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Series of population studies examining the effect of the economic crisis on oral health in Spain

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Abstract

Objectives: To evaluate the impact of the economic crisis on the oral health of individuals in Spain based on variables including sex, unemployment, social class, and educational level.

Methods: A population-based cross-sectional series study was performed. Data from the National Health Surveys in Spain for the years before the crisis (2003 and 2006) and during the crisis (2011, 2014, and 2017) were used. The independent variables were sex, occupation, social class, and educational level. The dependent variables were related to oral health and included dental caries, tooth extractions, dental fillings, bleeding gums, tooth mobility, prostheses, missing teeth, and tooth preservation. Descriptive statistics, chi-square tests and the Cochran-Mantel-Haenszel test were performed.

Results: A total of 189,543 patients from the precrisis surveys (n=72,789) and the surveys during the crisis period (n=116,754) were analyzed. The results showed that there were statistically significant differences (p = 0.000) in all oral health indicators. Men had a statistically higher probability of tooth extractions, dental fillings, prostheses and missing teeth. Unemployed individuals were statistically more likely to have dental caries and missing teeth. The working class had a statistically higher probability of tooth extractions, bleeding gums, prostheses and missing teeth. Participants with a basic or intermediate level of studies had a statistically higher probability of dental mobility, prostheses and missing teeth.

Conclusions: The economic crisis affected the oral health of the Spanish population and had a negative impact on men, the working class, and the unemployed, and significant differences were not observed for individuals based on their educational attainment.

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Strengths and limitations of this study

- The effects of the austerity policies of the 2008 economic crisis have been analyzed in many European countries. This unique study evaluated variables such as sex, unemployment, social class, and educational level based on data from the National Health Survey.

- This study provided a representative sample size of the Spanish population before the economic crisis and during the economic crisis to assess its impact on oral health.

- The variables used to come from responses to telephone surveys, so they are based on the participants' perceptions.

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Introduction

Economic crises affect the health of individuals, and some of the factors that influence their impacts are related to the social protection model of each country and the measures adopted by governments to combat the recession [1,2]. It is widely recognized that there is a relationship between the economy and the population's health; thus, crises can have negative consequences on health care [3–5].

The Spanish public health system offers limited dental care for individuals with acute pathology that are over 16 years of age. There is public funding for preventive and restorative treatments for children. However, the rest of the dental procedures are provided through private entities, which necessitates an additional cost for households [6,7].

Periods of economic instability are associated with unemployment, lower incomes, problems with public financing, and problems with healthcare access [8]. During the 2008 economic crisis in Europe, the use of healthcare became more restrictive. In Spain, all macroeconomic indicators, including employment, national income, and gross domestic product (GDP), fell; this contributed to inequalities in access to dental care and less access for the most vulnerable socioeconomic groups [9].

The effects of the austerity policies of the 2008 economic crisis have been analyzed in European countries with universal health coverage, such as Germany, the United Kingdom, Ireland, Latvia, Greece, and Spain, and an increase in the number of suicides and dissatisfaction with health care was found [1,10].

The aim was to evaluate the impact of the economic crisis in Spain on oral health based on variables including sex, unemployment, social class, and educational level.

Methods

A population-based cross-sectional series study was conducted following the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) [11] guidelines.

Setting and participants

The data were obtained from the National Health Surveys (NHS) of Spain for the years 2003 (from April 2003 to March 2004), 2006 (from June 2006 to June 2007), 2011

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(from July 2011 to June 2012), 2017 (from October 2016 until October 2017) [12] and the 2014 European Health Survey (EHS) in Spain (from January 2014 to January 2015).

The target population of the study was people residing in family homes in Spanish territory. When a dwelling consisted of two or more families, the study was extended to include all of them but each family was still considered independently.

A computer-assisted interview was performed for the data collection, and when necessary, a telephone interview was conducted. The NHS of Spain were carried out by the Ministry of Health, Consumption and Social Welfare in collaboration with the National Institute of Statistics. The EHS in Spain were carried out by the Ministry of Health, Social Services and Equality and the National Institute of Statistics.

Stratified three-stage sampling was used. The first stage units were the census sections. The second-stage units were the primary family dwellings, which involved investigating all the households with their habitual residence. Within each household, an adult (15 or over) was selected. The third-stage units were selected from the list of surveyable individuals in the dwelling at the time of the interview.

The sample size was calculated by the National Institute of Statistics. The other methodological details are accessible for public use [13,14].

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Variables

The absolute frequency data from the databases were used, and the variables were recoded to homogenize the results of each survey. For the analyses, the gross domestic product of Spain was considered to group the data in the periods before the crisis and during the crisis. The surveys carried out in 2003 and 2006 corresponded to the period before the crisis, and the surveys carried out in 2011, 2014, and 2017 corresponded to the period during the crisis.

All the variables collected were categorical. The independent variables were sex, occupation, social class, and educational level. The dependent variables were related to oral health and included the following: (1) dental caries (cavities were present), (2) tooth

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extraction (teeth/molars were extracted), (3) dental filling (individuals had filled teeth/molars), (4) bleeding gums (the gums of individuals bled when brushing or spontaneously), (5) tooth mobility (the teeth/molars had moved), (6) prosthesis (crowns, bridges, other types of prostheses or denture were worn), (7) missing teeth (teeth/molars were missing and not replaced by prostheses), and (8) preservation of all teeth (individuals had all natural teeth/molars).

Statistical methods

Descriptive statistics include calculating the frequencies and the percentages of each variable. Missing data were not included in the data analysis; only complete cases were evaluated. Oral health variables before the crisis and after the crisis were analyzed with a chi-square test. To evaluate the relationship between the independent variables (sex, occupation, social class, and educational level) with the oral health variables, the Cochran-Mantel-Haenszel test was used. R Studio v. 1.1.456 was used for all tests. The values were considered statistically significant at p <0.05.

Results

A total of 189,543 patients from the precrisis surveys (n=72,789) and the surveys during the crisis period (n=116,754) were analyzed.

The oral health indicators evaluated in each of the surveys are shown in Table 1. Depending on the period, before the crisis or during the crisis, statistically significant differences (p = 0.000) in all oral health indicators (presence of dental caries, tooth extraction, dental filling, bleeding gums, tooth mobility, prosthesis, missing teeth and preservation of all teeth) (Supplemental table 1) were observed in the results.

Table 1: Oral health indicators in the 2003, 2006, 2011, 2014 and 2017 surveys.

	2003	2006	2011	2014	2017
Dental caries					
Yes (%)	9964 (28.18)	10491 (28.03)	10624 (27.43)	9692 (24.88)	8409 (21.52)
No (%)	25397 (71.82)	26937 (71.97)	28102 (72.57)	29267 (75.12)	30660 (78.48)
Total	35361 (100.00)	37428 (100.00)	38726 (100.00)	38959 (100.00)	39069 (100.00)
Tooth extraction					
Yes (%)	24778 (70.07)	26620 (71.12)	27202 (70.24)	28202 (72.39)	28640 (73.31)
No (%)	10583 (29.93)	10808 (28.88)	11524 (29.76)	10757 (27.61)	10429 (26.69)
Total	35361 (100.00)	37428 (100.00)	38726 (100.00)	38959 (100.00)	39069 (100.00)
Dental filling					

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Yes (%)	21664 (61.27)	23971 (64.05)	25137 (64.91)	24903 (63.92)	26273 (67.25)
No (%)	13697 (38.73)	13457 (35.95)	13589 (35.09)	14056 (36.08)	12796 (32.75)
Total	35361 (100.00)	37428 (100.00)	38726 (100.00)	38959 (100.00)	39069 (100.00)
Bleeding gums					
Yes (%)	5367 (15.18)	7970 (21.29)	6571 (16.97)	6837 (17.55)	6446 (16.50)
No (%)	29994 (84.82)	29458 (78.71)	32155 (83.03)	32122 (82.45)	32623 (83.50)
Total	35361 (100.00)	37428 (100.00)	38726 (100.00)	38959 (100.00)	39069 (100.00)
Tooth mobility					
Yes (%)	1972 (5.58)	2769 (7.40)	2385 (6.16)	2505 (6.43)	1992 (5.10)
No (%)	33389 (94.42)	34659 (92.60)	36341 (93.84)	36454 (93.57)	37077 (94.90)
Total	35361 (100.00)	37429 (100.00)	38726 (100.00)	38959 (100.00)	39069 (100.00)
Prostheses					
Yes (%)	13498 (38.17)	14777 (39.48)	15141 (39.10)	15459 (39.68)	15375 (39.35)
No (%)	21863 (61.83)	22651 (60.52)	23585 (60.90)	23500 (60.32)	23694 (60.65)
Total	35361 (100.00)	37428 (100.00)	38726 (100.00)	38959 (100.00)	39069 (100.00)
Missing teeth					
Yes (%)	16293 (46.08)	17774 (47.49)	19245 (49.70)	21262 (54.58)	22323 (57.14)
No (%)	19068 (53.92)	19654 (52.51)	19481 (50.30)	17697 (45.42)	16746 (42.86)
Total	35361 (100.00)	37428 (100.00)	38726 (100.00)	38959 (100.00)	39069 (100.00)
Preservation of all teeth					
Yes (%)	26935 (76.17)	7590 (20.28)	9211 (23.79)	10163 (26.09)	10418 (26.67)
No (%)	8426 (23.83)	29838 (79.72)	29515 (76.21)	28796 (73.91)	28651 (73.33)
Total	35361 (100.00)	37428 (100.00)	38726 (100.00)	38959 (100.00)	39069 (100.00)

Oral health evaluation between the crisis periods according to sex

Men had a statistically higher probability of tooth extraction (OR = 1.41, p = 0.000), dental filling (OR = 1.30, p = 0.000), prostheses (OR = 1.04, p = 0.008) and missing teeth (OR = 1.35, p = 0.000). However, women were more likely to have preserved teeth (OR = 1.33, p = 0.000) and less likely to have dental caries (OR = 0.90, p = 0.000) (Table 2).

