Comparison between Korea and the United States about smoking and tooth loss

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Comparison between Korea and the United States about smoking and tooth loss

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또한 이 논문을 쓰는 과정에서 뿐만 아니라 저의 한국 생활에 힘이 되어준 조교 선생님들을 비롯한 대학원 선생님들께 너무나도 감사하다고 말씀 드리고 싶습니다. 미국과 다른 한국 학교 시스템 가운데에서 하나부터 열까지 모든 것이 낯선 저에게 첫 학기부터 지금까지 많이 가르쳐주시고 신경 써주시고 자기 일처럼 발 벗고 도와주신 모든 분들께 감사드립니다.

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나의 최고의 친구이자 이제는 평생의 동반자가 될 재용에게...힘들 때도 기쁠 때도 격려와 응원을 아끼지 않고 한결같이 배려해 준 그 마음에 항상 고맙고 사랑한다는 말을 전합니다. 그리고 너무 좋으신 우리 어머님 아버님, 항상 부족한 제게 늘 최고로 대해주시고 예뻐해 주시고 신경써주시고 응원해 주신 덕분에 드디어 제 논문이 탄생합니다. 제게 베풀어주신 사랑을 잊지 않고 평생 갚으며 살아가겠습니다.

마지막으로 이 논문을 받아보시고 가장 뿌듯해 하실 이 세상에서 가장 사랑하고 존경하는 아버지 손인호, 어머니 김옥순 님. 미국에 가셔서 평생 저와 제 동생을 위해 헌신적으로 뒷바라지 해주신, 큰 사랑을 주신 부모님께 진심으로 감사드립니다. 사랑합니다. 그리고 하나밖에 없는 남동생 에릭, 항상 자랑스럽고 너무 든든한 내 동생에게 누나가 멀리 있어 못 챙겨줘서 항상 미안하고 고맙다는 말을 전합니다.

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손애슐리 올림

TABLE OF CONTENTS

LIST OF FIGURES ····· iii

LIST OF TABLES ····· iv

ABSTRACT ····· v

1. INTRODUCTION ····· 1

2. MATERIALS AND METHODS ····· 4

2.1. Data Sources ····· 4

2.1.1. NHANES ····· 4

2.1.2. KNHANES ····· 5

2.2. Research Design ····· 7

2.2.1. Sampling design method ····· 7

2.3. Sampling design method comparison between Korea and U.S.A.. ····· 9

2.4. Definition of variables used in this study ····· 10

2.4.1. Smoking status ····· 10

2.4.2. Edentulism ····· 10

2.4.3. Socio-demographic variables ····· 10

2.4.4. Prevalence of diabetes ····· 11

2.4.5. Oral health status ····· 11

2.4.6. Health insurance ····· 12

2.5. Statistical analysis ····· 15

3. RESULTS ····· 17

3.1. Distribution of survey subjects ····· 17

3.1.1. Distribution of subjects according to smoking status ····· 19
3.2. Association between smoking and edentulism ····· 22
3.2.1. Characteristics for edentulous subjects ····· 22
3.3. Association between number of tooth loss and smoking ····· 25
3.3.1. Characteristics for tooth loss and smoking ····· 25
3.3.2. Odd ratio of edentulism based on smoking ····· 29
4. DISCUSSION ····· 34
5. CONCLUSION ····· 40
6. REFERENCES ····· 42
ABSTRACT (IN KOREAN) ····· 45

LIST OF FIGURES

Fig 1. Process of selecting subjects ····· 8

Fig 2. Research model of Korea and U.S.A. ····· 14

Fig 3. Process of statistical analysis ····· 16

LIST OF TABLES

Table 1. Number of subjects examined for Korea ····· 7

Table 2. Number of subjects examined for U.S.A. ····· 7

Table 3. Sampling design characteristics of Korea and U.S.A ····· 9

Table 4. Variables used in this study ····· 13

Table 5. Distribution of subjects by demographic, socio-economic, smoking history and diabetic conditions ····· 18

Table 6. Characteristics of subjects according to smoking status ····· 20

Table 7. Socio-demographic and diabetic conditions among edentulous subjects 23

Table 8. Average number of tooth loss based on socio-demographic and diabetic condition ····· 26

Table 9. Prevalence of odds ratio of edentulism in relation to smoking status ··· 31

Table 10. Prevalence of odds ratio of edentulism in relation to smoking status and demographic factors ····· 32

Table 11 .Prevalence of odds ratio of edentulism in relation to smoking status, demographic factors and diabetic conditions ····· 33

ABSTRACT

Comparison between Korea and the United States about smoking and tooth loss

Various different chemicals are contained in cigarettes and when they combust, majority of poisonous chemicals are produced and some of them are found to cause cancer. One of the most common reasons for tooth loss among adult populations is periodontal disease, also known as gum disease is known to be affected by smoking. Smokers show higher prevalence of periodontitis compared to never smokers and smokers also have a higher chance of redeveloping periodontitis later even after treatment. Periodontal disease eventualy can lead to tooth loss.

In this study, the National Health and Nutrition Examination Survey for the four years from 2007-2010 for Korea and the United States was used by conducting investigation based on subjects aged 19 and older with existing dental examination records. The association between smoking history and tooth loss and edentulism was investigated and the influence of demographic factors, socio-economic factors and prevalence of diabetes. Therefore, to determine association between tooth loss and smoking using two countries nationally representative data was the purpose of this study. The results were as follows:

1) Results of performing chi-square analysis with smoking history as the dependent variable showed the statistically significant results for age group ($p<0.0001$), gender ($p<0.0001$), education attainment level ($p<0.0001$), insurance status ($p<0.0001$) and prevalence of diabetes ($p<0.0001$) for both countries. Level of income for Korea showed ($P=0.010$).

2) Results of performing chi-square analysis with prevalence of edentulism as the dependent variable showed that edentulism was a statistically significant factor for age group ($p<0.0001$), education attainment level ($p<0.0001$), level of income

($p<0.0001$), insurance status ($p<0.0001$) and prevalence of diabetes ($p<0.0001$). For NHANES gender ($p=0.453$), smoking history for KNHANES ($p=0.059$) and NHANES ($p=0.168$) did not show statistically significant results.

3) Results performing t-test and ANOVA analysis with number of tooth loss as the dependent variable showed that increased number of tooth loss with increased in age group for both KNHANES and NHANES ($p<0.0001$) were shown. Gender ($p<0.0001$), education attainment level ($p<0.0001$), level of income ($p<0.0001$), insurance status ($p<0.0001$) prevalence of diabetes ($p<0.0001$) and smoking history ($p<0.0001$) were all statistically significant factor for number of tooth loss for both KNHANES and NHANES.

4) Results of performing simple logistic regression analysis with edentulism as the dependent variable showed that smoking history factor for KNHANES (odds ratio 1.16) and NHANES (odds ratio 0.88) was a statistically not significant factor ($p=0.06$) and ($p=0.16$) respectively.

5) Results of performing multiple logistic regression analysis with edentulism as the dependent variable with demographic factors and prevalence of diabetes showed that smoking history ($p<0.0001$), age group ($p<0.0001$) and education attainment level ($p<0.0001$) were statistically significant factors. Also other statistically significant factors were level of income (upper vs. low) for KNHANES and NHANES ($p<0.0001$).

From the above results, smoking was the risk factor for tooth loss and becoming edentulism for both countries.

