Associations between Missing Teeth with Unmet Needs and Socioeconomic Status among South Korean Dentate Government Employees

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Abstract

Objective: *This study aims to examine associations between missing teeth with unmet needs (MTUN) and socioeconomic status, represented by income and place of residence.* ***Methods:*** *The National Health Insurance Corporation dataset of 822,325 dentate Korean government employees' dental examinations results, questionnaire responses in the year 2000, and basic information collected for administrative purposes was used for this analysis. The main outcome variable was the number of MTUN, categorized into three groups: none, 1-2, and ≥3. Explanatory variables were assessed and a multinomial logistic regression was employed.* ***Results:*** *Seventy percent were men, with a mean age of 39.1 years (range 18 to 74). The mean number of MTUN was 0.34, and 19.1 percent had ≥1 MTUN. After adjusting for other variables, age and income were the most salient independent predictors. Rural residents, men, older adults, persons having smoking experience, and persons visiting a dental clinic in the past year were more likely to have ≥1 MTUN than their counterparts. People performing frequent toothbrushing or having received professional scaling in the past year were less likely to have ≥1 MTUN than their counterparts.* ***Conclusion:*** *Among South Korean government employees with a general dental care insurance benefit, exclusive of prosthetic services, having normative unmet prosthetic need was significantly associated with older age, lower income, and rural residence, taking into account other demographic factors, personal health practices, and dental service utilization.*

Key Words: missing teeth, tooth loss, unmet need, prosthetic treatment need, socioeconomic status, oral health behaviors

Introduction

Restoration of missing teeth by appropriate prosthetic treatments is important for the rehabilitation of oral function, chewing ability, esthetics, and maintenance of oral and general health. Because prosthetic treatments are usually high-cost services, and failure to replace missing teeth rarely causes acute symptoms, people may postpone prosthetic rehabilitation. We defined missing teeth with unmet needs (MTUN) as missing teeth with no prosthesis, where the normative expectation would be that a prosthesis was needed. While a general trend of a decline in the extraction of teeth, fewer denture wearers, and less edentulism has been reported (1), high normative prosthetic need rates have still been reported from studies using representative samples from the United States (2) and Germany (3).

Socioeconomic status (SES) has been reported to be associated with tooth loss and subsequent prosthetic treatment. People of low SES are more likely to lose teeth, be edentulous, and have the greatest need for care (4-6). People of low SES are also more likely to have negative attitudes toward dental care, are less likely to obtain regular or preventive care, and are more likely to receive dental extractions when they do seek care (4,7). Because people of low SES lack resources for high-cost prosthetic treatment, they are less likely to obtain appropriate prosthetic treatment, and thus have more normative prosthetic treatment needs than people of higher SES (5,6).

The National Health Insurance Corporation (NHIC) is the only government-sponsored insurer in South Korea, covering about 45.9 million people (97.0 percent of the entire South Korean population). Since 1996, NHIC has been providing biennial dental examination services to all insured enrollees. These examinations assessed and documented existing need for dental treatment among the insured.

The purpose of this study was to examine the association between the distribution of normatively determined MTUN with SES, represented by income and place of residence,

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under consideration of demographic factors, personal health practices, and previous dental service utilization, among a subgroup of over a million employed, insured Korean adults, using the NHIC data.

Methods

Data Structure Supplied by the NHIC. The NHIC supplied a linked dataset of government employee enrollees, free of unique patient identifiers, composed of three different data sources: a) biannual examination findings; b) salary data; and c) basic demographic information. Among the total 1,272,866 government employees serving in the year 2000, 968,466 persons (76 percent) received an oral examination. They visited designated dental care institutions, underwent oral examinations by dentists, and were asked to complete a questionnaire about personal health practices and dental service utilization. Dentists working in the 1,995 designated health care institutions for health examinations in the year 2000 examined people using a standardized structured examination sheet surveying dental care needs. Examiner calibration was not done for practical reasons.

MTUN was operationally defined based on both biological imperative and professional judgment by general dentists. Dentists were asked to count missing teeth, excluding third molars, with no existing prosthetic replacement. They were asked not to count the need for replacement of ill-fitting or ill-functioning prosthesis or the need for single crowns. A self-administered questionnaire was used to inquire about dental health behaviors including a) frequency of toothbrushing per day, b) past smoking experience and current smoking behaviors, c) experience with visiting a dental clinic in the past year, and d) professional scaling experience in the past year, as a proxy variable for preventive treatment.

The NHIC classified all enrollees according to their salary levels during 2000 to determine a sliding scale for its premium charges. The NHIC provided basic information on the enrollees including age, sex, residence, and occupation. After excluding edentulous enrollees and those with incomplete records, 822,325 dentate cases remained eligible for analysis, making a final response rate of 64.6 percent.