Table 2: Cochran-Mantel-Haenszel test to assess the oral health relationship before the crisis and during the crisis according to sex. P-value <0.05 statistically significant.

Dental caries	**OR**	**95% CI**	**p-value**
Male	0.93	0.90-0.96	0.000
Woman	0.90	0.87-0.92	0.000
M-H combined	0.91	0.89-0.93	0.000
Tooth extraction			
Male	1.41	1.37-1.45	0.000

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Woman	1.21	1.17-1.24	0.000
M-H combined	1.31	1.28-1.33	0.000
Dental filling			
Male	1.30	1.27-1.34	0.000
Woman	1.23	1.20-1.27	0.000
M-H combined	1.27	1.24-1.29	0.000
Bleeding gums			
Male	1.02	0.99-1.06	0.197
Woman	0.94	0.91-0.97	0.000
M-H combined	0.98	0.96-1.00	0.088
Tooth mobility			
Male	0.90	0.85-0.95	0.000
Woman	0.88	0.83-0.93	0.000
M-H combined	0.89	0.86-0.92	0.000
Prostheses			
Male	1.04	1.01-1.07	0.008
Woman	0.98	0.95-1.00	0.010
M-H combined	0.99	0.86-1.03	0.533
Missing teeth			
Male	1.35	1.31-1.39	0.000
Woman	1.25	1.22-1.28	0.000
M-H combined	1.30	1.27-1.32	0.000
Preservation of all teeth			
Male	1.07	1.04-1.10	0.000
Woman	1.33	1.29-1.37	0.000
M-H combined	1.19	1.16-1.21	0.000

Oral health evaluation between the crisis periods based on unemployment

Unemployed individuals were statistically more likely to have dental caries (OR = 1.08, p = 0.038) and missing teeth (OR = 1.36, p = 0.000). However, employed individuals had a higher probability of tooth extraction (OR = 1.55, p = 0.000), dental filling (OR = 1.68, p = 0.000), prostheses (OR = 1.09, p = 0.000) and preservation of all teeth (OR = 1.08, p = 0.000), as well as a lower probability of tooth mobility (OR = 0.87, p = 0.000) and gum bleeding (OR = 0.87, p = 0.000) (Table 3).

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Table 3: Cochran-Mantel-Haenszel test to evaluate the oral health relationship before the crisis and during the crisis depending on the employment situation. P-value <0.05 statistically significant.

Dental caries	OR	95% CI	p-value
Workers	0.86	0.84-0.89	0.000
Unemployed	1.08	1.00-1.16	0.038
M-H combined	0.89	0.87-0.91	0.000
Tooth extraction			
Workers	1.55	1.51-1.59	0.000
Unemployed	1.41	1.31-1.51	0.000
M-H combined	1.53	1.49-1.57	0.000
Dental filling			
Workers	1.68	1.64-1.73	0.000
Unemployed	1.26	1.17-1.35	0.000
M-H combined	1.62	1.58-1.66	0.000
Bleeding gums			
Workers	0.87	0.82-0.92	0.000
Unemployed	1.06	0.92-1.21	0.441
M-H combined	0.90	0.85-0.95	0.000
Tooth mobility			
Workers	0.87	0.82-0.92	0.000
Unemployed	1.06	0.92-1.21	0.441
M-H combined	0.90	0.85-0.95	0.000
Prostheses			
Workers	1.09	1.06-1.12	0.000
Unemployed	0.98	0.91-1.06	0.653
M-H combined	1.08	1.05-1.10	0.000
Missing teeth			
Workers	1.29	1.26-1.32	0.000
Unemployed	1.36	1.27-1.46	0.000
M-H combined	1.30	1.27-1.33	0.000
Preservation of all teeth			
Workers	1.08	1.05-1.12	0.000
Unemployed	1.06	0.98-1.15	0.172
M-H combined	1.08	1.05-1.11	0.000

Oral health evaluation between the crisis periods according to social class

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The working class had a statistically higher probability of tooth extraction (OR = 1.63, p = 0.000), bleeding gums (OR = 1.04, p = 0.008), prostheses (OR = 1.05, p = 0.000), and missing teeth (OR = 1.36, p = 0.000). However, the bourgeois class had a higher probability of preservation of all teeth (OR = 1.36, p = 0.000) and dental filling (OR = 1.58, p = 0.000), as well as a lower probability of presenting dental caries (OR = 0.84, p = 0.000) and dental mobility (OR = 0.74, p = 0.000) (Table 4).

Table 4: Cochran-Mantel-Haenszel test to assess the oral health relationship before the crisis and during the crisis according to social class. P-value <0.05 statistically significant.

Dental caries	OR	95% CI	p-value
Bourgeois class	0.84	0.81-0.87	0.000
Working class	0.99	0.96-1.01	0.342
M-H combined	0.93	0.91-0.95	0.000
Tooth extraction			
Bourgeois class	1.44	1.40-1.48	0.000
Working class	1.63	1.59-1.67	0.000
M-H combined	1.53	1.51-1.57	0.000
Dental filling			
Bourgeois class	1.58	1.53-1.63	0.000
Working class	1.43	1.39-1.46	0.000
M-H combined	1.48	1.46-1.51	0.000
Bleeding gums			
Bourgeois class	1.01	0.97-1.05	0.623
Working class	1.04	1.01-1.07	0.008
M-H combined	1.03	1.01-1.05	0.016
Tooth mobility			
Bourgeois class	0.74	0.69-0.79	0.000
Working class	0.94	0.89-0.98	0.006
M-H combined	0.86	0.83-0.90	0.000
Prostheses			
Bourgeois class	0.97	0.94-1.00	0.035
Working class	1.05	1.02-1.07	0.000
M-H combined	1.01	0.99-1.03	0.201
Missing teeth			
Bourgeois class	1.17	1.14-1.21	0.000
Working class	1.36	1.33-1.39	0.000
M-H combined	1.28	1.26-1.30	0.000

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Preservation of all teeth			
Bourgeois class	1.36	1.32-1.40	0.000
Working class	1.11	1.08-1.14	0.172
M-H combined	1.21	1.19-1.24	0.000

Oral health evaluation between the crisis periods depending on the level of studies

Participants with a basic or intermediate level of studies had a statistically higher probability of dental mobility (OR = 1.13, p = 0.000), prostheses (OR = 1.11, p = 0.000) and missing teeth (OR = 1.42, p = 0.000). However, participants with a high level of education had a higher probability of preservation of all teeth (OR = 1.16, p = 0.000), gum bleeding (OR = 1.44, p = 0.000), dental filling (OR = 1.86, p = 0.000), and dental caries (OR = 1.13, p = 0.001) (Table 5).

Table 5: Cochran-Mantel-Haenszel test to evaluate the oral health relationship before the crisis and during the crisis according to the level of studies. P-value <0.05 statistically significant.

