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RESEARCH ARTICLE

Effects of Oral Health on Obesity in Korean Adults

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Background: To promote and maintain oral health among adults, the relationship between oral health and obesity was examined, and the effects of oral health on obesity were investigated.

Methods: A total of 4,270 Korean adults aged ≥20 years were selected as study subjects using raw data from the first year (2019) of the eighth period of the Korea National Health and Nutrition Examination Survey (KNHANES). Complex sample Rao-Scott chi-square test and complex sample logistic regression analysis were performed using PASW Statistics ver. 18.0.

Results: The prevalence of abdominal obesity was 1.3 times higher subjects with poor oral health than in those with good perceived oral health and 1.3 times higher in subjects who did not receive dental checkups compared to those that did. The frequency of brushing of teeth was 1.2 times higher for subjects who reported brushing 2~3 times per day compared to those who reported brushing four or more times per day. The risk of being overweight was 1.3 times higher in subjects with one or more dental implants than in those with none.

Conclusion: To build an integrated health program, it is thought that a preventive approach through self and expert oral health care, considering the age-specific characteristics of adults, is necessary for the intervention process used to build customized obesity prevention projects at the national level.

Key Words: Abdominal obesity, Adult, Obesity, Oral health, Overweight

Introduction

1. Background

As the socioeconomic status of Korean adults has changed, nutrient intake has increased, but the amount of energy-consuming physical activity that people engage in has decreased. As a result, the prevalence of chronic diseases, which are major causes of death, has been increasing[1)]. Obesity in adults is attributed to excessive drinking, smoking, and binge eating due to various stresses experienced in work life. Health-related behaviors such as these play important roles in determining lifelong health during working adult life, which is a crucial period[2)].

The World Health Organization (WHO) defines overweight and obesity as abnormal or excessive accumulation of fat that poses a health risk. According to their report on the subject, the global burden of the disease has grown to epidemic levels, with over four million people having died in 2017 as a result of being overweight or obese[3)]. Obesity is also a major risk factor for many chronic diseases, including cardiovascular diseases such as heart disease and stroke, which are major causes of death worldwide and are classified as a disease group that requires treatment due to chronic/mental illness[4)]. To address this issue, the Ministry of Health and Welfare of Korea held the "National Health Promotion Policy Review Committee" in 2018 and announced the "National Obesity Management Comprehensive Measures (2018~2022)" for the purpose of managing obesity at the national level[5)], and a systematic approach began to be reflected in government

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policy. In the published data of the "2017 Obesity White Paper," a study on obesity in Korea, the overall obesity rate in 2016 was 33.55%, at 41.29% for men and 23.74% for women[6]. In the 2019 National Health and Nutrition Examination Survey, the overall prevalence of obesity among adults aged 19 years and older was 33.8%, at 41.8% for men and 25.0% for women, showing a growing sex-independent pattern of obesity in Korea[7]. This finding suggests that obesity, along with chronic diseases, is an important index for systemic health.

Examining the association between obesity and oral disease, it was reported that obese people have a high risk of decreased interest in oral health and oral health practice behaviors because the probability of consuming caries-inducing food is also high in this group[8]. Obesity caused by higher fructose consumption is known to affect the development of dental caries[9]. Therefore, obesity can have a negative effect on oral health, and education on proper health and oral health management behaviors, as well as obesity prevention, is important[2]. According to a study that systematically analyzed oral health across 195 countries from 1990～2015[10], it was reported that oral health did not improve and that the global health burden due to oral health issues increased rapidly. In addition, the importance of oral health has increased due to the extension of overall human life expectancy, making it increasingly necessary to efficiently manage oral diseases through individual efforts as well as joint systematic efforts[11]. Therefore, it is necessary to intervene at the national level to promote and maintain oral health.

