

Tooth Loss and Oral Rehabilitation in Greek Middle-Aged Adults and Senior Citizens

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Purpose: The aims of this study were to investigate the prevalence of tooth loss in Greek individuals aged 35 to 44 and 65 to 74 years in relation to sociodemographic parameters and to describe their prosthetic status and needs. **Materials and Methods:** A stratified cluster sample of 1,188 middle-aged adults and 1,093 senior citizens was selected according to World Health Organization (WHO) guidelines for national pathfinder surveys. Tooth loss and prosthetic status and needs were recorded according to WHO criteria. Sociodemographic data were collected through face-to-face interviews. **Results:** Complete edentulism affected 0.3% of individuals aged 35 to 44 years and 31.5% of those aged 65 to 74 years. Most middle-aged adults (92.1%) had ≥ 21 natural teeth, while the corresponding percentage for the senior citizens was 23.1%. The mean number of missing teeth was 5.2 in middle-aged adults and 21.6 in senior citizens. The multivariate analysis showed that education level was the only predictor of tooth loss in both age groups. Approximately 38% of those aged 35 to 44 years and 80% of those aged 65 to 74 years had dental prostheses, while 47.6% of middle-aged adults and 66.3% of senior citizens did not need any prosthetic treatment. The need for complete dentures was relatively low in both age groups. Comparisons of the present results with those of 1985 indicate that the dentate status of Greek adults aged 35 to 44 years has not improved. Furthermore, the prevalence of tooth loss in the elderly population was high compared with internationally reported findings. **Conclusion:** The replacement of missing teeth with fixed or removable prostheses will continue to be common in Greece for the foreseeable future. *Int J Prosthodont* 2012;25:173–179.

Tooth loss is the end product of oral diseases such as dental caries and periodontal diseases, and although there are several social as well as clinical factors concerning decision-making in tooth retention or extraction,^{1,2} the extent of tooth loss determines the prosthetic status and needs of the population; the

greater the number of missing teeth, the higher the use and need for dental prostheses and vice versa.

Several years ago, the prevalence of edentulism in industrialized countries was high, and therefore, complete denture use and need were also high. However, recently, many of these countries have reported a significant reduction in tooth loss^{3–9} and a reduced use and need for complete dentures^{4,6,9,10} among middle-aged and older adults. Such changes in dental status may have a strong influence on dental education and treatment provisions. Thus, it is important for all countries to obtain data regarding the levels of tooth loss and the prosthetic status and needs of the population and to identify changes that occur over time.

In Greece, a national oral health pathfinder survey was organized in 1985 by the dental department of the Ministry of Health, Welfare, and Social Security in cooperation with the Regional Office for Europe of the World Health Organization (WHO). The purpose of that survey was to evaluate the oral health status and treatment needs of the population aged 7, 12, and 35 to 44 years of age. Twenty years later, the Hellenic Dental Association, in cooperation with the Dental

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Schools of Athens and Thessaloniki, decided to carry out a second national oral health pathfinder survey to investigate trends in oral disease epidemiology. In this survey, a group of individuals 65 to 74 years of age was also included since the aging of the population in Greece,¹¹ as in most industrialized countries,¹² and the economic, social, and health consequences of this demographic evolution made the investigation of the oral health of elderly individuals very important.

This paper presents the findings of the survey concerning the prevalence of tooth loss in subjects aged 35 to 44 and 65 to 74 years of age in relation to sociodemographic parameters. It also describes the prosthetic status and needs of the surveyed population by arch and type of prosthesis. Finally, it compares the data for 35- to 44-year-olds with those obtained from the survey in 1985.

Materials and Methods

A stratified cluster sample was selected according to WHO guidelines for national pathfinder surveys, which ensure the participation of a satisfactory population sample that may present different disease prevalence in the conditions that are being examined.¹³ For comparison reasons, the sample was collected in the same manner and from the same areas as the survey of 1985,¹⁴ but four new areas were also included to increase its size. Namely, the study covered two big cities (Athens and Thessaloniki), six counties (Achaia, Chania, Evros, Ioannina, Kastoria, and Larissa), and three islands (Lesbos, Naxos, and Kefallinia). Three communities of different socioeconomic backgrounds were selected randomly within each of the big cities, while one urban and one rural community were selected randomly within each county or island. Therefore, the survey was conducted in 24 sites (15 urban and 9 rural), and 50 subjects were examined in each site. Samples of subjects aged 35 to 44 years were drawn from office or factory workers as well as readily accessible groups, while samples of individuals aged 65 to 74 years were drawn from their homes and day centers for the elderly, according to WHO national pathfinder survey methodology for these age groups.¹³ The final sample consisted of 1,188 35- to 44-year-old adults and 1,093 65- to 74-year-old senior citizens of Greek nationality living in urban and rural areas.