Dental caries	**OR**	**95% CI**	**p-value**
Higher studies	1.13	1.05-1.22	0.001
Basic or intermediate studies	1.02	0.99-1.04	0.257
M-H combined	1.03	1.00-1.06	0.027
Tooth extraction			
Higher studies	1.72	1.62-1.81	0.000
Basic or intermediate studies	1.69	1.65-1.73	0.000
M-H combined	1.69	1.65-1.73	0.000
Dental filling			
Higher studies	1.86	1.75-1.97	0.000
Basic or intermediate studies	1.41	1.38-1.45	0.000
M-H combined	1.48	1.47-1.50	0.000
Bleeding gums			
Higher studies	1.44	1.33-1.57	0.000
Basic or intermediate studies	1.32	1.28-1.37	0.000
M-H combined	1.34	1.30-1.38	0.000
Tooth mobility			
Higher studies	0.96	0.82-1.13	0.640
Basic or intermediate studies	1.13	1.07-1.19	0.000
M-H combined	1.11	1.06-1.17	0.000

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Prostheses			
Higher studies	0.89	0.83-0.94	0.000
Basic or intermediate studies	1.11	1.08-1.14	0.000
M-H combined	1.07	1.05-1.10	0.000
Missing teeth			
Higher studies	1.33	1.25-1.41	0.000
Basic or intermediate studies	1.42	1.38-1.46	0.000
M-H combined	1.41	1.37-1.44	0.000
Preservation of all teeth			
Higher studies	1.16	1.08-1.23	0.000
Basic or intermediate studies	1.00	0.97-1.03	0.797
M-H combined	1.02	1.00-1.05	0.087

Discussion

The 2008 economic crisis in Spain negatively affected oral health indicators, with statistically significant differences between the period before and during the crisis.

Accessibility to health services depends on individual factors, the social context, and the health system [15]. Our study considered the data available from the national health surveys that included sex, employment status, social class, and educational level. However, other studies that have evaluated the economic impact of the crisis on oral health have also included other factors, such as age, marital status, or the presence of chronic diseases [16,17].

Women had better oral health than men, and in general, women go to the dentist more often than men [18], take better care of their teeth (i.e., more frequent brushing and use of dental floss or fluoride paste), more greatly value aesthetics, and have better knowledge of oral health [19–21]. However, some studies show that men are more likely to brush and floss [22]. These differences may be because economic crises cause multifactorial health effects [23–25].

Compared to unemployed individuals, employed individuals were less likely to develop periodontal disease (such as gum bleeding and tooth mobility), more extractions and conservative treatments (such as fillings and prosthetics) were performed, and they preserved their teeth better. Other studies show that employed individuals go to the

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dentist significantly more [18] than unemployed individuals; however, they were more prone to cavities.

In regard to social class, the working class was more likely to have dental extractions. However, the bourgeois class had better oral health with better preservation of teeth and was less likely to present tooth mobility and cavities. These results are consistent with other studies in which a low income level negatively affected health [26–28].

In regard to the level of studies, the negative oral health indicators were more balanced compared to the previous socioeconomic factors evaluated. Participants with a primary or intermediate level of education had a greater probability of tooth loss, tooth mobility, and conservative treatments such as the placement of dental prostheses. In the case of participants with a high level of education, although they had a greater probability of teeth preservation and conservative treatments such as fillings, they had a more significant presence of cavities, bleeding gums, and extractions. Other studies have shown that individuals with lower educational attainment are at higher risk for unmet dental needs [6,22,28].

One of the most critical limitations of this study is that the results were collected from self-report surveys, which include biases due to the subjectivity of the participants' responses. In addition, in some publications, it has been observed that in periods of crisis, individuals tend to have more negative self-evaluations on health [4,5,29]. Despite this bias, national country surveys have been frequently used to assess the general state of the population, providing a representative sample size. In Spain, other self-report surveys were carried out to assess the economic crisis in the state of health with 44,138 participants. In our study, we included 189,543 respondents, and more socioeconomic factors were evaluated, but the results obtained were the same concerning the negative impact of the crisis on unemployed individuals and the working class [6]. Additionally, it should be acknowledged that the variables collected concerning the missing teeth were included if the absence has not been restored. Therefore, the number of preserved teeth did not necessarily reflect the number of missing teeth.

Not all countries experiencing crises observe a negative effect on the health of individuals. For example, in the case of Cyprus, the only report was that more patients were having difficulties financing their health needs [30]. However, the most vulnerable

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social groups suffered devastating consequences in most European countries during the 2008 crisis [1,10,31,32].

This study suggests that the economic crisis affected the oral health of the Spanish population, had a negative impact on men, the working class, the unemployed, and did not significantly affect individuals differently based on their educational attainment.

Contributors: SME, data curation and investigation; RR, formal analysis; SME, JS-R-M and AL, methodology and conceptualization; AG, resources; JS-R-M and AL, supervision; JS-R-M, AG and AL, validation; SME and RR, visualization and writing – original draft. All authors contributed to data interpretation, reviewed successive drafts and approved the final version of the manuscript.

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Competing interests: None declared.

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Supplemental table 1: Oral health indicators before the crisis (2003 and 2006 surveys) and during the crisis (2011, 2014 and 2017 surveys). Chi-square test. P-value <0.05 statistically significant.

Dental caries	Before the crisis	During the crisis	P-value
Yes (%)	20455 (28.10)	28725 (24.60)	0.000
No (%)	52334 (71.90)	88029 (75.40)	
Total	72789 (100.00)	116754 (100.00)	
Tooth extraction			
Yes (%)	51398 (70.61)	84044 (71.98)	0.000
No (%)	21391 (29.39)	32710 (28.02)	
Total	72789 (100.00)	116754 (100.00)	
Dental filling			
Yes (%)	45635 (62.69)	76313 (65.36)	0.000
No (%)	27154 (37.31)	40441 (34.64)	
Total	72789 (100.00)	116754 (100.00)	
Bleeding gums			
Yes (%)	13337 (18.32)	19854 (17.00)	0.000
No (%)	59452 (81.68)	96900 (83.00)	
Total	72789 (100.00)	116754 (100.00)	
Tooth mobility			
Yes (%)	4741 (6.51)	6882 (5.89)	0.000
No (%)	68048 (93.49)	109872 (94.11)	
Total	72789 (100.00)	116754 (100.00)	
Prostheses			
Yes (%)	28275 (38.85)	45975 (39.38)	0.000
No (%)	44514 (61.15)	70779 (60.62)	
Total	72789 (100.00)	116754 (100.00)	
Missing teeth			
Yes (%)	34067	62830	0.000
No (%)	38722	53924	
Total	72789	116754	
Preservation of all teeth			
Yes (%)	34525	29792	0.000
No (%)	38264	86962	
Total	72789	116754	

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	NA
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	6-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-7

		(*b*) Report category boundaries when continuous variables were categorized	6-7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA

Discussion

Key results	18	Summarise key results with reference to study objectives	7
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	8-9

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	3

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Series of cross-sectional studies of population-based health surveys examining the effect of the economic crisis on oral health in Spain over the years

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Series of cross-sectional studies of population-based health surveys examining the effect of the economic crisis on oral health in Spain over the years

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Abstract

Objectives: To evaluate the impact of the economic crisis on the oral health of individuals in Spain based on variables including sex, unemployment, social class, and educational level.

Design: Population-based cross-sectional series.

Setting: National general health surveys in Spain.

Participants: A total of 189,543 participants were recruited from the pre-crisis surveys (n=72,789) and the surveys during the crisis period (n=116,754).

Interventions: Self-reported surveys conducted before the crisis (2003 and 2006) and during the crisis (2011, 2014, and 2017).

Primary and secondary outcome measures: The independent variables were sex, employment, social class, and educational level. The dependent variables were related to oral health and included dental caries, tooth extractions, dental fillings, bleeding gums, tooth mobility, prostheses, missing teeth, and tooth preservation. Descriptive statistics, chi-square tests and the Cochran-Mantel-Haenszel test were performed.

Results: The results showed that there were differences (p =< 0.001) in all oral health indicators. Men had a higher probability of tooth extractions, dental fillings, prostheses and missing teeth. Unemployed individuals were more likely to have dental caries and missing teeth. The working class had a higher probability of tooth extractions, bleeding gums, prostheses and missing teeth. Participants with a basic or intermediate level of studies had a higher probability of dental mobility, prostheses and missing teeth.

Conclusions: The economic crisis of 2008 affected the oral health of the Spanish population, with a more significant deterioration in men, the working class, and the unemployed. Educational level was not influential. National surveys represent the population, but it is necessary to control self-reported responses and design more specific questions.

Strengths and limitations of this study

- Series of national oral health surveys were conducted in Spain before and during the 2008 economic crisis.
- Surveys were conducted through computer-assisted personal interviews.

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- A representative sample size of the population over 15 years of age.

- Data were self-reported by participants.

- Study the influence of sex, employment, social class, and level of education.

3

Introduction

Economic crises affect the health of individuals, and some of the factors that influence their impacts are related to the social protection model of each country and the measures adopted by governments to combat the recession [1,2]. It is widely recognized that there is a relationship between the economy and the population's health; thus, crises can have negative consequences on health care [3–5].

The Spanish public health system offers limited dental care for individuals with acute pathology that are over 16 years of age. There is public funding for preventive and restorative treatments for children. However, the rest of the dental procedures are provided through private entities, which necessitates an additional cost for households [6,7].