Key words: smoking, tooth loss, edentulism, KNHANES, NHANES, oral health

Comparison between Korea and the United States about smoking and tooth loss

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1. INTRODUCTION

Research studies regarding the effects smoking have on one's health have been conducted for years (How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report of the Surgeon General, 2010). About 600 different chemicals are contained in cigarettes and when they combust, 4000 or more various chemicals are produced. Most chemicals are poisonous and among 4000 chemicals, about 50 of them are found to cause cancer(Centers for Disease and Prevention, 2008). Smoking causes various types of cancers and chronic diseases. The duration of smoking and amount of exposure to smoking lead to the degree of deleterious effects on one's health. Some of the major health disease caused by smoking include cancer, cardiovascular disease, pulmonary diseases, reproductive and developmental defects. There is no safe form of tobacco use and nicotine plays a large role in its addictiveness (How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report of the Surgeon General, 2010). According

to the World Health Organization WHO, about 5,000,000 people die each year from smoking (WHO). In the United States, about 393,000 people die each year from smoking and smoking is the most preventable death (Centers for Disease and Prevention, 2008). Smoking is not only causing serious health issue in the United States, but also in Korea as well. Korea is considered to have one of the highest prevalence rates of smoking in the world. Among Korean adult population, mortality rates related to smoking increase every year and the smoking rate among Korean males is relatively high compared to other countries which places their health at a higher risk (Kang et al., 2003).

Among various health diseases caused by smoking, smoking leads to various oral health problems as well such as the loss and decrease alveolar bone, gingival recession, poor periodontal condition, higher level of calculus and tooth loss(Albandar et al., 2000). Smoking effects cause dental caries (Axelsson et al., 1998) and loss of gingival recession (Albandar et al., 2000). Periodontitis, also known as gum disease is greatly affected by smoking as well - smokers show higher prevalence of periodontitis compared to never smokers (Tomar and Asma, 2000). Along with the onset of periodontitis, smokers have a higher chance of redeveloping periodontitis later even after treatment and experiencing implant failure(Krall et al., 1999).

Poor oral health along with poor care and treatment can eventually lead to tooth loss. Two of the most common reasons for tooth loss among adult populations are periodontal disease and dental caries (Yanagisawa et al., 2009). Some countries have reported that tobacco use is an important risk factor that causes oral health problems regardless of social and demographic factors. Smoking and periodontal disease are significantly related and smoking leads to higher risk of periodontitis among adult populations (Jette et al., 1993). Furthermore, smoking has a strong association of becoming edentulous with fewer remaining teeth (Yanagisawa et al.,

2009). Some studies have stated that socio and demographic factors don't necessary play a role when it comes to oral health problems (Jette et al., 1993), but other studies claim that becoming edentulous are sociologically and psychologically related as well (Eklund and Burt, 1994). Some of the social factors, such as level of education, status of dental insurance, and level of income, reflect the number of missing teeth(Jimenez et al., 2009).

It is important to maintain healthy oral health condition throughout one's lifetime because oral health affects one's quality of life. Losing teeth not only esthetically affects one's physical appearance but it also affects one's overall body systems (Yanagisawa et al., 2009). The result of different circumstances and factors coming together can cause tooth loss. An analysis of tooth loss trend among different countries would be an interesting study to investigate. Therefore, the objective of this study is to investigate the relationship between smoking and tooth loss between two countries, South Korea and the United States.

2. MATERIALS AND METHODS

2.1. Data Sources

This research utilized two national health and nutrition surveys that are representative of the United States and Korea which composed of data from oral examinations from the years 2007 through 2010.

2.1.1. NHANES

The National Health and Nutrition Examination Survey (NHANES) is a complex cluster survey that is regulated by the National Center for Health Statistics (NCHS). NCHS is a part of the Centers for Disease Control and Prevention (CDC) system collects health and nutritional statuses of adults and children in the United States. The survey includes interviews, physical examinations and laboratory test results from blood and urine samples. NHANES assesses demographic, socioeconomic, dietary and health information through examinations, laboratory tests, and questionnaires. Various different methods were applied to gather data, such as interviews, the Mobile Examination Center (MEC), clinical tests, measurements and physical examinations. The first National Health Examination Surveys (NHES) was conducted in 1960 and by 1970, three different set of NHES were formed: NHES I (1960-62), NHES II (1963-1965) and NHES III (1966-70). Starting from 1970, researchers realized the importance of association between nutrition and health status, thus affiliations with secretary of the Department of Health, Education and Welfare, the National Nutrition Surveillance System were

established by NCHS. This allowed the collection of nutritional statuses over time to assess changes. NCHS and NHES then formed the National Health Examination Survey (NHANES) and five surveys were created after 1970: NHANES (1971-75), NHANES II (1976-80), Hispanic Health and Nutrition Examination Survey, HHANES (1982-84), NHANES III (1988-94) and NHANES 99 (1999-05). These past NHANES surveys were formed as multiyear data sets. But in later years, NHANES decided to conduct continuous annual surveys to release the data every two years. Due to the shorter time periods, sample sizes decreased as well as their statistical reliability. Starting in 2007, with the new sampling size method, the oversampling of the Hispanic population's subgroup was different from the previous survey method. Age groups 12-15 and 16-19 were combined while 40-49 and 50-59 were separated.

2.1.2. KNHANES

Korean National Health and Nutrition Examination Survey (KNHANES) is a complex cluster multistage survey system composed of health and nutrition information over the South Korean population. The first set of surveys was created in November 1998, which was conducted through public social research and the second set of surveys was then created in 2011. Third set of surveys was created in 2005 and involved the Division of Chronic Disease Surveillance, Korea Centers for Disease Control and Prevention in comprising the survey from KNHANES IV, which was conducted in July 2007 through 2009 and included three subsets. KNHANES V started in 2010 and for this study, full sets of data from KNHANES IV and first subset of V were pulled together. KNHANES collected data via randomized selection method. This method chose households recorded in the population and housing census in Korea, in which the entire nation was

divided into 29 ranks. Subjects from both KNHANES IV and V included sampled households >1 years of age with questionnaires, examinations, laboratory results, nutrition and demographic information. KNHANES I-III data surveys comprised of large population size compared to KNHANES IV and V.

2.2. Research Design

2.2.1. Sampling design method

The KNHANES information from 2007-2010 were merged together by selecting subjects aged 19 and older with oral examination. A total number of 25,146 subjects from KNHANES were selected in this study. Secondly, NHANES data from 2007-2008 and 2009-2010 were merged together by same method as KNHANES, selecting subjects aged 19 and older with oral examination. A total number of 11,055 subjects were selected.

Table 1. Number of subjects examined for Korea

Korea	total data	total subjects	exclude 18 and under	final number of subjects
2007	4,594	4,246	911	3,335
2008	9,744	9,307	2,129	7,178
2009	10,533	10,078	2,185	7,893
2010	8,958	8,473	1,733	6,740
Total	33,829	32,104	6,958	25,146

Table 2. Number of subjects examined for U.S.A.

U.S.A.	total data	mobile examination center	oral examination	final number of subjects
2007-2008	10,149	9,762	8,311	5,858
2009-2010	10,536	10,253	8,189	5,197
Total	20,685	20,015	16,500	11,055

Figure 1. From the total number of subjects, those who refused to participate in the survey, were missing data, did not have an oral examination and/or were aged 18 and under were excluded.