Regarding previous studies on oral health and obesity, one study[12] reported that the lower the number of times that subjects brushed their teeth, the higher their chances were of being obese. Another study[13] also showed a tendency of decreased frequencies of brushing of teeth in obese subjects. It was confirmed that there is a bidirectional relationship between the frequency of tooth brushing and obesity. A study by Lee and Kim[14] reported that the caries experience Decayed, Missing, and Filled Teeth (DMFT) index was higher in the overweight group than in the underweight or normal weight groups. Another study reported that the obese group had a three times higher risk of dental caries than the normal group[15]. In addition, according to a study by Kim and Kim[16], who confirmed the relationship between body mass index (BMI) and oral diseases in adults aged 20 years or older, the risk of periodontitis was reported to be 1.27 times higher in the obese group. One study reported that the risk of obesity increased when subjects had fewer than 20 remaining natural teeth[17] and that the prevalence of abdominal obesity was found to be high in subjects with fewer than 20 remaining natural teeth[18]. Patients with poor oral hygiene have been reported to be more likely to suffer from obesity than those with good oral hygiene[19]. Previous studies have confirmed the association between oral disease and obesity in adults, but the number of studies that have subdivided obesity into abdominal obesity, overweight, and obesity in Korean adults, and have analyzed oral health status and the oral health behavioral factors that affect it, is insufficient. As such, it is thought that there is limited evidence to aid in the establishment of a systematic adult oral health and obesity prevention program that considers the relationship between oral health and obesity.

2. Objectives

The purpose of this study was to identify oral health status factors that affect obesity in Korean adults, using national statistical data representative of Korean adults' health statuses and behaviors. It is intended to be presented as basic data to be used for preparing a national-level health promotion strategy to comprehensively address oral health and obesity in Korean adults.

Materials and Methods

1. Ethics statement

This study used raw data[20] from the eighth Korea National Health and Nutrition Examination Survey (KNHANES VIII-1) of the Ministry of Health and Human Services. As this study analyzed secondary data, it was approved for review exemption by the Institutional Bioethics Committee of Gangneung- Wonju National University (GWNUIRB-R2022-14).

2. Subjects

The subjects of the study were 6,542 adults over the age

of 20 who responded to the survey, 356 people diagnosed with cancer who could affect the research results, 34 people who had been ill for over 15 days, and 1,882 missing values. Of these, 4,270 people who responded to all the questions were selected to be our study subjects. Fig. 1 shows the subject selection model.

3. Study design

In this study, the variables of the health survey and oral examination data[20] from KNHANES VIII-1 were converted and used. The dependent variable was obesity and the independent variables were general characteristics and oral health.

1) Obesity

Data on abdominal obesity and BMI were used in this study. Abdominal obesity was defined as having a waist circumference of 90 cm or more for men and 85 cm or more for women, according to the definition of the Society of Obesity[21]. BMI was classified into three stages: underweight, normal, and obese, according to the definition of the Society for Obesity. Underweight was defined as a BMI of less than 18.5 kg/m^2, normal as a BMI of 18.5～23 kg/m^2, overweight as a BMI of 23～25 kg/m^2, and obesity as a BMI of 25 kg/m^2 or more.

2) General characteristics

The general characteristics were sex, age, marital status, education level, income level, smoking status, and alcohol intake. Sex was classified as male or female, and age was subdivided into 20～29, 30～39, 40～49, 50～5, 60～69, and 70 years or older. Marital status was classified as "yes" or "no."

Education level was classified into middle school graduates and below, high school graduates, and college graduates and above. Income level was divided into lower, middle-lower, middle-upper, and upper-income quartiles. Smoking was recorded as "yes" for those who had smoked either more or less than five packs (100 cigarettes) over their lifetimes and "no" for those who had never smoked. Alcohol intake was recorded as "yes" for subjects who consumed alcohol more than once per month over the course of one year and "no" for those who consumed alcohol less than once a month.

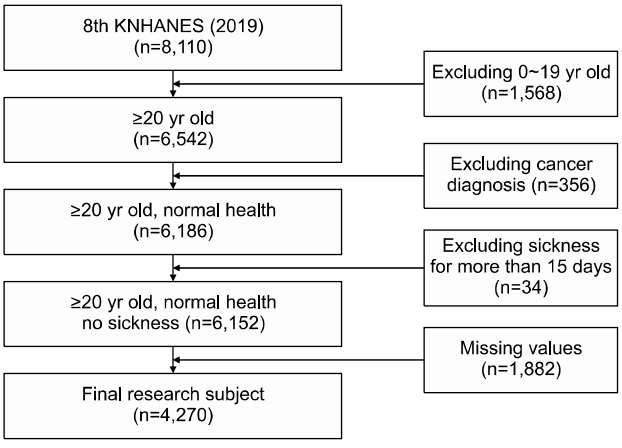

Fig. 1. Research subject selection model. KNHANES: Korea National Health and Nutrition Examination Survey.