Periods of economic instability are associated with unemployment, lower incomes, problems with public financing, and problems with healthcare access [8]. During the 2008 economic crisis in Europe, the use of healthcare became more restrictive. In Spain, all macroeconomic indicators, including employment, national income, and gross domestic product (GDP), fell. The GDP before the crisis in 2003 and 2006 was 3.0 and 4.1, respectively, and after the crisis, in 2011, 2014, and 2017 it fell to negative values, being -0.8, 1.4, and 3.0, respectively [9].This contributed to inequalities in access to dental care and less access for the most vulnerable socioeconomic groups [10]. For example, the average unemployment rate before the crisis in 2003 and 2006 was 11.5% and 8.5%, respectively. After the crisis, it was higher in 2011, 2014, and 2017, is 21.4%, 24.4%, and 17.2%, respectively. Higher level of education in 2003 and 2006 was 3.5% and 3.3%, respectively. After the crisis, it was similar in 2011, 2014, and 2017, being 3.4%, 3.3%, and 3.4%, respectively. High school and intermediate level of education in 2003 and 2006 were 16.2% and 15.7%, respectively. After the crisis, in 2011, 2014, and 2017 it was higher, being 16.8%, 17.4%, and 17.5%, respectively [11].

The effects of the austerity policies of the 2008 economic crisis have been analyzed in European countries with universal health coverage, such as Germany, the United Kingdom, Ireland, Latvia, Greece, and Spain, and an increase in the number of suicides and dissatisfaction with health care was found [1,12].

The aim was to evaluate the impact of the economic crisis in Spain on oral health based on variables including sex, unemployment, social class, and educational level.

4

Methods

A population-based cross-sectional series study was conducted following the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) [13] guidelines.

Setting and participants

The data were obtained from the National Health Surveys (NHS) of Spain for the years 2003 (from April 2003 to March 2004), 2006 (from June 2006 to June 2007), 2011 (from July 2011 to June 2012) [14], 2017 (from October 2016 until October 2017) [15] and the 2014 European Health Survey (EHS) in Spain (from January 2014 to January 2015) [16]. The databases used belong to the National Institute of Statistics of Spain (https://www.ine.es/dyngs/INEbase/es/categoria.htm?c=Estadistica_P&cid=125473557 3175) and are accessible for public use [14–16].

The target population of the study was people residing in family homes in Spanish territory. When a dwelling consisted of two or more families, the study was extended to include all of them but each family was still considered independently. The data was self-reported.

For data collection, a computer-assisted personal interview was carried out (a face-to-face interview in which the interviewer uses software that navigates through the questionnaire, generates flows, and may even have consistency validations), which was complemented, when necessary and in exceptional cases, by telephone interview. The NHS of Spain were carried out by the Ministry of Health, Consumption and Social Welfare in collaboration with the National Institute of Statistics. The EHS in Spain were carried out by the Ministry of Health, Social Services and Equality and the National Institute of Statistics three-stage sampling was used. The first stage units were the census sections. The second-stage units were the primary family dwellings, which involved investigating all the households with their habitual residence. To estimate the characteristics of the population, ratio estimators were used to which calibration techniques were applied, taking as auxiliary variables the age and sex groups, and nationality groups, of the population of the autonomous community. Finally, adults were included in the group aged 15 years and older. Within each household, an adult (15 or over) was selected. The third-stage units were selected from the list of surveyable individuals in the dwelling at the time of the interview. The exclusion criteria were: the

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selected person is admitted to a hospital or residence; the selected person is unable to answer due to severe illness or disability and the selected person cannot answer because of the language.

The sample size was calculated by the National Institute of Statistics. The data sets and other methodological details are accessible for public use [14–16]. The current study are available from the corresponding author on reasonable request.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Variables

The absolute frequency data from the databases were used, and the variables were recoded to homogenize the results of each survey. For the analyses, the gross domestic product of Spain was considered to group the data in the periods before the crisis and during the crisis. The surveys carried out in 2003 and 2006 corresponded to the period before the crisis, and the surveys carried out in 2011, 2014, and 2017 corresponded to the period during the crisis.

All the variables collected were categorical. The independent variables were sex (male/woman), employment (workers: employed, working/unemployed: unemployed, unemployed), social class (bourgeois: includes class I, - Directors and managers of establishments with ten or more salaried and traditionally professional associated with university degrees, class II: Directors and managers of establishments with less than ten employees, professionals traditionally associated with university degrees and other technical support professionals, athletes, artists, and class III: Intermediate employers and self-employed workers / working: Class IV: Supervisors and workers in skilled technical employee, Class V: Skilled workers in the primary sector and other semi-skilled workers, and Class VI: Unskilled workers) and level of education (higher level of education: university studies or equivalent / basic or intermediate level of education: training professional, high school and secondary education). The dependent variables were related to oral health and included the following: (1) dental caries (cavities were present as

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erosion of the enamel and ivory of the teeth/molars by the action of certain bacteria), (2) tooth extraction (teeth/molars were extracted), (3) dental filling (individuals had filled teeth/molars), (4) bleeding gums (the gums of individuals bled when brushing or spontaneously), (5) tooth mobility (the teeth/molars had moved), (6) prosthesis (crowns, bridges, other types of prostheses or denture were worn), (7) missing teeth (teeth/molars were missing and not replaced by prostheses), and (8) preservation of all teeth (individuals had all natural teeth/molars).

Statistical methods

Descriptive statistics include calculating the frequencies and the percentages of each variable. Missing data were not included in the data analysis; only complete cases were evaluated. Oral health variables before the crisis and after the crisis were analyzed with a chi-square test. To evaluate the relationship between the independent variables (sex, employment, social class, and educational level) with the oral health variables, the Cochran-Mantel-Haenszel test was used. R Studio v. 1.1.456 was used for all tests. The values were considered statistically significant at p <0.05.

Results

A total of 189,543 patients from the precrisis surveys (n=72,789) and the surveys during the crisis period (n=116,754) were analyzed.

The oral health indicators evaluated in each of the surveys are shown in Table 1. Depending on the period, before the crisis or during the crisis, statistically significant differences (p < 0.001) in all oral health indicators (presence of dental caries, tooth extraction, dental filling, bleeding gums, tooth mobility, prosthesis, missing teeth and preservation of all teeth) (Supplemental table 1) were observed in the results.

Table 1: Oral health indicators in the 2003, 2006 (precrisis) 2011, 2014 and 2017 (during crisis) surveys. The p-value shows the results of the chi-square test.

		2003			2006			2011	
	n	Yes (%)	No (%)	*n*	Yes (%)	No (%)	*n*	Yes (%)	N
Dental caries		9964 (28.18)	25397 (71.82)		10491 (28.03)	26937 (71.97)		10624 (27.43)	2810
Tooth extraction	35361	24778 (70.07)	10583 (29.93)	37428	26620 (71.12)	10808 (28.88)	38726	27202 (70.24)	1152
Dental filling		21664 (61.27)	13697 (38.73)		23971 (64.05)	13457 (35.95)		25137 (64.91)	1358
Bleeding gums		5367 (15.18)	29994 (84.82)		7970 (21.29)	29458 (78.71)		6571 (16.97)	3215

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Tooth mobility		1972 (5.58)	33389 (94.42)	37429	2769 (7.40)	34659 (92.60)		2385 (6.16)	3634
Prostheses		13498 (38.17)	21863 (61.83)		14777 (39.48)	22651 (60.52)		15141 (39.10)	2358
Missing teeth		16293 (46.08)	19068 (53.92)	37428	17774 (47.49)	19654 (52.51)		19245 (49.70)	1948
Preservation of all teeth		26935 (76.17)	8426 (23.83)		7590 (20.28)	29838 (79.72)		9211 (23.79)	2951

The influence of gender, employment situation, social class and level of education on oral health indicators in the years prior to the crisis and during the crisis are shown in Table 2.

Table 2: Cochran-Mantel-Haenszel test to assess the oral health relationship before the crisis and during the crisis according to sex, employment situation, social class and level of education. p<0.001, ** p<0.01, and * p<0.05 statistically significant.