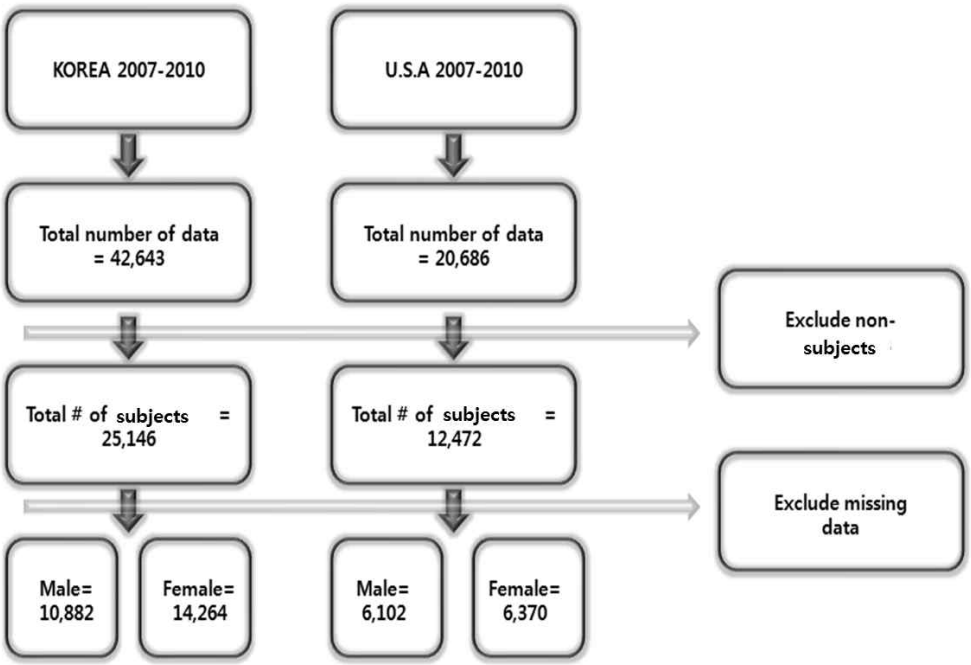

Figure 1. process of selecting subjects

2.3. Sampling design method comparison between Korea and U.S.A.

Table 3 presents a comparison between sampling design method for Korea and the United States. KNHANES dataset composed of survey data collected every two years. In the United States, dataset are collected every year and survey subjects began from as early as time of birth and dental examinations began at age of 5. Dental examinations for Korea started at the age of 1.

Table 3. Sampling design characteristics of Korea and U.S.A.

Characteristic	Korea		U.S.A.	
	2007-2009	2010	2007-2008	2009-2010
Age of the target population	Adult: 19+ Adolescent: 12-18 yrs old Child:1-11yrs old		From birth	
Dental exam age	1 years and older		5 years and older	
Number of survey locations	600	192	30	30
Eligible geographical areas for sample	52	52	50 states +DC	50 states +DC
Total mobile examination center examined	23,631	8,473	9,762	10,253
Total with an oral examination record	23,631	8,473	8,311	8,189

2.4. Definition of variables used in this study

2.4.1. Smoking status

Based on the KNHANES survey questionnaire, current smokers are subjects who have ever smoked more than 100 cigarettes, which is equivalent to 5 packs of cigarettes, and are currently smoking. Subjects who have smoked in the past but are not currently smoking were considered to be former smokers, and for those who have never smoked they were selected as never smokers. From KNHANES. Based on the NHANES, survey questionnaire, current smokers are subjects who have ever smoked more than 100 cigarettes and are currently smoking everyday or some days. Subjects who have ever smoked more than 100 cigarettes but are not currently smoking were considered to be former smokers and for those who have never smoked they were selected as never smokers.

2.4.2. Edentulism

Excluding third molars, based on the natural teeth, if all 28 teeth were missing, then subjects were considered as edentulous.

2.4.3. Socio-demographic variables

Age, gender, highest level of education attained, level of income, and presence or absence of insurance were used as a socio-demographic variables. Gender was divided into male and female. Age was separated into four different groups, starting from ages 19 and older; 19-38, 39-58, 59-78 and >79. Level of income was divided into quartiles and classified into low, mid-low, mid-upper and upper.

KNHANES presented four different levels of income while NHANES data provided a quantitative value of the poverty line. The range of values were from 0 to 5.00, 0 being the lowest and 5.00 being the highest. Within 0-5.00, numerical values were divided evenly into four quarters: 0.00-1.0900, 1.10-2.0200, 2.030-3.920 and 3.930-5.00. 0.00-1.0900 being the lowest quarter and 3.930-5.00 being the highest quarter. The NHANES survey questions related to level of education were categorized into eight different sections. There are three different levels of educational attainment. Less than 9th grade and 9-11th grade (including 12th grade with no diploma) were grouped together as lowest educational attainment level, <high school. High school graduates or individuals with a GED or equivalent were categorized as high school graduates. Individuals with some college or AA degree as well as college graduates or above were all grouped as the highest educational level, >high school. KNHANES level of education was categorized into four different sections, under elementary graduate, middle school graduate, high school graduate and college or higher. Under elementary and middle school graduate were grouped together as one section and three different levels of educational attainment level were formed, <high school, high school and >high school.

2.4.4. Prevalence of diabetes

Presence or absence of diabetic condition diagnosed by a health professional was used as an indicator to determine if subject was diabetic or not.

2.4.5. Oral health status

Oral health dentition contained information on both primary and permanent teeth.

KNHANES divided each tooth into either four or five different sections depending on the tooth number. Sections were then divided into: buccal, distal, occlusal, mesial or lingual. According to the guideline provided by KNHANES, each tooth was then categorized into 9 different description, they are as follow: 0-sound tooth surface, 1-caries tooth surface, 3-history of dental caries with treated surface, 4-loss of tooth surface due to past history of caries, 5-loss of tooth surface without history of dental caries, 6-sealant filled tooth surface, 7-tooth surface treated without any experience of dental caries, 8-unerupted tooth and 9-unable to categorize.

2.4.6. Health Insurance

The NHANES survey questionnaire asked whether or not if subject was covered by health insurance. KNHANES insurance was categorized into three different types of insurance. First type of insurance was coverage provided by employment or a specific county or residence's location. Second, two different types of government issued insurance: type 1 and 2 based on level of income. Lastly, the third insurnace category, without insurance.

Table 4. Variables used in this study

Category	Variable name	Criteria
Demographic factors	age	In years at time of examination, 19 and up
	age group	19-38 39-58 59-78 79+
	gender	Male Female
Socio-economic factors	income level	Upper Mid-Upper Mid-low Low
	insurance status (NHANES)	Present Absent
	insurance status (KNAHES)	Employment & county Government issued Absent
	education level	>High school High school <High school
Types of smokers	smoking history	Never smoked Former smoker Current smoker
General health	DM	Present Absent
Oral health status	edentulism	Present Absent
	tooth loss	0-28

* DM: diabetes

Figure 2. presents visual illustration of how smoking play a role of becoming edentulous and tooth loss for Korea and the United States.