3) Oral health

The oral health variables used in this study included perceived oral health, dental checkups per year, use of dental floss, frequency of brushing of teeth (per day), DMFT index, prosthetic status, dental implant status, and number of remaining natural teeth. Perceived oral health was classified as good, moderate, or poor, and dental checkups per year were classified as "yes" or "no." Dental flossing was classified as "yes" or "no." Frequency of brushing of teeth per day was classified as ≤1, 2～3 times, and ≥4. DMFT indexes were recorded as "less than 7 (<7)" and "7 or higher (≥7)" by obtaining the median value for each study subject. Prosthetic status was initially defined as "no prosthesis," "one fixed prosthodontic," "two or more fixed prosthodontics," "only partial dentures," "coexistence of prosthodontics and partial dentures," and "full dentures;" however, it was reclassified into "full dentures," "partial dentures," "fixed prosthodontics," and "no." Dental implant status was divided into "≥1" and "no."

The number of remaining teeth was reclassified according to oral examination results that investigated the condition of teeth in units of tooth surfaces. If the oral examination result was recorded as "sound teeth", "carious", "treated carious teeth", "sealant-treated teeth", "intreated carious teeth", or "unable to record", it was changed to "1"

for having teeth. In addition, when the oral examination result was recorded as “teeth without caries experience”, “teeth without caries experience”, and “non-emerged teeth”, it was changed to “0”, which is no tooth. The number of remaining teeth was calculated by summing the scores for the 28 teeth, excluding wisdom teeth[22]. We adopted the definition of Yamanaka et al.[23] of number of remaining teeth dicided into categories of “more than 20” and “less than 20.” Yamanaka et al.[23] were defined 20 teeth as the number of teeth that the authoring function was adequate to some extent and the meal was delicious.

4. Statistical methods

The collected data were analyzed using PASW Statistics ver. 18.0 (IBM Corp., Armonk, NY, USA). Complex sample analysis was performed after generating a planning file considering the weights of the variance estimation layer, survey district, health survey, and screening survey. A frequency analysis was performed to examine the general characteristics of the study participants, and a Rao-Scott chi-square test was performed to examine the differences in obesity according to general characteristics and oral health. To investigate the effects on obesity, a complex sample logistic regression analysis was performed with oral health as an independent variable. The statistical significance level was set at $p < 0.05$.

Results

1. Characteristics of the study subjects

There were more female study subjects than males, with 2,040 (52.9%) males and 2,230 females (47.1%). There were 869 people aged 40～49 years (21.3%), 839 people aged 50～59 years (20.3%), 731 aged 30～39 years

Table 1. Characteristics of the Study Subjects (n=4,270)

Variables	Divisions	n	%
Sex	Male	2,040	52.9
	Female	2,230	47.1
Age (y)	20～29	559	18.7
	30～39	731	19.3
	40～49	869	21.3
	50～59	839	20.3
	60～69	726	12.0
	≥70	546	8.4
Marital status	Yes	3,471	75.2
	No	799	24.8
Education level	≤Middle school	998	16.9
	High school	1,451	35.5
	≥College	1,821	47.6
Income level	Low	1,012	22.7
	Middle-low	1,056	24.9
	Middle-high	1,113	26.4
	High	1,089	26.0
Smoking	Yes	1,875	46.5
	No	2,395	53.5
Alcohol intake	Yes	2,638	64.7
	No	1,632	35.3
Abdominal obesity	Yes	1,490	33.3
	No	2,780	66.7
BMI	Underweight	164	4.3
	Normal	1,634	38.3
	Overweight	1,001	22.9
	Obesity	1,471	34.6

BMI: body mass index.