	Dental caries OR (95% CI)	Tooth extraction OR (95% CI)	Dental filling OR (95% CI)	Bleeding gums OR (95% CI)	
Male	0.93 (0.90-0.96)***	1.41 (1.37-1.45)***	1.30 (1.27-1.34)***	1.02 (0.99-1.06)	
Woman	0.90 (0.87-0.92)***	1.21 (1.17-1.24)***	1.23 (1.20-1.27)***	0.94 (0.91-0.97)***	
Cochran-Mantel-Haenszel	0.91 (0.89-0.93)***	1.31 (1.28-1.33)***	1.27 (1.24-1.29)***	0.98 (0.96-1.00)	
Workers	0.86 (0.84-0.89)***	1.55 (1.51-1.59)***	1.68 (1.64-1.73)***	0.87 (0.82-0.92)***	
Unemployed	1.08 (1.00-1.16)*	1.41 (1.31-1.51)***	1.26 (1.17-1.35)***	1.06 (0.92-1.21)	
Cochran-Mantel-Haenszel	0.89 (0.87-0.91)***	1.53 (1.49-1.57)***	1.62 (1.58-1.66)***	0.90 (0.85-0.95)***	
Bourgeois class	0.84 (0.81-0.87)***	1.44 (1.40-1.48)***	1.58 (1.53-1.63)***	1.01 (0.97-1.05)	
Working class	0.99 (0.96-1.01)	1.63 (1.59-1.67)***	1.43 (1.39-1.46)***	1.04 (1.01-1.07)**	0
Cochran-Mantel-Haenszel	0.93 (0.91-0.95)***	1.53 (1.51-1.57)***	1.48 (1.46-1.51)***	1.03 (1.01-1.05)*	
Higher level of education	1.13 (1.05-1.22)***	1.72 (1.62-1.81)***	1.86 (1.75-1.97)***	1.44 (1.33-1.57)***	
Basic or intermediate level of education	1.02 (0.99-1.04)	1.69 (1.65-1.73)***	1.41 (1.38-1.45)***	1.32 (1.28-1.37)***	
Cochran-Mantel-Haenszel	1.03 (1.00-1.06)*	1.69 (1.65-1.73)***	1.48 (1.47-1.50)***	1.34 (1.30-1.38)***	

Oral health evaluation between the crisis periods according to sex

Men had a statistically higher probability of tooth extraction (OR = 1.41, 95% CI= 1.37-1.45), dental filling (OR = 1.30, 95% CI= 1.27-1.34), prostheses (OR = 1.04, 95% CI= 1.01-1.07) and missing teeth (OR = 1.35, 95% CI= 1.31-1.39). However, women were

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more likely to have preserved teeth (OR = 1.33, 95% CI= 1.29-1.37) and less likely to have dental caries (OR = 0.90, 95% CI= 0.87-0.92).

Oral health evaluation between the crisis periods based on unemployment

Unemployed individuals were statistically more likely to have dental caries (OR = 1.08, 95% CI= 1.00-1.16) and missing teeth (OR = 1.36, 95% CI= 1.27-1.46). However, employed individuals had a higher probability of tooth extraction (OR = 1.55, 95% CI= 1.51-1.59), dental filling (OR = 1.68, 95% CI= 1.64-1.73), prostheses (OR = 1.09, 95% CI= 1.06-1.12) and preservation of all teeth (OR = 1.08, 95% CI= 1.05-1.12), as well as a lower probability of tooth mobility (OR = 0.87, 95% CI= 0.82-0.92) and gum bleeding (OR = 0.87, 95% CI= 0.82-0.92).

Oral health evaluation between the crisis periods according to social class

The working class had a statistically higher probability of tooth extraction (OR = 1.63, 95% CI= 1.59-1.67), bleeding gums (OR = 1.04, 95% CI= 1.01-1.07), prostheses (OR = 1.05, 95% CI= 1.02-1.07), and missing teeth (OR = 1.36, 95% CI= 1.33-1.39). However, the bourgeois class had a higher probability of preservation of all teeth (OR = 1.36, 95% CI= 1.32-1.40) and dental filling (OR = 1.58, 95% CI= 1.53-1.63), as well as a lower probability of presenting dental caries (OR = 0.84, 95% CI= 0.81-0.87) and dental mobility (OR = 0.74, 95% CI= 0.69-0.79).

Oral health evaluation between the crisis periods depending on the level of studies

Participants with a basic or intermediate level of studies had a statistically higher probability of dental mobility (OR = 1.13, 95% CI= 1.07-1.19), prostheses (OR = 1.11, 95% CI= 1.08-1.14) and missing teeth (OR = 1.42, 95% CI= 1.38-1.46). However, participants with a high level of education had a higher probability of preservation of all teeth (OR = 1.16, 95% CI= 1.08-1.23), gum bleeding (OR = 1.44, 95% CI= 1.33-1.57), dental filling (OR = 1.86, 95% CI= 1.75-1.97), and dental caries (OR = 1.13, 95% CI= 1.05-1.22).

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Discussion

The 2008 economic crisis in Spain negatively affected oral health indicators, with statistically significant differences between the period before and during the crisis.

Accessibility to health services depends on individual factors, the social context, and the health system [17]. Our study considered the data available from the national health surveys that included sex, employment status, social class, and educational level. However, other studies that have evaluated the economic impact of the crisis on oral health have also included other factors, such as age, marital status, or the presence of chronic diseases [18,19].Women had better oral health than men, and in general, women go to the dentist more often than men [20], take better care of their teeth (i.e., more frequent brushing and use of dental floss or fluoride tooth paste), more greatly value aesthetics, and have better knowledge of oral health [21–23]. However, some studies show that men are more likely to brush and floss [24]. These differences may be because economic crises cause multifactorial health effects [25–27]. Our results coincide with another study carried out in Italy where the impact of the 2008 economic crisis on oral health was assessed, and a worsening was observed in men and people with a low educational level [28].

Compared to unemployed individuals, employed individuals were less likely to develop periodontal disease (such as gum bleeding and tooth mobility), more extractions and conservative treatments (such as fillings and prosthetics) were performed, and they preserved their teeth better. Other studies show that employed individuals go to the dentist significantly more [20] than unemployed individuals; however, they were more prone to cavities.

In regard to social class, the working class was more likely to have dental extractions. However, the bourgeois class had better oral health with better preservation of teeth and was less likely to present tooth mobility and cavities. These results are consistent with other studies in which a low income level negatively affected health [29–31]. In addition, the López-Valcarcel *et. al* [32]study carried out in Spain showed that during the 2008 crisis, health problems worsened in the most vulnerable population groups and the most disadvantaged social classes.

In regard to the level of studies, the negative oral health indicators were more balanced compared to the previous socioeconomic factors evaluated such as sex, unemployment

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and social class. Participants with a primary or intermediate level of education had a greater probability of tooth loss, tooth mobility, and conservative treatments such as the placement of dental prostheses. In the case of participants with a high level of education, although they had a greater probability of teeth preservation and conservative treatments such as fillings, they had a more significant presence of cavities, bleeding gums, and extractions. Other studies have shown that individuals with lower educational attainment are at higher risk for unmet dental needs [6,24,31].

One of the most critical limitations of this study is that the results were collected from self-report surveys, which include biases due to the subjectivity of the participants' responses. For example, in the surveys, the variable referring to preserved teeth does not indicate whether they consider third molars in their response. Therefore, the results must be interpreted with caution. In addition, in some publications, it has been observed that in periods of crisis, individuals tend to have more negative self-evaluations on health [4,5,33]. Despite this bias, national country surveys have been frequently used to assess the general state of the population, providing a representative sample size. In Spain, other self-report surveys were carried out to assess the economic crisis in the state of health with 44,138 participants. In our study, we included 189,543 respondents, and more socioeconomic factors were evaluated, but the results obtained were the same concerning the negative impact of the crisis on unemployed individuals and the working class [6]. Additionally, it should be acknowledged that the variables collected concerning the missing teeth were included if the absence has not been restored. Therefore, the number of preserved teeth did not necessarily reflect the number of missing teeth.

Not all countries experiencing crises observe a negative effect on the health of individuals. For example, in the case of Cyprus, the only report was that more patients were having difficulties financing their health needs [34]. However, the most vulnerable social groups suffered devastating consequences in most European countries during the 2008 crisis [1,12,35,36].

This study suggests that the economic crisis affected the oral health of the Spanish population, had a negative impact on men, the working class, the unemployed, and did not significantly affect individuals differently based on their educational attainment.

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Ethics approval: Patient information was made anonymous prior to analysis. Rey Juan Carlos University Research Ethics Committee ruled that no formal ethical approval was required for this study.

Data sharing: The data details are accessible for public use. The current study are available from the corresponding author on reasonable request.

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Supplemental table 1: Oral health indicators before the crisis (2003 and 2006 surveys) and during the crisis (2011, 2014 and 2017 surveys). Chi-square test. P-value <0.05 statistically significant.