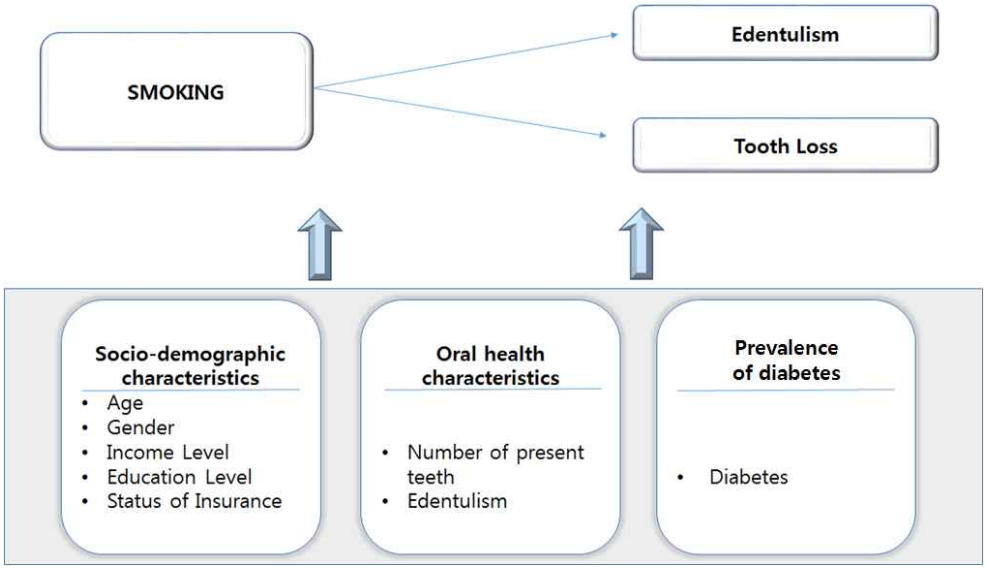

Figure 2. Research model of Korea and U.S.A.

2.5. Statistical analysis

KNHANES and NHANES used a stratified, multistage probability sampling design which dealt with complex sampling design. In order to produce reliable results without bias, the weighted variation, stratification variation and clustered variation (primary sampling unit) were considered. Weighted variation, stratification variation, and clustered variation are set up in every surveyed group. Because the sample represents the population in the statistics, this study was analyzed based on applying qualified variables in the analysis step. The weighted value of the sample indicated by the national health and nutrition examination survey was recalculated with weighted value for each year. Also the value was analyzed by designing a complex sample factor of statistical analysis. The Chi-squared test and linear regression were applied to evaluate a linear trend of edentulism and number of teeth loss with confounders, such as types of smokers, demographic factors and systemic health factors. Multiple logistic regression analyses were applied to estimate the odds ratio (OR) for the association between dependent variable, edentulism and smoking history. Also included confounders were demographic factors and prevalence of diabetic condition to determine if any statistical significance existed. T-test analysis was applied to investigate the average number of teeth lost (based on 28 total number of teeth, excluding third molars) as a dependent variable and types of smokers as an independent variable. Along with the t-test, ANOVA analysis was applied for three or more different variables such as education attaintment level, level of income and age group. The statistical significance was determined by a p-value <0.05 and a 95% confidence interval. All statistical analysis was conducted by using statistical product and service solution, SPSS.

Figure 3. represents the process of statistical analysis in three different steps. The first step was to merge data from the years 2007-2010 for both countries. Then, excluded data from the study for subjects aged 18 and younger who were without oral examination. In the second step, simple statistical analysis was applied through the chi-square test, t-test and ANOVA. Then the third step was to apply multiple logistic regression to determine the odds ratio for prevalence of becoming edentulous.

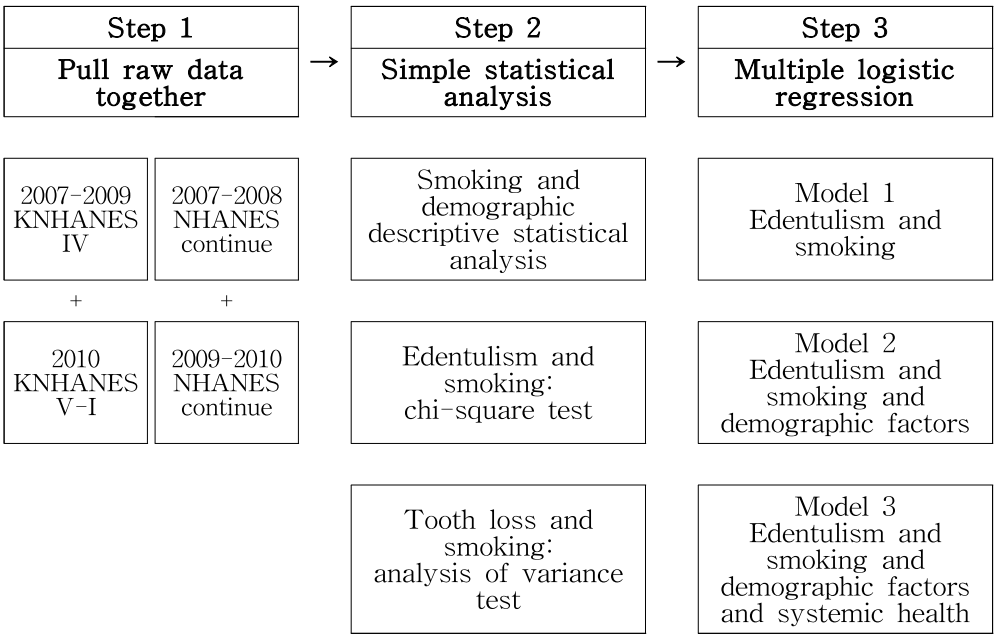

Figure 3. Process of statistical analysis

3. RESULTS

3.1. Distribution of survey subjects

KNHANES - Of the 25,146 subjects, 14,264 (56.7%) of female and 10,882 (43.3%) were male. Age group 39-58, 9,359 (37.2%), < high school 9,222 (39.3%) and upper income group 6,635 (27.1%) presented most number of subjects. 24,560 (97.7%) of subjects were covered under insurance. Most number of subjects were never smokers 13,717 (58.4%) and 8,516 (36.2%) were current smokers.

NHANES - Of the 12,472 subjects, 6,370 (51.1%) of female and 6,102 (48.9%) of male were presented. Age group 19-38, 4,065 (32.6%), > high school 5,606 (46.2%) and low income group, 2,877 (25.6%) presented most number of subjects. 9,373 (75.2%) of subjects were covered under insurance and 6,479 (53.3%) of never smokers and 2,665 (21.9%) of current smokers were presented.