(19.3%), 726 aged 60～69 years (12.0%), 559 aged 20～29 years (18.7%), and 546 subjects (8.4%) who were 70 or older. Regarding marital status, 3,471 (75.2%) were married and 799 (24.8%) were single. In terms of education level, 1,821 subjects (47.6%) had college degrees or higher, followed by high school degrees 1,451 students (35.5%), and middle school graduates or below at 998 subjects (16.9%). Regarding income level, middle-high had the largest number of subjects, at 1,113 (26.4%), followed by high at 1,089 (26.0%), middle-low had 1,056 (24.9%), and low had the lowest number of subjects, at 1,012 (22.7%). Non-smokers accounted for 2,395 (53.5%) subjects, vs. 1,875 (46.5%) smokers. The number of study subjects who consumed alcohol was 2,638 (64.7%), which was higher than those who did not consume alcohol, 1,632 (35.3%). The number of subjects with abdominal obesity was 1,490 (33.3%), and in terms of BMI "obese" was the highest group, with 1,471 (34.6%) subjects, followed by overweight (1,001 [22.9%]) and underweight (164 [4.3%]) (Table 1).

2. Obesity according to general characteristics

Males (F=59.501, p＜0.001), older subjects (F=185.400, p＜0.001), married people (F=68.434, p＜.001), and smokers (F=34.647, p＜0.001) showed high rates of abdominal obesity. Males (F=249.643, p＜0.001), married people (F=71.174, p＜0.001), those with lower education levels (F=60.608, p＜0.001), and smokers (F=104.118, p＜0.001) were also found to be more likely to be overweight

Table 2. Obesity according to General Characteristics

Variable	Division	Abdominal obesity		BMI (kg/m^2)			
		Yes	No	Underweight (＜18.5)	Normal (18.5～23)	Overweight (23～25)	Obesity (≥25)
Sex	Male	807 (38.6)	1,233 (61.4)	41 (1.9)	613 (30.0)	533 (26.0)	853 (42.1)
	Female	683 (27.4)	1,547 (72.6)	123 (7.0)	1,021 (47.5)	468 (19.4)	618 (26.1)
	F (p)	59.501 (＜0.001)			249.463 (＜0.001)		
Age (y)	20～29	99 (18.8)	460 (81.2)	49 (9.2)	268 (48.0)	91 (14.5)	151 (28.2)
	30～39	205 (29.3)	526 (70.7)	42 (6.0)	289 (38.1)	156 (21.1)	244 (34.9)
	40～49	267 (32.1)	602 (67.9)	29 (2.9)	345 (37.0)	193 (23.5)	302 (36.6)
	50～59	291 (36.4)	548 (63.6)	19 (1.9)	314 (35.3)	210 (26.6)	296 (36.2)
	60～69	334 (45.2)	392 (54.8)	10 (1.6)	230 (32.9)	202 (27.6)	284 (37.9)
	≥70	294 (53.6)	252 (46.4)	15 (2.3)	188 (34.9)	149 (28.6)	194 (34.3)
	F (p)	185.400 (＜0.001)			159.591 (＜0.001)		
Marital status	Yes	1,311 (36.8)	2,160 (63.2)	110 (3.3)	1,279 (36.1)	859 (25.1)	1,223 (35.5)
	No	179 (22.9)	620 (77.1)	54 (7.0)	355 (44.8)	142 (16.3)	248 (31.9)
	F (p)	68.434 (＜0.001)			71.174 (＜0.001)		
Education level	≤Middle school	504 (48.9)	494 (51.1)	20 (1.4)	311 (30.9)	261 (27.4)	406 (40.3)
	High school	472 (32.2)	979 (67.8)	50 (3.5)	567 (38.7)	348 (23.8)	486 (34.0)
	≥College	514 (28.6)	1,307 (71.4)	94 (5.8)	756 (40.5)	392 (20.7)	579 (32.9)
	F (p)	100.214 (＜0.001)			60.608 (＜0.001)		
Income level	Low	380 (35.5)	632 (64.5)	41 (4.2)	382 (38.3)	219 (21.6)	370 (35.8)
	Middle-low	358 (32.5)	698 (67.5)	37 (3.5)	393 (37.3)	261 (24.1)	365 (35.1)
	Middle-high	396 (33.5)	717 (66.5)	48 (5.0)	425 (37.9)	254 (22.1)	386 (35.0)
	High	356 (32.1)	733 (67.9)	38 (4.3)	434 (39.4)	267 (23.7)	350 (32.5)
	F (p)	3.153 (0.632)			7.700 (0.778)		
Smoking	Yes	734 (37.9)	1,141 (62.1)	47 (2.2)	613 (32.7)	476 (25.3)	739 (39.7)
	No	756 (29.4)	1,639 (70.6)	117 (6.0)	1,021 (43.1)	525 (20.8)	732 (30.1)
	F (p)	34.647 (＜0.001)			104.118 (＜0.001)		
Alcohol intake	Yes	910 (32.8)	1,728 (67.2)	100 (4.4)	1,001 (37.6)	615 (23.1)	922 (34.9)
	No	580 (34.3)	1,052 (65.7)	64 (3.9)	633 (39.5)	386 (22.6)	549 (34.0)
	F (p)	1.014 (0.408)			1.846 (0.725)		