Dental caries	Before the crisis	During the crisis	P-value
Yes (%)	20455 (28.10)	28725 (24.60)	0.000
No (%)	52334 (71.90)	88029 (75.40)	
Total	72789 (100.00)	116754 (100.00)	
Tooth extraction			
Yes (%)	51398 (70.61)	84044 (71.98)	0.000
No (%)	21391 (29.39)	32710 (28.02)	
Total	72789 (100.00)	116754 (100.00)	
Dental filling			
Yes (%)	45635 (62.69)	76313 (65.36)	0.000
No (%)	27154 (37.31)	40441 (34.64)	
Total	72789 (100.00)	116754 (100.00)	
Bleeding gums			
Yes (%)	13337 (18.32)	19854 (17.00)	0.000
No (%)	59452 (81.68)	96900 (83.00)	
Total	72789 (100.00)	116754 (100.00)	
Tooth mobility			
Yes (%)	4741 (6.51)	6882 (5.89)	0.000
No (%)	68048 (93.49)	109872 (94.11)	
Total	72789 (100.00)	116754 (100.00)	
Prostheses			
Yes (%)	28275 (38.85)	45975 (39.38)	0.000
No (%)	44514 (61.15)	70779 (60.62)	
Total	72789 (100.00)	116754 (100.00)	
Missing teeth			
Yes (%)	34067	62830	0.000
No (%)	38722	53924	
Total	72789	116754	
Preservation of all teeth			
Yes (%)	34525	29792	0.000
No (%)	38264	86962	
Total	72789	116754	

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	NA
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	6-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-7

		(*b*) Report category boundaries when continuous variables were categorized	6-7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA

Discussion

Key results	18	Summarise key results with reference to study objectives	7
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	8-9

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	3

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Effect of the 2008 economic crisis on oral health in Spain: Analysis of serial cross-sectional, population-based health surveys

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Effect of the 2008 economic crisis on oral health in Spain: Analysis of serial cross-sectional, population-based health surveys

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Number of references: 36 references.

Abstract count: 299 words.

Word count: 2640 words.

1

Abstract

Objectives: To evaluate the impact of the economic crisis on the oral health of individuals in Spain based on variables including sex, unemployment, social class, and educational level.

Design: This was an analysis of serial cross-sectional, population-based health surveys conducted before the crisis (2003 and 2006) and during the crisis (2011, 2014, and 2017).

Setting: National Health Surveys of Spain and the European Health Survey in Spain.
Participants: A total of 189,543 participants were recruited.

Outcome measures: The independent variables were sex, employment, social class, and educational level. The dependent variables were related to oral health. Descriptive statistics, chi-square tests and the Cochran–Mantel–Haenszel test were performed.

Results: The results showed that there were differences ($p < 0.001$) in all oral health indicators before and after the crisis. Compared to the precrisis period, men had a higher probability of tooth extractions (OR = 1.41, 95% CI = 1.37-1.45), dental fillings (OR = 1.30, 95% CI = 1.27-1.34), prostheses (OR = 1.04, 95% CI= 1.01-1.07) and missing teeth (OR = 1.35, 95% CI= 1.31-1.39). Unemployed individuals were more likely to have dental caries (OR = 1.08, 95% CI= 1.00-1.16) and missing teeth (OR = 1.36, 95% CI= 1.27-1.46). Working class individuals had a higher probability of tooth extractions (OR = 1.63, 95% CI= 1.59-1.67), bleeding gums (OR = 1.04, 95% CI= 1.01-1.07), prostheses (OR = 1.05, 95% CI= 1.02-1.07) and missing teeth (OR = 1.36, 95% CI= 1.33-1.39). Participants with a basic or intermediate level of education had a higher probability of dental mobility (OR = 1.13, 95% CI= 1.07-1.19), prostheses (OR = 1.11, 95% CI= 1.08-1.14) and missing teeth (OR = 1.42, 95% CI= 1.38-1.46).

Conclusions: The economic crisis affected the oral health of the Spanish population, with a more significant deterioration among men, working class individuals, and unemployed individuals.

Strengths and limitations of this study

- A series of national oral health surveys were conducted in Spain before and during the 2008 economic crisis. This is a strength as this study analyzed the results in two different periods.

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- Surveys were conducted through computer-assisted personal interviews, which is a strength since prevented data loss and improved the selection of participants.

- A representative sample of the population over 15 years of age is a strength since an adequate number of participants was used.

- Data were self-reported by participants, which is a limitation, as the data were subjective.

- Studying the influence of sex, employment, social class, and level of education is a strength since it included the analysis of multivariate models.

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Introduction

Economic crises affect the health of individuals, and some of the factors that influence their impacts are related to the social protection model of each country and the measures adopted by governments to combat the recession [1,2]. It is widely recognized that there is a relationship between the economy and the population's health; thus, crises can have negative consequences on health care [3–5].

The Spanish public health system offers limited dental care for individuals with acute pathology who are over 16 years of age. There is public funding for preventive and restorative treatments for children. However, other dental procedures are provided through private entities, which necessitates an additional cost for households [6,7].

Periods of economic instability are associated with unemployment, lower incomes, problems with public financing, and problems with health care access [8]. During the 2008 economic crisis in Europe, the use of health care became more restrictive. In Spain, all macroeconomic indicators, including employment, national income, and gross domestic product (GDP), fell. The GDP before the crisis in 2003 and 2006 was 3.0 and 4.1, respectively, and after the crisis, in 2011, 2014, and 2017, it fell to negative values of -0.8, 1.4, and 3.0, respectively [9]. This contributed to inequalities in access to dental care and less access for the most vulnerable socioeconomic groups [10]. For example, the average unemployment rates before the crisis in 2003 and 2006 were 11.5% and 8.5%, respectively. After the crisis, in 2011, 2014, and 2017, these rates were higher at 21.4%, 24.4%, and 17.2%, respectively. Higher education levels in 2003 and 2006 was 3.5% and 3.3%, respectively. After the crisis, they were similar in 2011, 2014, and 2017, at 3.4%, 3.3%, and 3.4%, respectively. High school and intermediate education levels in 2003 and 2006 were 16.2% and 15.7%, respectively. After the crisis, in 2011, 2014, and 2017, these rates were higher at, 16.8%, 17.4%, and 17.5%, respectively [11].

The effects of the austerity policies of the 2008 economic crisis have been analyzed in European countries with universal health coverage, such as Germany, the United Kingdom, Ireland, Latvia, Greece, and Spain, and an increase in the number of suicides and dissatisfaction with health care was found [1,12].

The aim of this study was to evaluate the impact of the economic crisis in Spain on oral health based on variables such as sex, unemployment, social class, and educational level.

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Methods

A population-based cross-sectional series study was conducted following the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) [13] guidelines.

Setting and participants

The data were obtained from the National Health Surveys (NHSs) of Spain for the years 2003 (from April 2003 to March 2004), 2006 (from June 2006 to June 2007), 2011 (from July 2011 to June 2012) [14], 2017 (from October 2016 until October 2017) [15] and the 2014 European Health Survey (EHS) in Spain (from January 2014 to January 2015) [16]. The databases used belong to the National Institute of Statistics of Spain (https://www.ine.es/dyngs/INEbase/es/categoria.htm?c=Estadistica_P&cid=125473557 3175) and are accessible for public use [14–16].

The target population of this study was people residing in family homes in Spanish territory. When of two or more families lived in a dwelling, the study was extended to include all of them, but each family was still considered independently. The data were self-reported.

For data collection, a computer-assisted personal interview was carried out (a face-to-face interview in which the interviewer used software that navigated through the questionnaire, generated flows, and may even have had consistency validations), which was complemented, when necessary and in exceptional cases, by a telephone interview. At the time of the interview, the participants have consent to participate in this study, and the approval of an ethics committee was not necessary since the data were anonymized and for public use. The NHSs of Spain were carried out by the Ministry of Health, Consumption and Social Welfare in collaboration with the National Institute of Statistics. The EHS in Spain was carried out by the Ministry of Health, Social Services and Equality, and National Institute of Statistics three-stage sampling was used. The first-stage units were the census sections. The second-stage units were the primary family dwellings, which involved investigating all the households with their habitual residents. To estimate the characteristics of the population, ratio estimators were used to which calibration techniques were applied, taking as auxiliary variables the age and sex groups and nationality groups of the population of the autonomous community. Finally, adults aged 15 years and older were included in the group. Within each household, an

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adult (15 years or over) was selected. The third-stage units were selected from the list of surveyable individuals in the dwelling at the time of the interview. The exclusion criteria were as follows: the selected person was admitted to a hospital or residence; the selected person was unable to answer due to severe illness or disability; or the selected person could not answer because of the language.

The sample size was calculated by the National Institute of Statistics. The datasets and other methodological details are accessible for public use [14–16]. The current study data are available from the corresponding author upon reasonable request.

Patient and public involvement

Patients and/or the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

Variables

The absolute frequency data from the databases were used, and the variables were recoded to homogenize the results of each survey. For the analyses, the gross domestic product of Spain was used to group the data in the periods before the crisis and during the crisis. The surveys carried out in 2003 and 2006 corresponded to the period before the crisis, and the surveys carried out in 2011, 2014, and 2017 corresponded to the period during the crisis.