Prior to the survey, a meeting was organized in the Athens Dental School to train and calibrate the examiners. Interexaminer reliability and agreement was assessed with an experienced investigator as the gold standard. For the examined indices, levels of concordance were very good (kappa coefficient > 0.90). The examinations were carried out under artificial

light using dental mirrors and a WHO CPI periodontal probe. Cotton rolls and gauze were available for moisture control and removal of plaque when necessary.

Tooth loss and prosthetic status and needs were recorded according to WHO criteria.¹³ Sociodemographic data (location, sex, education, and monthly income) reported to be associated with oral health were collected through a structured questionnaire that was completed face-to-face at the time of the clinical examination. The classification of education was based on the total number of years of education. Economic status of the participants was recorded according to their monthly income, and it was divided into three categories (≤ 590 €, 591 to 1,760 €, and $\geq 1,761$ €). Since only four subjects in the 65- to 74-year-old age group belonged to the high income category, this group was divided into two categories (≤ 590 € and ≥ 591 €).

Data were processed and analyzed by means of the statistical package for the social sciences (SPSS version 19.0, IBM). The level of statistical significance for all tests was set at .05. Initial data analysis relied on descriptive statistics; subsequent univariate examination of statistical associations was conducted using the Mann-Whitney and Kruskal-Wallis tests because of the non-Gaussian distribution of the outcome variable (number of missing teeth). Finally, multivariate binary logistic regression analysis was performed for the simultaneous investigation of a number of sociodemographic predictors, namely sex, location, education level, and monthly income. The outcome variable (number of missing teeth) was dichotomized by using the median value as the threshold value.

Results

Tooth Loss

Only four individuals (0.3%) from the 35- to 44-year-old group were completely edentulous, while most (92.1%) had 21 or more natural teeth retained in their oral cavity (Table 1). The mean number of missing teeth in that age group was 5.2, while the median value was 4.0. Univariate analysis of the data showed that the mean number of missing teeth among middle-aged adults was significantly lower in those living in urban areas compared to those living in rural ones ($P < .001$) and decreased significantly as their education level and monthly income increased ($P < .001$ and $P < .01$, respectively). However, when multivariate analysis was undertaken to control for the effects of confounding variables, only low education level remained as a risk indicator for tooth loss (Table 2). Significant differences in the mean number of missing teeth were also observed between the surveyed areas ($P < .001$). The

Table 1 Distribution of Middle-Aged Greeks According to No. of Retained Teeth and Mean and Median Values of Missing Teeth by Location, Sex, Education, and Monthly Income

	Retained teeth								Missing teeth	
	≥ 21		15–20		1–14		0 (edentulous)		Mean (SD)	Median (IR)
	n	%	n	%	n	%	n	%		
Location (<i>P</i> < .001*)										
Rural	355	89.6	21	5.4	18	4.5	2	0.5	6.0 (5.2)	5.0 (5.0)
Urban	739	93.3	35	4.4	16	2.0	2	0.3	4.8 (4.2)	4.0 (4.0)
Sex (NS*)										
Men	568	93.0	25	4.1	18	2.9	0	0.0	5.1 (4.6)	4.0 (5.0)
Women	526	91.1	31	5.4	16	2.8	4	0.7	5.4 (4.6)	4.0 (5.0)
Education (<i>P</i> < .001†)										
≤ 6 y	103	78.0	18	13.6	10	7.6	1	0.8	7.8 (6.2)	6.0 (6.0)
9 y	86	86.9	7	7.1	6	6.0	0	0.0	7.0 (5.2)	6.0 (5.0)
12 y	367	92.0	17	4.2	12	3.0	3	0.8	5.5 (4.4)	5.0 (4.0)
> 12 y	519	96.3	14	2.6	6	1.1	0	0.0	4.1 (3.7)	4.0 (4.0)
Monthly income (<i>P</i> < .01†)										
0–590 €	114	88.4	7	5.4	6	5.3	2	1.6	5.9 (5.2)	4.0 (7.0)
591–1,760 €	720	93.0	34	4.4	18	2.3	2	0.3	5.3 (4.3)	4.0 (5.0)
≥ 1,761 €	63	98.4	1	1.6	0	0.0	0	0.0	3.7 (2.9)	3.5 (4.8)
Total	1,094	92.1	56	4.7	34	2.9	4	0.3	5.2 (4.6)	4.0 (5.0)

SD = standard deviation; IR = interquartile range; NS = not significant.