Values are presented as unweighted count (weighted %).
BMI: body mass index, F: Rao-Scott test.

and obese. The prevalence of being overweight increased with age, and obesity was highest in the 60～69 age group (F=159.591, p＜0.001) (Table 2).

3. Obesity according to oral health

The abdominally obese group showed a worse perceived oral health status (F=18.341, p=0.003), more cases of subjects who had received no dental checkups per year (F=20.753, p＜0.001), and higher numbers of subjects who did not use dental floss (F=21.543, p＜0.001), who brushed their teeth less frequently (F=26.925, p＜0.001), who had full dentures with prosthetics (F=89.360, p＜0.001), who had more than one dental implant (F=27.218, p＜0.001), and who had less than 20 remaining natural teeth (F=57.301, p＜0.001). The poorer the perceived oral health status, the higher the overweight and obesity (F=22.203, p＜0.05). In addition, cases of not receiving an oral examination (F=20.495, p=0.002), not using dental floss (F=34.361, p＜0.01), low frequency of brushing (F=33.332, p＜0.001), and overweight and obesity were higher. Furthermore, overweight and obesity were higher in cases with more than one dental implant (F=39.800, p＜0.001) and less than 20 remaining teeth (F=8.770, p＜0.05). In the group with dental prosthetics, the number of overweight subjects was higher for those that wore fixed prosthodontics, and obesity was higher in those that wore

Table 3. Obesity according to Oral Health

Variable	Division	Abdominal obesity		BMI (kg/m^2)			
		Yes	No	Underweight (＜18.5)	Normal (18.5～23)	Overweight (23～25)	Obesity (≥25)
Perceived oral health	Poor	612 (37.2)	961 (62.8)	55 (3.7)	561 (35.3)	373 (23.3)	584 (37.6)
	Moderate	706 (31.9)	1,422 (68.1)	80 (4.3)	836 (38.9)	510 (23.2)	702 (33.7)
	Good	172 (28.4)	397 (71.6)	29 (5.8)	237 (43.8)	118 (20.7)	185 (29.8)
	F (p)	18.341 (0.003)		22.203 (0.015)			
Dental checkup per year	No	963 (36.1)	1,590 (63.9)	93 (3.7)	923 (36.2)	607 (23.2)	930 (36.9)
	Yes	527 (29.4)	190 (70.6)	71 (5.1)	711 (41.2)	394 (22.5)	541 (31.3)
	F (p)	20.753 (＜0.001)		20.495 (0.002)			
Using dental floss	No	1,153 (35.5)	1,925 (64.5)	106 (3.6)	1,109 (36.2)	754 (24.0)	1,109 (36.2)
	Yes	337 (28.1)	855 (71.9)	58 (5.8)	525 (43.3)	247 (20.3)	362 (30.6)
	F (p)	21.543 (＜0.001)		34.361 (＜0.001)			
Frequency of toothbrushing per day	≤1	138 (44.6)	160 (55.4)	5 (1.0)	92 (30.3)	73 (24.4)	128 (44.3)
	2～3	1,156 (33.6)	2,117 (66.4)	125 (4.1)	1,239 (38.1)	783 (23.4)	1,126 (34.4)
	≥4	196 (27.5)	503 (72.5)	34 (6.3)	303 (42.0)	145 (20.0)	217 (31.7)
	F (p)	26.925 (＜0.001)		33.332 (＜0.001)			
DMFT index	＜7	631 (32.9)	1,224 (67.1)	64 (3.8)	694 (37.8)	419 (21.5)	678 (36.9)
	≥7	859 (33.7)	1,556 (66.3)	100 (4.6)	940 (38.7)	582 (24.1)	793 (32.6)
	F (p)	0.352 (0.596)		10.568 (0.077)			
Prosthetic status	Full denture	85 (53.0)	75 (47.0)	8 (4.0)	58 (34.7)	35 (23.1)	59 (38.3)
	Partial denture	110 (49.5)	107 (50.5)	6 (2.4)	79 (37.5)	56 (25.6)	76 (34.5)
	Fixed prosthodontics	520 (40.8)	705 (59.2)	26 (2.0)	398 (32.8)	336 (27.4)	465 (37.9)
	No	775 (28.9)	1,893 (71.1)	124 (5.2)	1,099 (40.5)	574 (21.1)	871 (33.2)
	F (p)	89.360 (＜0.001)		54.006 (＜0.001)			
Dental implant status	≥1	369 (41.5)	480 (58.5)	16 (1.8)	270 (31.6)	237 (28.7)	326 (37.9)
	No	1,121 (31.6)	2,300 (68.4)	148 (4.8)	1,364 (39.7)	764 (21.7)	1,145 (33.9)
	F (p)	27.218 (＜0.001)		39.800 (＜0.001)			
Number of remaining teeth	＜20	256 (51.6)	246 (48.4)	16 (3.0)	173 (32.5)	120 (24.2)	193 (40.3)
	≥20	1,234 (31.7)	2,534 (68.3)	148 (4.4)	1,461 (38.8)	881 (22.8)	1,278 (34.1)
	F (p)	57.301 (＜0.001)		8.770 (0.029)			