Table 5. Distribution of subjects by demographic, social-economic, smoking history and diabetic conditions

Characteristic	Korea 2007-2010 (N=25,146)		U.S.A 2007-2010 (N=12,472)	
	N	%	N	%
Age group				
19-38	7,887	31.40	4,065	32.60
39-58	9,359	37.20	4,032	32.30
59-78	7,031	28.00	3,410	27.30
79+	869	3.50	965	7.70
Gender				
Male	10,882	43.30	6,102	48.90
Female	14,264	56.70	6,370	51.10
Education				
<High school	9,233	39.30	3,637	30.00
High school	7,982	34.00	2,888	23.80
>High school	6,278	26.70	5,606	46.20
Income				
Low	5,161	21.10	2,877	25.60
Mid-low	6,149	25.10	2,757	24.50
Mid-upper	6,556	26.80	2,821	25.10
Upper	6,635	27.10	2,796	24.90
Insurance				
Presence (employer & county)	23,667	96.20	9,373	75.20
Presence (government)	893	3.60		
Absence	34	.10	3,090	24.80
DM				
Present	1,867	7.90	759	12.50
Absent	21,697	92.00	5,323	87.50
Smoking history				
Never smoked	13,717	58.40	6,479	53.30
Former smoker	1,270	5.40	3,002	24.70
Current smoker	8,516	36.20	2,665	21.90

* DM: diabetes
† totals do not equal 100% because of missing data

3.1.1. Distribution of subjects according to smoking status

Age group between 39-58 showed highest number of subjects among current smokers 3172(37.2%) and 1078 (40.5%) for Korea and the United States, respectively. High percentage of male current smokers were presented in Korea, 7,112 (83.5%). Meanwhile, majority of never smokers were female 11,871 (86.5%). Most female were non-smokers in Korea 11871 (86.5%). While majority of current 2,377 (28.0%) and former smokers 395 (31.2%) from Korea were from highest level of education group, it was opposite for the United States. Majority of current smokers were from low level of income group in the United States, while upper level of income had the least number of current smokers. In korea, most never smokers were from upper level of income group. Subjects without diabetes were mostly from non-smokers 12697 (92.6%) for Korea while in the United States, subjects with diabetes were highest among current smokers 1191 (90.4%).

Table 6. Characteristics of subjects according to smoking status

Characteristic	Korea			P-value*	U.S.A.			P-value*
	Current	Former	Never		Current	Former	Never	
	N (%)				N (%)			
Age group								
19-38	2787 (32.7)	282 (22.2)	4188 (30.5)	<0.0001	1,058 (39.7)	429 (14.3)	2,257 (34.8)	<0.0001
39-58	3,172 (55.4)	428 (43.3)	5,162 (54.2)		1,078 (40.5)	870 (29.0)	2,082 (32.1)	
59-78	2,286 (39.9)	506 (51.2)	3,94 (41.4)		497 (18.6)	1,288 (42.9)	1,623 (25.1)	
79+	271 (4.7)	54 (5.5)	426 (4.5)		32 (1.2)	415 (13.8)	517 (8.0)	
Gender								
Male	7,112 (83.5)	1,059 (83.4)	1,846 (13.5)	<0.0001	1,492 (56.0)	1,798 (59.9)	2,621 (40.5)	<0.0001
Female	1,404 (16.5)	211 (16.6)	11,871 (86.5)		1,173 (44.0)	1,204 (40.1)	3,858 (59.5)	
Education								
<High school	2,910 (34.3)	456 (36.0)	5,840 (42.7)	<0.0001	1,008 (37.8)	874 (29.1)	1,751 (27.1)	<0.0001
High school	3,202 (37.7)	415 (32.8)	4,356 (31.8)		781 (29.3)	681 (22.7)	1,425 (22.1)	
>High school	2,377 (28.0)	395 (31.2)	3,495 (25.5)		875 (32.8)	1,444 (48.1)	3,286 (50.9)	

Table 6. Characteristics of subjects according to smoking status continues

Characteristic	Korea			P-value*	U.S.A.			P-value*
	Current	Former	Never		Current	Former	Never	
	N (%)				N (%)			
Income								
Low	1,709 (20.5)	280 (22.3)	2,854 (21.3)	0.010	1,058 (39.7)	429 (14.3)	2,257 (34.8)	<0.0001
Mid-low	2,176 (26.1)	297 (23.6)	3,296 (24.6)		1,078 (40.5)	870 (29.0)	2,082 (32.1)	
Mid-upper	2,284 (27.4)	345 (27.4)	3,543 (26.4)		497 (18.6)	1,288 (42.9)	1,623 (25.1)	
Upper	2,156 (25.9)	335 (26.7)	3,716 (27.7)		32 (1.2)	415 (13.8)	517 (8.0)	
Insurance								
Present-employment&county	8,062 (95.6)	1,241 (98.2)	13,145 (96.5)	<0.0001	1,691 (63.5)	2,535 (84.5)	4,956 (76.5)	<0.0001
Present-government issued	360 (4.3)	22 (1.7)	465 (3.4)					
Absent	11 (0.1)	1 (0.1)	18 (0.1)		972 (36.5)	466 (15.5)	1,519 (23.5)	
DM								
Present	702 (8.3)	144 (11.4)	1,011 (7.4)	<0.0001	127 (9.6)	258 (17.4)	371 (11.9)	<0.0001
Absent	7,807 (91.7)	1,124 (88.6)	12,697 (92.6)		1,191 (90.4)	1,221 (82.6)	2,754 (88.1)	

* p-value obtained from chi-square test
† DM: diabetes

3.2. Association between smoking and edentulism

3.2.1. Characteristics for edentulous subjects

Both Korea and U.S.A. demonstrated age group 59-78 years old had the most number of edentulous participants. Also there were most females with edentulism than male in both countries but only statistically significant for Korea with p-value 0.020. Prevalence of being edentulous was highest for those with under high school graduate and presence of insurance for both countries. Low and mid-low level of income had the most number of participants with edentulous and those without diabetes were less likely to be edentulous for both countries. Non-smokers from both countries showed the most number of edentulous participants but statistically not sigificant due to p-value being bigger than 0.05.

Table 7 .Socio-demographic and diabetic conditions among edentulous subjects

Characteristic	Korea (N=698)		P-value*	U.S.A. (N=831)		P-value*
	N	%		N	%	
Age group						
19-38	1	.1	<0.0001	13	1.6	<0.0001
38-58	38	5.4		153	18.4	
59-78	472	67.6		476	57.3	
78+	187	26.8		189	22.7	
Gender						
Male	272	39.0	.020	398	47.9	.453
Female	426	61.0		433	52.1	
Education						
<High school	597	90.5	<0.0001	424	51.1	<0.0001
High school	44	6.7		223	26.9	
>High school	19	2.9		183	22.0	

Table 7. Socio-demographic and diabetic conditions among edentulous subjects continues.

	Korea (N=698)		P-value*	U.S.A. (N=881)		P-value*
	N	%		N	%	
Income						
Low	392	59.4	<0.0001	238	31.9	<0.0001
Mid-low	140	21.2		264	35.4	
Mid-upper	69	10.5		168	22.6	
Upper	59	8.9		75	10.1	
Insurance						
Presence (employment and county)	598	88.1	<0.0001	733	88.3	<0.0001
Presence (government issued)	80	11.8				
Absence	1	.1		97	11.7	
DM						
Presence	128	19.0	<0.0001	139	27.9	<0.0001
Absence	547	81.0		360	72.1	
Smoking						
Current smoker	264	39.7	.059	241	42.3	.168
Never smoked	401	60.3		329	57.7	

*p-value obtained by chi-square test
† DM: diabetes

3.3. Association between number of tooth loss and smoking

3.3.1. Characteristics for tooth loss and smoking

Average number of tooth loss among both countries demonstrate that as age group increased, number of tooth loss increased as well. Females from both countries lost more number of teeth 4.25 and 5.71 for Korea and the United States, respectively. As level of income increased, both countries showed decrease in number of tooth loss and subjects with diabetes lost more teeth compared to those without diabetic condition. For Korea, participants who were covered by government issued insurance lost the most number of teeth 8.96 and for U.S.A, subjects with insurance coverage lost more teeth 6.11 than those without insurance 4.13. Current smokers from Korea lost the most number of teeth 8.66 while former smokers from the U.S.A. lost most number of tooth loss 7.24.