This NHIC dataset was classified into the components of Andersen's Behavioral Model-Phase 4 (8). In the population characteristics domain: a) the predisposing characteristics include an individual's age, sex, and occupation; b) the enabling components comprise income and area of residence as a proxy variable of health care supply, e.g., unequal geographical distribution of health care institutions; and c) the MTUN is a need component in this domain and is also considered as a normative evaluated health status in the outcomes domain. In the health behavior domain, "personal health practices" include toothbrushing and smoking, and "use of health services" includes a dental visit and scaling experience in the past year.

Data Analysis. The number of MTUN was categorized into three groups; people with natural or completely restored/replaced dentition were categorized as no missing teeth with unmet prosthetic need ("No MTUN") and two additional groups depending on the number of MTUN as, "1-2 MTUN," and "≥3 MTUN." Age was categorized into three groups based on the assumption of a nonlinear relationship; below 35 years, 35 to 44 years, and 45 years and over. Occupations of government employees were grouped into two types: a) "high" to describe educational, administrative, and executive occupations and b) "low" to refer to manual, partially skilled, unskilled occupations, and police officers. Income levels were based on the annual salary data of the employee and converted to US dollars (1,200 Korean won to the US$1, based on the exchange rate in 2000). As an important enabling factor, the annual income variable was categorized into four levels: >$26,975; $21,356 to $26,975; $16,484 to $21,355; <$16,484. Community of residence was grouped into three categories: "urban"; "metropolitan"; and "rural" according to their administrative geographic codes. Variables related to personal health practices were frequency of toothbrushing (more than twice a day or not) and smoking history (nonsmoker versus current smoker and former smoker). Dental visits and dental scaling experiences during the past year were used as proxy variables for the use of dental services and preventive dental care, respectively.

The bivariate relationships between the ordinal categories of MTUN and other explanatory factors were examined using Mantel–Haenszel chi-square statistics in cases of explanatory variables with two nominal categories, and using the Cochran–Mantel–Haenszel statistics for ordinal explanatory variables (9). The strength of association between ordinal categories of MTUN and the continuous or ordinal explanatory variables were gauged with Gamma statistics, taking values between −1 and 1, based on the numbers of concordant and discordant pairs (9). In investigating multivariate relationships, as the assumption of common slope was rejected ($P = 0.0001$), the ordinal categories of MTUN were treated as nominal and fit to a generalized multinomial logit model with individual slope parameters instead of proportional odds model (9,10). Odds ratios were calculated for the "1-2 MTUN" group and the "≥3 MTUN" group against the "No MTUN" group. While correlation between age and annual income was highly significant (rho = 0.53, $P < 0.0001$), it was confirmed that there was no multicollinearity among the explanatory variables using the variation inflation factor (11). A supercomputer system with the UNIX operating system was used to accelerate the statistical analysis using the SAS statistical package (SAS Institute, Inc., Cary, NC). The significance level of 0.05 was applied to identify statistical significance of explanatory variables.

Results

Seventy percent of the sample were men, and the overall mean age was 39.1 [standard deviation (SD) = 11.0] years, ranging from 18 to 74 years. The crude percentage of people having one or more MTUN was 19.1 percent, and the mean number of MTUN was 0.34 (SD = 1.33).

The bivariate associations between the MTUN and other explanatory variables are presented in Table 1. Most of the explanatory variables, except scaling experience, showed significant associations with the MTUN variable. Older adults, men, "low"-occupation group, high-income group, rural residents, people brushing less than twice a day, current smokers, and users of dental services in the past year were more likely to belong to the ≥3 MTUN group than their counterparts. It was notable that the high-income group was composed of a smaller percentage of people with "No MTUN" and larger percentage of people with "1-2 MTUN" and "≥3 MTUN" compared with other income groups in the bivariate relationship. Gamma values were calculated for age, income, residence, and smoking groups, as 0.40 [standard error (SE) = 0.002], 0.11 (SE = 0.002), 0.10 (SE = 0.003), and 0.27 (SE = 0.003), respectively, which showed the most prominent association of age with level of MTUN (table not shown).