*Mann-Whitney test.

†Kruskal-Wallis test.

Table 2 Odds Ratios and 95% Confidence Intervals Derived from Multivariate Binary Logistic Regression Analysis in 35- to 44-Year-Old Greeks

Dependent variable	Independent variable	OR	95% CI
Missing teeth*	Constant	3.604	
	Sex (ref: male)	1.251	0.949 to 1.649
	Area (ref: rural)	1.124	0.829 to 1.525
	Highest education level	0.207	0.113 to 0.377
	Highest monthly income	0.904	0.466 to 1.754

OR = odds ratio; CI = confidence interval.

*Median value of the missing teeth frequency distribution represented the cut-off point.

lowest value (3.3) was found for subjects living in Athens (urban population), and the highest (7.1) for those living in Ioannina County (urban and rural population).

Total edentulism affected 31.5% of 65- to 74-year-olds, while only 23.1% had 21 or more natural teeth (Table 3). The mean number of missing teeth was 21.6 (Table 3), while the mean number of retained teeth was 10.4 per subject among all subjects examined and

15.2 among dentate subjects (data not shown). Both univariate and multivariate analyses (Tables 3 and 4) showed that education level was a significant predictor of tooth loss; higher education was associated with fewer missing teeth. The regional differences in the mean number of missing teeth were significant ($P < .001$) and ranged between 19.0 in Kefallinia Island and 24.1 in Thessaloniki (data not shown).

Table 3 Distribution of Elderly Greeks According to No. of Retained Teeth and Mean and Median Values of Missing Teeth by Location, Sex, Education, and Monthly Income

	Retained teeth								Missing teeth*	
	≥ 21		15–20		1–14		0 (edentulous)		Mean (SD)	Median (IR)
	n	%	n	%	n	%	n	%		
Location (NS*)										
Rural	90	24.0	61	16.3	90	24.0	134	35.7	21.6 (10.1)	23.0 (20.0)
Urban	162	22.6	105	14.6	241	33.6	210	29.2	21.6 (9.8)	24.0 (19.0)
Sex (NS*)										
Men	138	22.4	93	15.1	196	31.8	189	30.7	21.6 (10.0)	24.0 (19.0)
Women	114	23.9	73	15.3	135	28.3	155	32.5	21.5 (9.8)	23.0 (20.0)
Education (P < .001†)										
≤ 6 y	187	21.4	127	14.6	272	31.2	286	32.8	22.0 (9.8)	25.0 (19.0)
9 y	21	25.6	11	13.4	27	32.9	23	28.0	20.6 (9.6)	21.5 (21.0)
12 y	25	29.8	22	26.2	21	25.0	16	19.0	18.1 (9.7)	15.5 (17.8)
> 12 y	17	42.5	5	12.5	9	22.5	9	22.5	17.5 (10.8)	15.0 (22.0)
Monthly income (NS*)										
0–590 €	123	21.9	84	15.0	177	31.6	177	31.6	21.8 (9.8)	24.0 (19.0)
≥ 591 €	39	24.7	27	16.9	60	36.4	35	22.1	20.2 (9.8)	21.0 (18.5)
Total	252	23.1	166	15.2	331	30.3	344	31.5	21.6 (9.9)	24.0 (19.0)

SD = standard deviation; IR = interquartile range; NS = not significant.

*Mann-Whitney test.

†Kruskal-Wallis test.

Table 4 Odds Ratios and 95% Confidence Intervals Derived from Multivariate Binary Logistic Regression Analysis in 65- to 74-Year-Old Greeks

Dependent variable	Independent variable	OR	95% CI
Missing teeth*	Constant	0.967	
	Sex (ref: male)	1.051	0.772 to 1.429
	Area (ref: rural)	1.137	0.829 to 1.560
	Highest education level	0.506	0.290 to 0.881
	Highest monthly income	0.966	0.652 to 1.433

OR = odds ratio; CI = confidence interval.

*Median value of the missing teeth frequency distribution represented the cut-off point.

Prosthetic Status and Needs

The prosthetic status and needs for the two age groups are presented in Tables 5 and 6. As can be seen, 61.9% of middle-aged adults and 20.1% of senior citizens did not have any prosthetic restorations in either the maxilla or mandible. Approximately 38% of 35- to 44-year-olds had dental prostheses, and most of these were fixed partial dentures. On the

other hand, the majority (79.9%) of 65- to 74-year-olds had dental prostheses, most of which were complete dentures. The prevalence of complete dentures in the maxilla was greater than that in the mandible in both age groups. Oral implants were found in 0.8% of 35- to 44-year-olds and 0.3% of 65- to 74-year-olds (data not shown). Most of the implants supported single crowns or fixed partial dentures, while only one implant-supported complete denture was noted.