Table 8. Average number of tooth loss based on socio-demographic and systemic health condition. Korea vs. U.S.A.

Characteristic	Korea Tooth Loss		U.S.A. Tooth Loss		P-value2
	Mean	SD	Mean	SD	
Age group					
19-38	.49	1.23[a]	1.19	2.98[a]	<0.0001
38-58	2.20	4.03[b]	4.42	6.86[b]	
59-78	9.24	8.99[c]	9.52	10.20[c]	
78+	16.55	10.01[d]	11.42	11.03[d]	
P-value1	<0.0001		<0.0001		
Gender					
Male	3.97	6.96	5.58	8.53	<0.0001
Female	4.25	7.24	5.71	8.55	
P-value1	<0.0001		<0.0001		
Education					
<High school	8.47	8.97[a]	8.31	9.99[a]	<0.0001
High school	1.92	4.22[b]	6.48	8.95[b]	
>High school	1.30	3.32[c]	3.78	6.75[c]	
P-value1	<0.0001		<0.0001		

Table 8. Average number of tooth loss based on socio-demographic and diabetic condition continues

Characteristic	Korea Tooth Loss		U.S.A. Tooth Loss		P-value2
	Mean	SD	Mean	SD	
Income					
Low	8.66	9.48[a]	6.74	9.35[a]	<0.0001
Mid-low	4.03	6.76[b]	7.24	9.55[b]	
Mid-upper	2.48	5.17[c]	5.56	8.28[c]	
Upper	2.15	4.83[d]	3.15	5.98[d]	
P-value1	<0.0001		<0.0001		
Insurance					
Presence-employment and county	3.39	6.93[a]	6.11	8.94[a]	<0.0001
Presence-government issued	8.96	9.78[b]			
Absence	8.15	9.68[c]	4.13	6.83[c]	
P-value1	<0.0001		<0.0001		
DM					
Presence	8.68	8.97	11.38	10.76	<0.0001
Absence	3.97	6.92	5.25	8.32	
P-value1	<0.0001		<0.0001		

Table 8. Average number of tooth loss based on socio-demographic and diabetic condition continues

Characteristic	Korea Tooth Loss		U.S.A. Tooth Loss		P-value2
	Mean	SD	Mean	SD	
Smoking					
Current smokers	8.66	9.48[a]	6.74	9.35[a]	<0.0001
Former smokers	4.03	6.76[b]	7.24	9.55[b]	
Never smoked	2.48	5.17[c]	5.56	8.28[c]	
P-value1	<0.0001		<0.0001		

*P-value obtained by t-test and ANOVA,
** a denotes the same subgroup by scheff post-hoc analysis
† P-value1 = analysis based on each countries tooth loss
‡ P-value2 = analysis based on comparison within two countries group.

3.3.2. Odd ratio of edentulism based on smoking

The KNHANES simple logistic regression analysis was applied for model 1 to investigate odds ratio between smoking status and edentulism, Compared to never smokers, current smokers experienced 1.164 higher chance of becoming edentulous but this result was statistically not significant. For model 2 when socio-demographic factors were added to multiple logistic regression analysis, smokers experienced 1.452 higher chance of becoming edentulous compared to non-smokers and this result was statistically significant. For KNHANES, age group 19-38 didn't have a single participants with edentulism. Therefore this age group was excluded for this analysis. Prevalence of edentulism increased dramatically with increased in age group as well as lower educational level experienced higher chance of becoming edentulous compared to upper educational level. Among four different level of income groups, low and upper level of income group showed statistically significant results, low income group experienced 1.784 higher chance of becoming edentulous compared to upper group. Government issued insurance subjects experienced 1.350 higher chance of being edentulous compared to those who were covered by insurance by an employment or specific county or resident's location. Model 3 applied socio-demographic factors along with prevalence of diabetes and the outcome were same as model 2 except for insurance which were statistically not significant compared to model 2. Subjects diagnosed with diabetes showed 1.275 higher chance of becoming edentulous compared to those without diabetes.

The NHANES simple logistic analysis was applied for model 1 to investigate odds ratio between smoking status and edentulism, Compared to never smokers, current smokers experienced .884 higher chance of becoming edentulous but it was statistically not significant (p=.169). For model 2, socio-demographic factors were added to run multiple logistic regression analysis and smokers experienced 1.729 higher chance of becoming edentulous compared to never smokers with statistically significant results. Prevalence of edentulism increased along with increased in age group. Also for educational attaintment level and level of income represented that lower group in both variables experienced higher prevalence of becoming edentulous. Subjects without insurance showed .492 higher chance of becoming edentulous than those who were covered by insurance. When model 3 applied socio-demographic factors along with prevalence of diabetes, all the other factors outcome were same as model 2 and subjects with diabetes represented 1.430 higher chance of becoming edentulous compared to those without diabetes.

Table 9. Prevalence of odds ratio of edentulism in relation to smoking status

Characteristic	Korea			U.S.A.		
	OR	95% CI	P-value	OR	95% CI	P-value
Smoking						
Never	1			1		
Current	1.16	0.99-1.36	0.06	0.88	0.74-1.05	0.16

* model 1: edentulism and smoking
** The odds ratios were adjusted for age, gender, income, education and diabetes
† P-value obtained by multiple regression analysis
‡ CI: confidence interval

Table 10. Prevalence of odds ratio of edentulism in relation to smoking status and demographic factors

Characteristic	Korea			U.S.A.		
	OR	95% CI	P-value	OR	95% CI	P-value
Smoking history						
Never	1			1		
Current	1.45	1.16-1.80	<0.0001	1.72	1.38-2.16	<0.0001
Age group						
19-38				1		
39-58	1			10.20	4.95-21.01	<0.0001
59-78	9.30	6.52-13.26	<0.0001	33.42	16.26-68.68	<0.0001
79+	30.62	20.72-45.36	<0.0001	56.02	26.19-1119.81	<0.0001
Education						
>High school	1			1		
High school	1.12	0.64-1.98	0.678	1.84	1.40-2.41	
<high school	2.71	1.64-4.47	<0.0001	2.16	1.68-2.78	<0.0001
Income						
Upper	1			1		
Mid-upper	0.98	0.67-1.43	0.93	1.90	1.33-2.72	<0.0001
Mid-low	1.19	0.85-1.67	0.302	2.94	2.08-4.16	<0.0001
Low	1.78	1.30-2.44	<0.0001	3.21	2.25-4.59	<0.0001
Insurance						
employment and county	1			1		
government issued	1.35	1.01-1.79	0.037			
absent	0.57	0.07-4.56	0.603	0.49	0.35-0.67	<0.0001

* model 2: edentulism and smoking and demographic factors
** P-value obtained by multiple regression analysis

Table 11. Prevalence of odds ratio of edentulism in relation to smoking status, demographic factors and diabetic conditions