Values are presented as unweighted count (weighted %).
BMI: body mass index, F: Rao–Scott test.

full dentures (F=54.006, p＜0.001; Table 3).

4. The effects of oral health on obesity

The risk of abdominal obesity was 1.3 times (p＜0.05) higher for those with poor oral health than those with good oral health. The risk of abdominal obesity was 1.3 times (p＜0.01) higher in subjects who underwent no dental checkups per year than those who did. The risk of abdominal obesity was 1.2 times (p＜0.05) higher for those who brushed their teeth 2～3 times per day vs. those who brushed ≥4 per day. The risk of being overweight was 1.3 times (p＜0.05) higher in subjects with one or more dental implants than those without any. The risk of obesity was 1.2 times (p＜0.01) higher in cases with poor perceived oral health than in cases with good perceived oral health The risk of obesity was 1.3 times (p＜0.01) significantly higher in those who did not receive dental checkup per year than in those who received dental checkup per year. The risk of obesity was 1.3 times (p＜0.05) significantly higher in the case of having one or more implants than in the case of not having one (Table 4).

Discussion

1. Interpretation and comparison to previous studies

Recently, Westernized eating habits and lack of physical activity have resulted in an increase in the obesity rate, which has in turn caused various chronic diseases and has become a risk factor for shortening healthy lifespans[24]. According to a policy report of the National Health Insurance Service, as of 2019, the socioeconomic cost of the health-related risk factors of drinking, obesity, and smoking was estimated to be 41.8 trillion won, and in connection to this, the socioeconomic cost of obesity has increased significantly[25]. This can be seen in the fact that

Table 4. The Effects on Obesity

Variable	Division	Abdominal obesity		Overweigh (23～25 kg/m^2)		Obesity (≥25 kg/m^2)	
		OR	95% CI	OR	95% CI	OR	95% CI
Perceived oral health	Poor	1.309*	1.003～1.710	1.231	0.951～1.594	1.428**	1.092～1.867
	Moderate	1.174	0.910～1.514	1.204	0.927～1.564	1.207	0.944～1.543
	Good	1					
Dental checkup per year	No	1.293**	1.092～1.530	1.160	0.927～1.451	1.304**	1.098～1.548
	Yes	1					
Using dental floss	No	1.086	0.903～1.306	1.167	0.921～1.478	1.179	0.970～1.432
	Yes	1					
Frequency of toothbrushing per day	≤1	1.402	0.994～1.977	1.215	0.789～1.872	1.205	0.922～1.574
	2～3	1.230*	1.005～1.506	1.360	0.956～1.936	1.114	0.920～1.350
	≥4	1					
DMFT index	≥7	0.957	0.825～1.111	1.127	0.923～1.377	0.937	0.780～1.125
	＜7	1					
Prosthetic status	Full denture	1.191	0.756～1.875	0.716	0.415～1.235	0.944	0.592～1.504
	Partial denture	1.145	0.751～1.747	0.823	0.498～1.360	0.880	0.565～1.369
	Fixed prosthodontics	1.162	0.948～1.424	1.200	0.948～1.520	1.220	0.999～1.489
	No	1					
Dental implant status	≥1	1.118	0.920～1.358	1.347*	1.027～1.767	1.264*	1.000～1.599
	No	1					
Number of remaining teeth	＜20	1.180	0.922～1.510	0.790	0.571～1.095	1.073	0.796～1.447
	≥20	1					