The multivariate associations between the extent of MTUN and other explanatory variables are presented in Table 2. As a result of applying a generalized multinomial logit model, odds ratios (OR) were calculated and presented for the "1-2 MTUN" group and the "≥3 MTUN" group, against the "No MTUN"

Table 1
Distribution of Population Characteristics and Health Behaviors across Missing Teeth with Unmet Needs (MTUN) Categories

	No MTUN (%)	1-2 MTUN (%)	≥3 MTUN (%)	*P*-value
Total (n = 822,325)	80.9	13.0	6.1	
Predisposing				
Age (years)				<0.0001
18 to 34 (n = 261,499)	92.3	6.6	1.1	
35 to 44 (n = 313,305)	86.7	10.7	2.6	
≥45 (n = 247,519)	76.3	16.1	7.6	
Gender				<.0001
Male (n = 572,338)	82.5	13.0	4.5	
Female (n = 249,986)	91.3	7.0	1.7	
Occupation				<0.0001
High (n = 316,595)	87.6	9.6	2.9	
Low (n = 505,729)	84.1	11.9	4.0	
Enabling				
Annual income (US$)				<0.0001
>26,975 (n = 246,697)	82.1	13.1	4.8	
21,356 to 26,975 (n = 150,485)	86.6	10.6	2.8	
16,484 to 21,355 (n = 241,763)	86.8	10.0	3.2	
<16,484 (n = 183,378)	87.1	9.7	3.2	
Residence				<0.0001
Metropolitan (n = 394,716)	86.8	10.1	3.1	
Urban (n = 350,310)	84.7	11.5	4.8	
Rural (n = 77,298)	81.9	13.3	4.8	
Personal health practices				
Toothbrushing				<0.0001
≥twice/day (n = 696,509)	85.9	10.7	3.4	
<twice/day (n = 125,815)	82.3	12.4	5.3	
Smoking experience				<0.0001
Nonsmoker (n = 437,476)	89.0	8.6	2.4	
Ex-smoker (n = 90,455)	83.0	13.1	3.9	
Current smoker (n = 293,570)	80.3	14.3	5.4	
Use of dental services				
Dental visit in the past year				<0.0001
Yes (n = 332,219)	82.8	12.8	4.4	
No (n = 490,105)	87.1	9.8	3.1	
Scaling in the past year				0.6621
Yes (n = 211,337)	85.3	11.2	3.5	
No (n = 610,987)	85.4	10.9	3.7	

Table 2
Odds Ratios (OR) and 95% Confidence Intervals (95% CI) for Having Missing Teeth with Unmet Needs (MTUN) Compared with Having No MTUN

	1-2 MTUN/None		≥3 MTUN/None	
	OR	95% CI	OR	95% CI
Predisposing				
Age (years)				
19 to 34	Reference	–	Reference	–
35 to 44	1.03	1.02-1.04	0.97	0.95-0.99
≥45	1.80	1.60-2.04	3.64	3.57-3.72
Gender				
Male	Reference	–	Reference	–
Female	0.84	0.83-0.85	0.81	0.80-0.83
Occupation				
High	Reference	–	Reference	–
Low	1.06	1.05-1.07	1.03	1.02-1.05
Enabling				
Annual income (US$)				
>26,975	Reference	–	Reference	–
21,356 to 26,975	0.92	0.91-0.93	0.97	0.95-1.00
16,484 to 21,355	1.02	1.01-1.04	1.16	1.14-1.19
<16,484	1.29	1.27-1.31	1.67	1.63-1.71
Residence				
Metropolitan	Reference	–	Reference	–
Urban	0.99	0.98-1.01	0.99	0.97-1.01
Rural	1.18	1.16-1.20	1.27	1.24-1.31
Personal health practices				
Frequent toothbrushing (≥2/day)	0.97	0.96-0.98	0.88	0.87-0.90
Current or ex-smoking	1.13	1.12-1.14	1.22	1.20-1.24
Use of dental services				
Dental visit in the past year	1.25	1.24-1.26	1.38	1.36-1.40
Scaling in the past year	0.87	0.86-0.88	0.80	0.79-0.81

group. People 45 years or older were 1.8 and 3.6 times more likely to have 1-2 and ≥3 MTUN, respectively, compared to people in the 19 to 34 years age group. Women were 1.19 times and 1.23 times, respectively, less likely to have 1-2 and ≥3 MTUN than men. While the people with the highest income comprised a larger percentage of those in the 1-2 MTUN and ≥3 MTUN groups in the bivariate relationship, in contrast, in the multivariate relationship, people with the lowest income were 1.29 times more likely to have 1-2 MTUN and 1.67 times more likely to have ≥3 MTUN, than people with the highest income, when other factors were adjusted. People residing in rural areas, current smokers or former smokers, and people who visited dental care institutions in the past year were more likely to have one or more MTUN, while people who brushed their teeth more than twice a day and people who received scaling treatment in the past year were less likely to have MTUN. In summary, older age and lower income showed the most salient associations with increasing MTUN.