All the variables collected were categorical. The independent variables were sex (male/female), employment (workers: employed, working/unemployed), social class (the upper class included class I: directors and managers of establishments with ten or more salaried and traditionally associated with university degrees; class II: directors and managers of establishments with fewer than ten employees, professionals traditionally associated with university degrees and other technical support professionals, athletes, and artists; class III: intermediate employers and self-employed workers; class IV: supervisors and workers in skilled technical fields; class V: skilled workers in the primary sector and other semiskilled workers; and class VI: unskilled workers) and level of education (higher level of education: university studies or equivalent; basic or intermediate level of education: training professional, high school and secondary education). The dependent

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variables were related to oral health and included the following: (1) dental caries (cavities were present as erosion of the enamel and ivory of the teeth/molars by the action of certain bacteria), (2) tooth extraction (teeth/molars were extracted), (3) dental fillings (filled teeth/molars), (4) bleeding gums (the gums bled when brushing or spontaneously), (5) tooth mobility (the teeth/molars had moved), (6) prostheses (crowns, bridges, other types of prostheses or dentures were worn), (7) missing teeth (teeth/molars were missing and not replaced by prostheses), and (8) preservation of all teeth (individuals had all natural teeth/molars).

Statistical methods

Descriptive statistics included calculating the frequencies and percentages of each variable. Missing data were not included in the data analysis; only complete cases were evaluated. Oral health variables before the crisis and after the crisis were analyzed with a chi-square test. To evaluate the relationship between the independent variables (sex, employment, social class, and educational level) and the oral health variables, the Cochran–Mantel–Haenszel test was used. R Studio v. 1.1.456 was used for all tests. The values were considered statistically significant at p <0.05.

Results

A total of 189,543 patients from the precrisis surveys (n=72,789) and the surveys during the crisis period (n=116,754) were analyzed.

The oral health indicators evaluated in each of the surveys are shown in Table 1. Depending on the period, before the crisis or during the crisis, statistically significant differences (p < 0.001) in all oral health indicators (presence of dental caries, tooth extractions, dental fillings, bleeding gums, tooth mobility, prostheses, missing teeth and preservation of all teeth) (Supplemental Table 1) were observed in the results.

Table 1: Oral health indicators in the 2003, 2006 (precrisis) 2011, 2014 and 2017 (during the crisis) surveys. The pvalues show the results of the chi-square test before the crisis (2003 and 2006) versus during the crisis (2011, 2014 and 2017).

	2003			2006			2011			2014			2017			
	n	Yes (%)	No (%)	*n*	Yes (%)	No (%)	*n*	Yes (%)	No (%)	*n*	Yes (%)	No (%)	*n*	Yes (%)	No (%)	pv al ue

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Indicator	(n, %)	(n, %)	N	(n, %)	(n, %)	N	(n, %)	(n, %)	N	(n, %)	(n, %)	N	(n, %)	(n, %)	N	p
Dental caries	9964 (28.18)	25397 (71.82)		10491 (28.03)	26937 (71.97)		10624 (27.43)	28102 (72.57)		9692 (24.88)	29267 (75.12)		8409 (21.52)	30660 (78.48)		<0.001
Tooth extractions	24778 (70.07)	10583 (29.93)		26620 (71.12)	10808 (28.88)	37428	27202 (70.24)	11524 (29.76)		28202 (72.39)	10757 (27.61)		28640 (73.31)	10429 (26.69)		<0.001
Dental fillings	21664 (61.27)	13697 (38.73)		23971 (64.05)	13457 (35.95)		25137 (64.91)	13589 (35.09)		24903 (63.92)	14056 (36.08)		26273 (67.25)	12796 (32.75)		<0.001
Bleeding gums	5367 (15.18)	29994 (84.82)	35361	7970 (21.29)	29458 (78.71)		6571 (16.97)	32155 (83.03)	38726	6837 (17.55)	32122 (82.45)	38959	6446 (16.50)	32623 (83.50)	39069	<0.001
Tooth mobility	1972 (5.58)	33389 (94.42)		2769 (7.40)	34659 (92.60)	37429	2385 (6.16)	36341 (93.84)		2505 (6.43)	36454 (93.57)		1992 (5.10)	37077 (94.90)		<0.001
Prostheses	13498 (38.17)	21863 (61.83)		14777 (39.48)	22651 (60.52)		15141 (39.10)	23585 (60.90)		15459 (39.68)	23500 (60.32)		15375 (39.35)	23694 (60.65)		0.065
Missing teeth	16293 (46.08)	19068 (53.92)		17774 (47.49)	19654 (52.51)	37428	19245 (49.70)	19481 (50.30)		21262 (54.58)	17697 (45.42)		22323 (57.14)	16746 (42.86)		<0.001
Preservation of all teeth	26935 (76.17)	8426 (23.83)		7590 (20.28)	29838 (79.72)		9211 (23.79)	29515 (76.21)		10163 (26.09)	28796 (73.91)		10418 (26.67)	28651 (73.33)		<0.001

The influence of sex, employment status, social class and level of education on oral health indicators in the years prior to the crisis and during the crisis are shown in Table 2.

Table 2: Cochran–Mantel–Haenszel test to assess the relationship of oral health before the crisis and during the crisis with sex, employment status, social class and level of education. ***p<0.001, ** p<0.01, and * p<0.05 were considered statistically significant.

	Dental caries OR (95% CI)	Tooth extractions OR (95% CI)	Dental fillings OR (95% CI)	Bleeding gums OR (95% CI)	Tooth mobility OR (95% CI)	Prostheses OR (95% CI)	Missing teeth OR (95% CI)	Preservation of all teeth OR (95% CI)
Males	0.93 (0.90-0.96)***	1.41 (1.37-1.45)***	1.30 (1.27-1.34)***	1.02 (0.99-1.06)	0.90 (0.85-0.95)***	1.04 (1.01-1.07)**	1.35 (1.31-1.39)***	1.07 (1.04-1.10)***
Females	0.90 (0.87-0.92)***	1.21 (1.17-1.24)***	1.23 (1.20-1.27)***	0.94 (0.91-0.97)***	0.88 (0.83-0.93)***	0.98 (0.95-1.00)**	1.25 (1.22-1.28)***	1.33 (1.29-1.37)***
Cochran–Mantel–Haenszel test results	0.91 (0.89-0.93)***	1.31 (1.28-1.33)***	1.27 (1.24-1.29)***	0.98 (0.96-1.00)	0.89 (0.86-0.92)***	0.99 (0.86-1.03)	1.30 (1.27-1.32)***	1.19 (1.16-1.21)***
Workers	0.86 (0.84-0.89)***	1.55 (1.51-1.59)***	1.68 (1.64-1.73)***	0.87 (0.82-0.92)***	0.87 (0.82-0.92)***	1.09 (1.06-1.12)***	1.29 (1.26-1.32)***	1.08 (1.05-1.12)***

Unemployed individuals	1.08 (1.00-1.16)*	1.41 (1.31-1.51)***	1.26 (1.17-1.35)***	1.06 (0.92-1.21)	1.06 (0.92-1.21)	0.98 (0.91-1.06)	1.36 (1.27-1.46)***	1.06 (0.98-1.15)
Cochran–Mantel–Haenszel test results	0.89 (0.87-0.91)***	1.53 (1.49-1.57)***	1.62 (1.58-1.66)***	0.90 (0.85-0.95)***	0.90 (0.85-0.95)***	1.08 (1.05-1.10)***	1.30 (1.27-1.33)***	1.08 (1.05-1.11)***
Upper class	0.84 (0.81-0.87)***	1.44 (1.40-1.48)***	1.58 (1.53-1.63)***	1.01 (0.97-1.05)	0.74 (0.69-0.79)***	0.97 (0.94-1.00)*	1.17 (1.14-1.21)***	1.36 (1.32-1.40)***
Working class	0.99 (0.96-1.01)	1.63 (1.59-1.67)***	1.43 (1.39-1.46)***	1.04 (1.01-1.07)**	0.94 (0.89-0.98)**	1.05 (1.02-1.07)***	1.36 (1.33-1.39)***	1.11 (1.08-1.14)
Cochran–Mantel–Haenszel test results	0.93 (0.91-0.95)***	1.53 (1.51-1.57)***	1.48 (1.46-1.51)***	1.03 (1.01-1.05)*	0.86 (0.83-0.90)***	1.01 (0.99-1.03)	1.28 (1.26-1.30)***	1.21 (1.19-1.24)***
Higher level of education	1.13 (1.05-1.22)***	1.72 (1.62-1.81)***	1.86 (1.75-1.97)***	1.44 (1.33-1.57)***	0.96 (0.82-1.13)	0.89 (0.83-0.94)***	1.33 (1.25-1.41)***	1.16 (1.08-1.23)***
Basic or intermediate level of education	1.02 (0.99-1.04)	1.69 (1.65-1.73)***	1.41 (1.38-1.45)***	1.32 (1.28-1.37)***	1.13 (1.07-1.19)***	1.11 (1.08-1.14)***	1.42 (1.38-1.46)***	1.00 (0.97-1.03)
Cochran–Mantel–Haenszel test results	1.03 (1.00-1.06)*	1.69 (1.65-1.73)***	1.48 (1.47-1.50)***	1.34 (1.30-1.38)***	1.11 (1.06-1.17)***	1.07 (1.05-1.10)***	1.41 (1.37-1.44)***	1.02 (1.00-1.05)

Oral health evaluation between the periods according to sex

Men had a significantly higher probability of tooth extractions (OR = 1.41, 95% CI= 1.37-1.45), dental fillings (OR = 1.30, 95% CI= 1.27-1.34), prostheses (OR = 1.04, 95% CI= 1.01-1.07) and missing teeth (OR = 1.35, 95% CI= 1.31-1.39). However, women were more likely to have preserved teeth (OR = 1.33, 95% CI= 1.29-1.37) and less likely to have dental caries (OR = 0.90, 95% CI= 0.87-0.92).