Characteristic	Korea			U.S.A.		
	OR	95% CI	P-value	OR	95% CI	P-value
Smoking						
Never	1			1		
Current	1.45	1.16-1.81	<0.0001	1.94	1.44-2.62	<0.0001
Age						
19-38				1		
39-58	1			8.76	4.16-18.43	<0.0001
59-78	9.05	6.34-12.92	<0.0001	29.00	13.76-61.15	<0.0001
79+	30.26	20.45-44.76	<0.0001	51.81	22.92-117.09	<0.0001
Education						
>High school	1			1		
High school	1.12	0.63-1.98	<0.0001	2.40	1.67-3.45	<0.0001
<High school	2.70	1.64-4.46	<0.0001	2.68	1.89-3.78	<0.0001
Income						
Upper	1			1		
Mid-upper	0.98	0.67-1.44	0.955	1.69	1.05-2.71	<0.0001
Mid-low	1.19	.855-1.68	0.294	2.60	1.65-4.11	<0.0001
Low	1.78	1.30-2.44	<0.0001	2.91	1.81-4.68	<0.0001
Insurance						
employment and county	1			1		
government issued	1.32	0.99-1.75	0.051			
uninsured	0.58	0.07-4.64	0.615	0.57	0.386-0.86	<0.0001
DM						
Absent	1			1		
Present	1.27	1.02-1.58	0.027	1.43	1.04-1.95	0.02

* model 3: edentulism and smoking and demographic factors and prevalence of diabetes
** P-value obtained by multiple regression analysis

4. DISCUSSION

Healthy oral health refers to having more than good teeth. Oral health is essential due to relationship with rest of the body system and it's also associated with systemic health (World Health Organization). For this reason, oral health problems are linked to quality of life(Arora et al., 2010) and became one of the significant public health problems (World Health Organization). Two major oral health risk factors in the United States are caries and periodontal disease. Various consequences can result from not properly taking care of oral health such as pain, esthetically unsatisfying appearance and low self-esteem. Among adult populations, tooth loss is mostly caused by periodontal disease (General, 2010). Smoking increases the risk of periodontal disease and dental caries which can eventually lead to loss of tooth (Arora et al., 2010). Even under good oral hygiene condition, smoking can cause destruction of tooth attachment (Holm, 1994) and when smokers stopped smoking, chances of losing teeth decreased compared to current smokers (Arora et al., 2010).

In this study, comparison analysis of two countries, the United States and South Korea evaluated how smoking play a role and affect one to become edentulous and lose teeth. This study demonstrated that in both countries, smoking may be the most significant factor that can be prevented in order to reduce the risk of tooth loss and becoming edentulous. Based on collected data for Korea and the United states, around 36% and 21% of subjects were considered as current smokers. One of the biggest difference between these two countries were majority of all Korean participants were covered by insurance (97.7%) while only 75.2% of participants from the United States were covered under insurance.

Among 4 different age groups, as age group increased, number of tooth loss increased as well and they were proportionally related in both countries. More

number of tooth loss occurred in the United States from age group 19-38, 38-58 and 59-78 for 1.19, 4.42 and 9.52 respectively. As average number of tooth loss increased as age group increased, this might be able to demonstrate that longer the duration of smoking period along with aging, tooth loss are proportionally related (Holm, 1994). Other studies demonstrated as well that age and tooth loss are related and aged 70 or older experienced three times higher chance of losing teeth (Hanioka et al., 2007). Higher number of tooth loss occurred for age group 79+ in Korea and more number of tooth loss occurred within female subjects for both Korea and the United States, 4.25 and 5.71 respectively.

Most number of tooth lost occurred for subjects who were under high school graduate, 8.47 and 8.31, Korea and the United States respectively. Level of education and income are inversely related to number of tooth loss. Lower level of education and income presented higher number of tooth loss and vice versa. Past research studies also shown similar results as this study, current smokers were common among lower income and education level under 12 years (Tomar and Asma, 2000). Subjects diagnosed with diabetes showed higher number of missing teeth in both countries than those without diabetes and the United States presented higher number of missing teeth. Subjects with diabetes were 87.5% and without diabetes 12% were shown among the United States. Percentage of diabetic participants for Korea were 7.4% and those without were 86.3%. Past studies reported that one of the reasons for cause of periodontitis is due to diabetes and periodontitis may develop inflammation and infection which may lead to bone resorption and eventually result tooth loss (Daniell, 1983).

Among different variables utilized in this study, one of the biggest difference between two countries was insurance. Due to different health insurance system regulated by government, majority of all Korean subjects were covered by insurance (97.7%) meanwhile about 75% of the United States participants were

covered under insurance. Two different types of insurance coverage provided by Korean government each represented different number of tooth loss. Korean subjects who were covered by insurance through an employment or based on specific residential county lost most number of teeth. Subjects from the United States with insurance coverage lost more number of teeth than compared to those without insurance. Smokers from both countries lost the most number of teeth compared to never smokers. Past studies demonstrated that smokers go through higher number of missing teeth and serious periodontal disease compared to non-smokers (Axelsson et al., 1998). Through an analysis of each countries data based on average number of tooth loss through linear regression included socio-demographic and systemic health variables resulted similar outcome for both countries. Based on four different levels of income, only upper and low level indicated statistically significant results whereas mid-upper and mid-low did not result statistically significant outcome. Status of insurance also did not play a significant role as far as statistically speaking. This might be due to majority of population of Korean subjects being covered by insurance with very small portion of uninsured population (0.1%). Similar outcome for linear regression analysis of the United States were demonstrated. All variables utilized in linear regression modeled represented statistically significant results. Increase in age group and number of tooth loss were inversely related while level of education and income were proportionally related to number of tooth loss. While Korea insurance was statistically not significant, the United States insurance status demonstrated statistically significant results. Less number of population compared to Korea in the United States were covered under insurance.

Prevalence of becoming edentulous based on types of smokers for both countries odds ratio was determined. Three different models were designed in order to meticulously scrutinize how each selected variables affected subjects with smoking

behavior and chances of being edentulous. Model 1 which consists of smoking variable demonstrated that odds of becoming edentulous among current smokers were greater than never smokers within both countries. But both countries results were statistically not significant. Model 2 and 3 included socio-economic and systemic health, diabetic variables along with smoking status. Analysis result for Korea, both model 2 and 3 showed that smoking played a role and effected participants of becoming edentulous.

In model 1, odds of current smokers from Korea and the United States to become edentulous were 1.164 and .884 but both of these odd ratio were statistically. From this result, smoking factor alone was not significant reason to cause edentulism. But when socio-demographic and systemic health were incorporated along with smoking factors, model 2 and 3, odds ratio of becoming edentulous became statistically significant for both countries. Health insurance system, one of the biggest difference in this study among two countries, showed that only the United State's insurance status were statistically significant for participants to become edentulous. Database of Korea only had .1% of subjects who were not covered by insurance and due to such a small portion of subjects without insurance, this might be the reason why insurance of Korea were statistically not significant to effect one becoming edentulous. Subjects from Korea who were covered by government issued insurance were more likely to become edentulous than those who were covered by an employment or under county at a specific location. Due to government issued insurance are provided for citizens who are under specific poverty guideline from Korea, this subject can be relate to level of income as well.