Discussion

The major finding of this study was that the MTUN outcome variable was significantly associated with the level of income and the area of residence, after the adjustment of the other factors in the model. Ettinger et al. (12) demonstrated that in the United States, there was a general strong inverse relationship between SES and the need for removable prosthodontic treatment. Edentulous persons earning less than $10,000 and/or having less than a high school education were more likely to have a need for prosthetic treatment. Consistent with our results, however, Ettinger et al. (12) reported that among groups with incomes over $15,000, a clear linear exposure-response relationship could not be established between the need for removable dentures and categorical income level. Urban or rural residence was not strongly associated with treatment need in their bivariate analysis. In our study, area of residence was used as a proxy variable of health care supply, one of the enabling components, and rural residents were more likely to have a need for prosthetic treatment than metropolitan or urban residents.

Even though the National Health Insurance (NHI) system in Korea covers most treatments for all Koreans, it excludes prosthetic treatment. The lack of insurance coverage for prosthetic treatment might be an important barrier against prosthetic treatment use. Lack of health care insurance is associated with significantly decreased use of health care services for people of all income ranges (13), and uninsured persons especially tend to delay health care use for chronic diseases (14).

Gilbert et al. (7) stressed that predisposing and enabling characteristics are considered to be closely related to dental care use, while need characteristics are closely related to medical care use. In our study, age was the most prominent predictor for unmet prosthetic treatment need, showing that people 45 years or older were more likely to have prosthetic treatment need than younger adults. This is consistent with the study of Douglass et al. (2), who reported that unmet needs for prosthetic treatment ranged from 31 percent in 18- to 44-year-old adults, to 45 percent in 45- to 64-year-old adults, to 41 percent in 65- to 74-year-old adults in the United States. Walter et al. (3) reported a continuous increase of normative prosthetic need with age among Germans.

Health behaviors were significantly associated with unmet needs.

We could infer that people who have preferable health practices, such as frequent toothbrushing or being a nonsmoker, would be less likely to have unmet prosthetic needs. The relationship of MTUN to the use of health services was paradoxical. While people receiving preventive scaling treatment in the past year were less likely to have unmet prosthetic needs, people visiting dental clinics last year were found to be more likely to have unmet prosthetic needs. This unusual association between unmet prosthetic needs and dental visits among Korean government employees could be partially explained by the NHI system in Korea. The universal mandatory enrollment system and small treatment co-payment of as low as 3,000 won (US$2.50 under rate of 1,200 won/US$), might allow easy entrance into the dental health care system. However, we could hypothesize that most of their dental service use was not related to uninsured expensive prosthetic treatments, e.g., around $800 for a three-unit bridge.

Prosthetic treatment need can be assessed as both a normative need and a subjective need. Changing paradigms and a more comprehensive view suggests using a different definition of prosthetic treatment need comprising social, psychological factors, and quality of life assessment (2,3,15). Walter et al. (3) stated that subjective unmet prosthetic treatment need was associated with dentist's recommendations and self-rated oral health. Usually, the subjective need rating is considerably lower than the normative treatment need rating (3,6). To maximize the interexaminer agreement in assessing prosthetic treatment need, the NHIC adopted the simplest objective method, with the normative gold-standard being the existence of a natural or prosthetic replacement of all 28 teeth, with a disregard for third molars and the need for single crowns or replacement of inadequate ill-functioning prostheses. In contrast, unmet prosthetic treatment need in the study by Walter et al. (3) included the need for single crowns to protect teeth with severe decay not restorable with plastic filling materials, the need for correction of severe esthetic and/or functional impairment, and the need to preserve oral tissues. This latter method of assessment is more subjective and influenced by differences in clinical judgment between various professional assessors. We estimated the percentages of having one or more MTUN as 19.1 percent, which is relatively small, compared to Walter et al.'s (3) result reporting around 80 percent of normative prosthetic need.

Strengths of this study include: a) the use of a very large dataset of Korean government employees; b) income data based on actual monthly salary; and c) occupation classification as registered officially by the government. In addition, we applied the well-established Andersen's Behavioral Model as the conceptual framework to propose a meaningful explanation of each factor's role in achieving different levels of the outcome of interest, "MTUN." Limitations of the study include: a) lack of a 100 percent examination response rate, with nonresponders being more likely to be females and younger than responders; b) the possibility of recall bias in self-reported data; and c) the possibility of other unknown biases. Among 1,272,866 government employees, 304,400 persons (24 percent) did not receive an oral examination during the year 2000. Sixty-one percent of them were men with mean age of 35.9 (SD = 10.3) years, but otherwise those examined were similar to recipients of oral examinations.

We observed a strong independent association between unmet prosthetic treatment need and SES factors, income, and area of residence. Therefore, we infer that reducing unmet prosthetic need might be limited by these SES factors even if we were able to improve other important factors, such as personal health practices including toothbrushing, smoking, and use of health services.

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