad Saude Publica* 2009; **25**: 2621–2631.
- 37 Herrera MS, Lucas-Rincón SE, Medina-Solís CE *et al.* Desigualdades socioeconómicas en salud bucal: factores asociados al cepillado dental en escolares nicaragüenses. *Rev Invest Clin* 2009; **61**: 489–496.
- 38 Avlund K, Holm-Pedersen P, Morse DE, Viitanen M, Winblad B. The strength of two indicators of social position on oral health among persons over the age of 80 years. *J Public Health Dent* 2005; **65**: 231–239.
- 39 Krusturup U, Holm-Pedersen P, Petersen PE, Lund R, Avlund K. The overtime effect of social position on dental caries experience in a group of old-aged Danes born in 1914. *J Public Health Dent* 2008; **68**: 46–52.
- 40 Siukosaari P, Ainamo A, Närhi TO. Level of education and incidence of caries in the elderly: a 5-year follow-up study. *Gerodontology* 2005; **22**: 130–136.
- 41 Laaksonen M, Rahkonen O, Martikainen P, Lahelma E. Socioeconomic position and self-rated health: the contribution of childhood socioeconomic circumstances, adult socioeconomic status, and material resources. *Am J Public Health* 2005; **95**: 1403–1409.
- 42 United Nations. *World Population Ageing 2009*. Department of Economic and Social Affairs Population Division. United Nations; New York. 2009. [Cited February 2010.] Available from URL: http://www.un.org/esa/population/publications/WPA2009/WPA2009_WorkingPaper.pdf