This study used two countries nationally representative data from the United States and Korea to compare how smoking status effected tooth loss. In order to analyze association between tooth loss and edentulism with smoking, other

socio-economic and systemic health variables were included. Our results demonstrated that smoking may be the modifiable factor which can prevent tooth loss. Because other factors other than oral disease such as sociological factors also play a role of becoming edentulous and to lose teeth, some of the major socio-economic factors such as age, sex, level of education and income and status of insurance were involved in this study. Longitudinal analysis from the United States reported that people from lower socio-economic group and women carried higher prevalence of becoming edentulous (Eklund and Burt, 1994). Quantity and duration also affected tooth loss, amount of cigarette smoked per day for long period of time developed higher risk of losing teeth as well (Arora et al., 2010). After controlling other confounders such as age, sex, level of education and income and status of insurance, smoking still remained as risk factors for tooth loss. Similar result was shown when socio-economic confounders were controlled to see if tooth loss was still at a risk with smoking. Usage of tobacco was still a risk factor after other factors were controlled (Jette et al., 1993).

Overall, the United States experienced higher prevalence of edentulism and tooth loss compared to Korea. Subjects from Korea who were covered by government issued insurance lost the most number of tooth loss. The reason for this might be due to dental insurance coverage provided throughout national health insurance system. Government issued insurance are provided only to those who are under specific income level. Because of this reason, level of income and government issued insurance have some sort of correlation. Limited dental treatments are covered under insurance and treatments that are more costly are not covered under national health insurance. Therefore, subjects who are covered under government insurance maybe go through hardship of able to afford expensive dental treatments and this might be the reason why subjects who are covered under government insurance go through higher risk of losing teeth.

Subjects of the United States who were covered under insurance also lost more number of teeth (6.11) compared to those without presence of insurance (4.13). Insurance variable used in this study asked whether they were covered by insurance or not, not specifically knowing types of insurance. This might be one of the limitations of this study. Without knowing specific types of insurance type, it is difficult to know number of subjects who are actually covered by dental insurance. Therefore this might be the reason why subjects with insurance coverage showed higher number of tooth loss. In the future, more meticulous analysis based on specific details regarding variables may allow thorough investigation.

5. Conclusion

1) Results of performing chi-square analysis with smoking history as the dependent variable showed the statistically significant results for age group ($p<0.0001$), gender ($p<0.0001$), education attainment level ($p<0.0001$), insurance status ($p<0.0001$) and prevalence of diabetes ($p<0.0001$) for both countries. Level of income for Korea showed ($P=0.010$).

2) Results of performing chi-square analysis with prevalence of edentulism as the dependent variable showed that edentulism was a statistically significant factor for age group ($p<0.0001$), education attainment level ($p<0.0001$), level of income ($p<0.0001$), insurance status ($p<0.0001$) and prevalence of diabetes ($p<0.0001$). For NHANES gender ($p=0.453$), smoking history for KNHANES ($p=0.059$) and NHANES ($p=0.168$) did not show statistically significant results.

3) Results performing t-test and ANOVA analysis with number of tooth loss as the dependent variable showed that increased number of tooth loss with increased in age group for both KNHANES and NHANES ($p<0.0001$) were shown. Gender ($p<0.0001$), education attainment level ($p<0.0001$), level of income ($p<0.0001$), insurance status ($p<0.0001$) prevalence of diabetes ($p<0.0001$) and smoking history ($p<0.0001$) were all statistically significant factor for number of tooth loss for both KNHANES and NHANES.

4) Results of performing simple logistic regression analysis with edentulism as the dependent variable showed that smoking history factor for KNHANES (odds ratio 1.16) and NHANES (odds ratio 0.88) was a statistically not significant factor ($p=0.06$) and ($p=0.16$) respectively.

5) Results of performing multiple logistic regression analysis with edentulism as the dependent variable with demographic factors and prevalence of diabetes showed that smoking history ($p<0.0001$), age group ($p<0.0001$) and education

attainment level ($p<0.0001$) were statistically significant factors. Also other statistically significant factors were level of income (upper vs. low) for KNHANES and NHANES ($p<0.0001$).

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국문 요약

한국과 미국의 흡연과 치아상실의 연관성 비교

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담배는 많은 종류의 화학 물질들이 포함되어 있으며 연소 시 다양한 독성 물질이 배출된다. 그 중 몇 물질은 발암 요인임이 밝혀진 바 있다. 치주질환 또한 흡연 시 그 발생 및 재발 위험이 높아진다고 알려져 있으며 이는 성인의 치아 상실의 주 원인이다. 따라서 본 연구에서는 흡연과 치아상실의 연관성을 한국과 미국의 대표성 있는 자료를 이용하여 알아보고자 하였다. 한국 국민건강영양조사 (Korea National Health and Nutrition Examination, KNHANES) 의 4기 및 5기 1차 자료와 미국 National Health and Nutrition Examination (NHANES) 의 2007-2010 자료를 이용하였고 연구 대상자는 19세 이상의 구강검진 기록이 있는 자였다. 흡연과 치아상실 및 무치악의 연관성을 인구학적 요인, 사회경제학적 요인, 당뇨를 보정한 모형을 이용하여 분석한 결과 다음과 같은 결과를 얻었다.

1. 카이제곱 검정 결과 흡연 경험과 연령군($p<0.0001$), 성별($p<0.0001$), 교육 수준($p<0.0001$), 보험 가입 상태($p<0.0001$), 당뇨 유병 여부($p<0.0001$)는 두 나라에서 모두 통계적으로 유의한 연관성을 나타냈다. 소득 수준은 한국에서만 유의한 연관성을 나타냈다.

2. 카이제곱 검정 결과 무치악 여부와 연령군($p<0.0001$), 교육 수준($p<0.0001$), 소득 수준($p<0.0001$), 보험 가입 상태($p<0.0001$), 당뇨 유병 여부($p<0.0001$)는 통계적으로 유의한 연관성을 나타냈다. 성별($p=0.453$)은 NHANES에서, 흡연 경험은 KNHANES($p=0.059$)와 NHANES($p=0.168$)에서 유의한 연관성을 나타내지 않았다.

3. 상관분석 결과 상실치아수와 연령군은 선형 연관성을 보였다. KNHANES와 NHANES에서 모두 연령군이 증가할 때 상실치아수도 증가하였다($p<0.0001$). 독립표

본 t 검정과 일원배치분산분석 검정 결과 상실치아수의 평균은 연령군($p<0.0001$), 성별($p<0.0001$), 교육 수준($p<0.0001$), 보험 가입 상태($p<0.0001$), 당뇨 유병 여부($p<0.0001$), 흡연 경험($p<0.0001$)에 따라 나눈 군간 KNHANES와 NHANES에서 모두 통계적으로 유의한 차이가 있었다.

4. 단순로지스틱 분석을 수행한 결과 흡연 경험이 있는 경우 무치악이 될 위험도가 KNHANES에서는 높아졌으며(오즈비 1.16) NHANES에서는 낮아졌으나(오즈비 0.88) 유의 확률은 각각 0.06과 0.16으로 통계적으로 유의하지 않았다.

5. 다중 로지스틱 회귀분석 결과 흡연 경험($p<0.0001$), 연령군($p<0.0001$), 교육 수준($p<0.0001$), 소득 수준($p<0.0001$)과 무치악 여부의 연관성이 KNHANES와 NHANES에서 모두 통계적으로 유의하게 나타났다.

본 연구 결과를 통해 흡연 경험은 두 나라에서 모두 치아 상실과 무치악의 위험 요인이 될 수 있음을 확인하였다.

핵심되는 말: 흡연, 치아상실, 무치악, KNHANES, NHANES, 구강 건강