CI: confidence interval, OR: odds ratio.
By complex sample logistic regression analysis (*p＜0.05, **p＜0.01).
Adjusted for sex, age, marital status, education level, income level, smoking, alcohol intake.

medical expenses for the treatment of obesity and serious diseases add to the socioeconomic burden of any country. The WHO designated obesity as one of the world's top 10 health risk factors[26], and emphasized that health issues should be approached in an integrated manner from all social fields rather than simply individually[27]. Therefore, a multifaceted approach that includes oral health is necessary to prevent obesity at the national level.

In this study, the raw data of the eighth first year (2019) of the KNHANES were used to identify the impact of oral health on obesity and to prepare basic data to prevent obesity, in order to promote and maintain systemic health in Korea.

As a result of analyzing abdominal obesity and BMI according to general characteristics, there was a statistically significant difference observed in obesity rates among males, married people, those with lower levels of education, and smokers − who all showed higher levels of obesity. Obesity rates were higher in males, which is consistent with the results of Park[18] and Kim and Lee[28]. In the case of men, it is thought that the obesity rate is high because they form interpersonal relationships through frequent dinners and business meetings and have difficult social lives. Our findings were also consistent with the results of Song and Jung[12], who reported a high obesity rate in married people. Compared to married people, unmarried people eat less regularly and strive for self-management[29]. In the case of married people, it is thought that the higher rate may be because they maintain regular diets through stable married life, which leads to higher-calorie dietary intakes compared to unmarried people.

In terms of age, there was a statistically significant difference in abdominal obesity and the overweight condition as age increased, with obesity being higher in 60～69-year-olds. Park[18], and Kim and Lee[28] reported similar results, in which being overweight, obesity, and abdominal obesity were found to increase with age. It is thought to be due to the gradual lack of social activity as age increases, resulting in muscle loss, which increases the risk of obesity. Obesity appears in people aged 60～69 years because they show a tendency toward reduced activity, both socially and economically, as they reach retirement age. Studies by Park and Lee[30] and Kim[31] reported that current smokers had a high obesity rate, which is similar to what we found in our study. This is thought to be due to obesity resulting from excessive stress in smokers. Studies from Kim[31] and Kim and Lee[28] reported that people with higher educational levels had lower obesity rates and waist circumference distributions and that those with lower educational levels had lower BMIs and abdominal obesity rates, which are also consistent with the results of this study. People with higher education levels likely have lower levels of obesity because their socioeconomic statuses are also high, giving them the freedom to choose healthier lifestyles and living environments[8]. In those with higher levels of education, obesity is thought to be low because these people tend to pay more attention to health and focus on exercise, in order to maintain happier lifestyles.

As a result of analyzing abdominal obesity and BMI according to oral health, we found a statistically significant difference. As abdominal obesity and BMI increased, perceived oral health conditions worsened. Song and Jung[12] reported that the higher the perception was of poor subjective oral health, the higher the degree of obesity was, which is consistent with our results. Similarly, a study by Lee and Choi[13] reported that higher body weight correlated with worse subjective oral health. This indicates that oral health and obesity are highly associated. In a study by Kim and Han[32], it was reported that the obese group was more dissatisfied with their physical appearance compared to the normal weight group. Because obesity, which is related to appearance, can negatively affect oral health according to quality of life, active oral health management is necessary in terms of self-management. As a result of analyzing abdominal obesity and BMI according to oral health, we found a statistically significant increase in abdominal obesity and BMI rates when dental checkups were not performed, the frequency of brushing of teeth was lower, and flossing was not done regularly. Examining differences in obesity according to oral health behaviors, a study[2] in which the obesity rate was higher in subjects who had not had dental checkups within the preceding year and a study by Kim[31], both reported that as the number of brushing sessions increased, BMI decreased. In a study by Song and Jung[12], it was reported that obesity