Oral health evaluation between the periods according to employment status

Unemployed individuals were significantly more likely to have dental caries (OR = 1.08, 95% CI= 1.00-1.16) and missing teeth (OR = 1.36, 95% CI= 1.27-1.46). However, employed individuals had a higher probability of tooth extractions (OR = 1.55, 95% CI= 1.51-1.59), dental fillings (OR = 1.68, 95% CI= 1.64-1.73), prostheses (OR = 1.09, 95% CI= 1.06-1.12) and preservation of all teeth (OR = 1.08, 95% CI= 1.05-1.12), as well as a lower probability of tooth mobility (OR = 0.87, 95% CI= 0.82-0.92) and gum bleeding (OR = 0.87, 95% CI= 0.82-0.92).

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Oral health evaluation between the periods according to social class

Working class individuals had a signicantly higher probability of tooth extractions (OR = 1.63, 95% CI= 1.59-1.67), bleeding gums (OR = 1.04, 95% CI= 1.01-1.07), prostheses (OR = 1.05, 95% CI= 1.02-1.07), and missing teeth (OR = 1.36, 95% CI= 1.33-1.39). However, upper class individuals had a higher probability of preservation of all teeth (OR = 1.36, 95% CI= 1.32-1.40) and dental fillings (OR = 1.58, 95% CI= 1.53-1.63), as well as a lower probability of dental caries (OR = 0.84, 95% CI= 0.81-0.87) and dental mobility (OR = 0.74, 95% CI= 0.69-0.79).

Oral health evaluation between the periods according to education level

Participants with a basic or intermediate level of education had a significantly higher probability of dental mobility (OR = 1.13, 95% CI= 1.07-1.19), prostheses (OR = 1.11, 95% CI= 1.08-1.14) and missing teeth (OR = 1.42, 95% CI= 1.38-1.46). However, participants with a high level of education had a higher probability of preservation of all teeth (OR = 1.16, 95% CI= 1.08-1.23), gum bleeding (OR = 1.44, 95% CI= 1.33-1.57), dental fillings (OR = 1.86, 95% CI= 1.75-1.97), and dental caries (OR = 1.13, 95% CI= 1.05-1.22).

Discussion

The 2008 economic crisis in Spain negatively affected oral health indicators, with statistically significant differences between the periods before and during the crisis.

Accessibility to health services depends on individual factors, the social context, and the health system [17]. Our study considered the data available from the national health surveys that included sex, employment status, social class, and educational level. However, other studies that have evaluated the economic impact of the crisis on oral health have also included other factors, such as age, marital status, or the presence of chronic diseases [18,19]. Women have better oral health than men, and in general, women go to the dentist more often than men [20], take better care of their teeth (i.e., more frequent brushing and use of dental floss or fluoride tooth paste), more greatly

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value aesthetics, and have better knowledge of oral health [21–23]. However, some studies show that men are more likely to brush and floss [24]. These differences may be because economic crises cause multifactorial health effects [25–27]. Our results are similar to those of another study carried out in Italy in which the impact of the 2008 economic crisis on oral health was assessed, and worse outcomes were observed among men and people with a low educational level [28].

Compared to unemployed individuals, employed individuals were less likely to develop periodontal disease (such as gum bleeding and tooth mobility), had more extractions and conservative treatments (such as fillings and prostheses) performed, and preserved their teeth better. Other studies show that employed individuals go to the dentist substantially more [20] than unemployed individuals; however, they are more prone to cavities.

In regard to social class, the working class was more likely to have dental extractions. However, the upper class had better oral health with better preservation of teeth and was less likely to present tooth mobility and cavities. These results are consistent with those of other studies in which a low income level negatively affected health [29–31]. In addition, study by López-Valcarcel *etal.* [32] carried out in Spain showed that during the 2008 crisis, health problems worsened among people of in the most vulnerable population groups and the most disadvantaged social classes.

In regard to education level, negative oral health indicators were more balanced compared to the previous socioeconomic factors evaluated, such as sex, employment status and social class. Participants with a primary or intermediate level of education had a greater probability of tooth loss, tooth mobility, and conservative treatments, such as the placement of dental prostheses. In the case of participants with a high level of education, although they had a greater probability of teeth preservation and conservative treatments such as fillings, they had a more substantial presence of cavities, bleeding gums, and extractions. Other studies have shown that individuals with lower educational attainment are at higher risk for unmet dental needs [6,24,31].

One of the most critical limitations of this study is that the results were collected from self-report surveys, which included biases due to the subjectivity of the participants' responses. For example, in the surveys, the variable that referred to preserved teeth did not indicate whether third molars were considered in the response. Therefore, the results

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must be interpreted with caution. In addition, in some publications, it has been observed that in periods of crisis, individuals tend to have more negative self-evaluations of health [4,5,33]. Despite this bias, national surveys have been frequently used to assess the general state of the population, providing a representative sample size. In Spain, other self-report surveys were carried out to assess the economic crisis and health status among 44,138 participants. In our study, we included 189,543 respondents, and more socioeconomic factors were evaluated, but the results obtained were the same concerning the negative impact of the crisis on unemployed individuals and working class individuals [6]. Additionally, it should be acknowledged that the variables collected concerning the missing teeth were included if the missing teeth were not restored. Therefore, the number of preserved teeth did not necessarily reflect the number of missing teeth.

Not all countries that experience crises observe a negative effect on the health of individuals. For example, in the case of Cyprus, the only report was that more patients had difficulties financing their health needs [34]. However, the most vulnerable social groups suffered devastating consequences in most European countries during the 2008 crisis [1,12,35,36].

This study suggests that the economic crisis affected the oral health of the Spanish population, had a negative impact on men, working class individuals, and unemployed individuals, and did not significantly affect individuals differently based on their educational level.

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Ethics approval: Patient information was anonymized before analysis. The Research Ethics Committee of Rey Juan Carlos University ruled that no formal ethical approval

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was required for this study since it involved the use of anonymous data obtained from the statistics of the National Health Surveys. **Data sharing:** The data details are accessible for public use. The current study data are available from the corresponding author upon reasonable request.

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Supplemental table 1: Oral health indicators before the crisis (2003 and 2006 surveys) and during the crisis (2011, 2014 and 2017 surveys). Chi-square test. P-value <0.05 statistically significant.

Dental caries	Before the crisis	During the crisis	P-value
Yes (%)	20455 (28.10)	28725 (24.60)	0.000
No (%)	52334 (71.90)	88029 (75.40)	
Total	72789 (100.00)	116754 (100.00)	
Tooth extraction			
Yes (%)	51398 (70.61)	84044 (71.98)	0.000
No (%)	21391 (29.39)	32710 (28.02)	
Total	72789 (100.00)	116754 (100.00)	
Dental filling			
Yes (%)	45635 (62.69)	76313 (65.36)	0.000
No (%)	27154 (37.31)	40441 (34.64)	
Total	72789 (100.00)	116754 (100.00)	
Bleeding gums			
Yes (%)	13337 (18.32)	19854 (17.00)	0.000
No (%)	59452 (81.68)	96900 (83.00)	
Total	72789 (100.00)	116754 (100.00)	
Tooth mobility			
Yes (%)	4741 (6.51)	6882 (5.89)	0.000
No (%)	68048 (93.49)	109872 (94.11)	
Total	72789 (100.00)	116754 (100.00)	
Prostheses			
Yes (%)	28275 (38.85)	45975 (39.38)	0.000
No (%)	44514 (61.15)	70779 (60.62)	
Total	72789 (100.00)	116754 (100.00)	
Missing teeth			
Yes (%)	34067	62830	0.000
No (%)	38722	53924	
Total	72789	116754	
Preservation of all teeth			
Yes (%)	34525	29792	0.000
No (%)	38264	86962	
Total	72789	116754	

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	NA
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	6-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-7

		(*b*) Report category boundaries when continuous variables were categorized	6-7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	7
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	8-9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	3

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.