Table 5 Distribution of 35- to 44-Year-Old Greeks According to Prosthetic Status and Needs

	Maxilla		Mandible		Both arches	
	n	%	n	%	n	%
Prosthetic status						
No prosthesis	815	68.6	939	79.0	735	61.9
One FPD	211	17.8	143	12.0	46	3.9
More than one FPD	122	10.3	73	6.1	35	2.9
Partial denture	16	1.3	18	1.5	7	0.6
FPD(s) and partial denture	13	1.1	11	0.9	4	0.3
Complete denture	11	0.9	4	0.3	4	0.3
Prosthetic needs						
No prosthesis needed	831	69.9	700	58.9	565	47.6
One-unit prosthesis	183	15.4	220	18.5	52	4.4
Multiunit prosthesis	57	4.8	70	5.9	10	0.8
Combination of one- or multiunit prostheses	113	9.5	196	16.5	56	4.7
Full prosthesis	4	0.3	2	0.2	1	0.1

FPD = fixed partial denture.

The results concerning the prosthetic needs of the subjects examined showed that 47.6% of middle-aged adults and 66.3% of senior citizens did not need any prosthetic treatment in either the maxilla or mandible. The need for prostheses was greater in the mandible than in the maxilla in both age groups. Most younger adults were in need of one-unit prostheses (15.4% in the maxilla and 18.5% in the mandible), while most elderly patients needed a combination of one- or multiunit prostheses (12.2% in the maxilla and 16.4% in the mandible). The need for a complete prosthesis was relatively low in both age groups.

Discussion

The main objectives of this study were to provide data on the prevalence of tooth loss and the prosthetic status and needs of the adult Greek population and to compare the data of the 35- to 44-year-olds with those of a survey conducted in 1985. For this reason, the sample was collected in the same manner and from the same areas as in 1985, but four new areas were also included. Since sampling adult subjects in Greece is difficult, the simplified pathfinder sampling methodology for data collection developed by the WHO was used in both surveys.¹³ Therefore,

Table 6 Distribution of 65- to 74-Year-Old Greeks According to Prosthetic Status and Needs

	Maxilla		Mandible		Both arches	
	n	%	n	%	n	%
Prosthetic status						
No prosthesis	255	23.3	334	30.6	220	20.1
One FPD	89	8.1	79	7.2	18	1.6
More than one FPD	109	10.0	67	6.1	30	2.7
Partial denture	133	12.2	202	18.5	75	6.9
FPD(s) and partial denture	43	3.9	51	4.7	16	1.5
Complete denture	464	42.5	360	32.9	330	30.2
Prosthetic needs						
No prosthesis needed	842	77.0	783	71.6	725	66.3
One-unit prosthesis	34	3.1	36	3.3	7	0.6
Multiunit prosthesis	39	3.6	50	4.6	11	1.0
Combination of one- or multiunit prostheses	133	12.2	179	16.4	92	8.4
Full prosthesis	45	4.1	45	4.1	28	2.6

FPD = fixed partial denture.

the sample cannot be characterized as random, but it can be considered as illustrative of the entire population since it ensures the participation of a satisfactory sample of people living in representative urban and rural areas of Greece.

The data from the present study concerning edentulism in middle-aged Greeks are in accordance with those of other studies that have reported a low prevalence of complete tooth loss in that age group.^{6-9,15} However, the mean number of missing teeth is either higher^{9,16,17} or lower^{15,18} than that of other European countries. On the other hand, tooth loss in elderly individuals, as expressed by complete edentulism and the mean number of missing teeth, is higher than that observed in most recent studies.^{5,6,9,18-20} These findings may reflect a higher supply of and demand for extractions in Greece and less positive attitudes of elderly patients toward preservation of natural teeth.

Similar to other studies,^{5,8,16,18} the present study showed that most middle-aged adults had 21 or more natural teeth. Since the presence of 21 or more teeth has been used internationally as a marker of a functional dentition, it is inferred that most adults had the ability to eat, speak, and socialize without the need for prosthetic restorations. However, it must be considered that the ability of a dentition to function well

does not depend only on the number of teeth present, but also on having anterior teeth and opposing posterior teeth that facilitate mastication.²¹ In contrast to the middle-aged adults, a high percentage of dentate older Greeks did not have functional dentitions.

The difference in the mean number of missing teeth between the two age groups was quite marked, as it was in other studies.^{6,15,17} Univariate analysis of the data showed that the mean number of missing teeth was significantly higher among middle-aged adults living in rural areas and those with lower education attainment and income. In rural areas of Greece, Public Health Centers provide preventive and restorative dental health services to children and adolescents up to 18 years of age and treatment services to adults with acute dental problems. Therefore, adults living in rural areas are usually obliged to seek dental treatment from private clinicians who practice mainly in urban areas, with a high cost and difficulties in accessibility. Such inefficiencies of the public health sector result in social inequalities that affect tooth loss since rural residents and lower income groups tend to prefer more radical treatment, such as tooth extraction, because of the higher number of dental visits and higher cost of restorative dental care. However, of all the sociodemographic variables that were associated with the number of missing teeth in the univariate analysis (location, education, and monthly income), only low education level remained as a significant risk indicator for tooth loss in the multivariate model. Also, education level was found to be the only significant predictor of tooth loss in the elderly population. These findings support the view that tooth loss is considerably influenced by education level^{15,8,9,19,22,23} and may be explained by the fact that those who have attained higher levels of education are better informed about dental care. The regional differences observed for the mean number of missing teeth may indicate different attitudes and behaviors of the population.

Comparisons of the present results concerning the 35- to 44-year-olds with those of 1985¹⁴ indicate that there were no changes in the prevalences of complete edentulism and number of retained teeth over the 20-year period between surveys. In fact, the percentages of subjects with complete tooth loss and those with 21 or more natural teeth were identical (0.3% and 92%, respectively) in both surveys, while the mean number of missing teeth was slightly lower in 2005 (5.2) compared to that in 1985 (5.6). These findings are in contrast with those of other studies that reported a trend toward decreasing edentulism and an increasing number of retained teeth in that age group.^{5,6,8,9} Perhaps it is of relevance that the efforts for the prevention of oral diseases by the

health systems of these countries were more intensive and started earlier than those in Greece.

Since the survey of 1985 did not examine subjects aged 65 to 74 years, there are not comparable data at a national level for this age group. However, previous epidemiologic data for Athens are available.²⁴ When comparing these data with those of this study, the prevalence of complete edentulism decreased in Athens from 26.3% in 1995 to 1996 to 22.3% in 2005. Therefore, it seems probable that the number of completely edentulous elderly individuals is decreasing in Greece, as in other countries.^{3,6,7,9,18}

The results concerning the prosthetic status of participants reflect the differences in tooth loss between younger and older adults. Thus, the percentage of subjects without prostheses was much greater in the younger age group than in the older. Furthermore, most of the middle-aged adults had fixed partial dentures, while most elderly patients had complete dentures. The percentage of participants aged 35 to 44 years having complete dentures in both arches (0.3%) did not change since 1985 (0.3%) and was similar to that reported for Switzerland (0.4%) in 2002.⁹ On the contrary, the corresponding percentage for the 65- to 74-year-olds (30.2%) was much higher than that observed in other countries^{4,9} and reflects the high prevalence of complete edentulism in that age group. Similar to other studies,^{9,25} the present study showed that the prevalence of complete dentures in the maxilla was greater than that in the mandible for both age groups, indicating that maxillary teeth are lost at an earlier age. The low need for complete dentures compared to that for other countries^{25,26} may be because in Greece, the main insurance funds cover all the expenses for dentures. The observation that the need for prostheses was greater in the mandible may be attributed to the fact that missing mandibular teeth are not as visible when someone speaks, smiles, or laughs, and therefore, the need for an esthetic rehabilitation is not as great.

The percentage of subjects with osseointegrated implants, although lower than that in Sweden⁴ and Switzerland,⁹ was higher than that in Finland,²⁷ indicating that this technique of replacing teeth has become an acceptable method of rehabilitation in Greece.

Conclusions

The results of this study indicate that the dentate status of Greek adults aged 35 to 44 years has not improved since 1985 but is similar to that reported for most industrialized countries. On the contrary, the prevalence of tooth loss in elderly individuals is high compared to internationally reported findings.

Therefore, it appears that the replacement of missing teeth with fixed or removable prostheses will continue to be common in Greece for the foreseeable future. Educational and social measures are needed to improve patients' attitudes toward retaining natural teeth for as long as possible. Additionally, consequent adjustments to the undergraduate training as well as to postgraduate continuing education programs are needed to assist dental practitioners in making the best decision to save or extract a tooth. Since this is the first national survey investigating the dental status of 65- to 74-year-old Greeks, it could serve as a baseline for the surveillance of the oral health of elderly individuals.

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