was higher when flossing was not done and the frequency of brushing of teeth was lower and that abdominal obesity decreased as the frequency of brushing of teeth increased, as well as when subjects had regular dental checkups and flossed, which is also consistent with our results. In terms of proper oral health care, it is thought that obesity can be prevented by receiving regular dental checkups and practicing oral health-related activities such as regular flossing and brushing. In addition, to prevent obesity and improve oral health, oral health-promoting behaviors are necessary[33], and it has been emphasized that the practice of health-promoting behaviors is important[14]. Regarding abdominal obesity and BMI according to the DMFT index, obesity was high when the DMFT index was seven or less, but this was not found to be statistically significant. However, in obese groups aged ≥19 years, a high DMFT index relevance has been reported related to dental caries, which conflicts with this study[30] This is likely a result of our permanent dental caries variable rather than a property of the DMFT index, so further studies examining the relationship between dental caries and obesity are needed.

Abdominal obesity and obesity were significantly higher in patients with full dentures and in overweight patients with fixed prosthodontics. In a study by Song and Jung[12], it was also reported that the degree of obesity was higher in those with maxillary prostheses, one or more fixed prostheses, or partial dentures. However, further research is needed to determine the relationship between full dentures and obesity. Abdominal obesity and BMI were significantly higher in subjects of our study cohort who had one or more implants. In a study by Song and Jung[12], obesity was found to be high in subjects with one or more implants in the maxilla and mandible, which is consistent with our results.

When the number of remaining natural teeth was less than 20, abdominal obesity and BMI were higher, showing statistically significant differences. Sheiham et al.[17] and Park[18] reported that the risk of obesity increased when the number of remaining natural teeth was less than 20 and that abdominal obesity was also high in this group, further supporting the results of our study. This indicates that a small number of remaining natural teeth is associated with obesity[34]. In patients suffering from systemic diseases, dental treatment is often not performed due to fear of bleeding or infection and the necessary restriction of physical activity during the dental treatment, resulting in loss of teeth because continued oral health management and conservative treatment are not performed[35]. It can be seen that missing teeth lead to a decrease in masticatory function during food intake, which lowers the quality of life and makes it difficult to maintain a healthy lifestyle[36].

In terms of factors affecting obesity, the risk of abdominal obesity was significantly higher in cases of poor perceived oral health status, those not receiving regular yearly dental checkups, and in subjects who only brushed their teeth 2～3 times per day. The risk of being overweight was also significantly higher in patients with more than one dental implant. Similarly, the risk of obesity was significantly higher in patients with perceived poor oral health, those who did not undergo yearly dental checkups, and those with one or more dental implants. Insufficient brushing frequency[12] and not receiving regular dental checkups[2] have a great impact on obesity, and these are perceived as bad oral health care habits that are neglectful of oral care, which can lower one's self-perceived opinion of their oral health. If this condition persists, the oral condition deteriorates, fixed prosthodontics are installed, and dental implants may be inserted[12], which all affect obesity. Poor oral hygiene care and poor oral health habits are thought to be associated with chronic diseases. Dental plaque is a major cause of oral diseases, and it is important to remove dental plaque to prevent oral diseases. Brushing for efficient removal of dental plaque and using interdental brushes or dental floss are oral care methods used to prevent chronic oral diseases[37]. Compared to general health, oral health is not directly related to disability but is closely related to physical, mental, and social health[38].

Oral health is associated with obesity at all ages[39]. The incidence of obesity has increased over the past 20 years, and an increase in obesity has been reported to be associated with oral disease[40]. Therefore, when establishing a plan for obesity prevention, oral health should be considered, in order to improve health and oral health-related quality of life.

2. Limitations

This study attempted to increase the possibility of generalization by analyzing raw data from the KNHANES, which guarantees the representativeness of adults and the reliability of the survey results. However, because this was a cross-sectional study, there were limitations in revealing the causal relationship between oral health and obesity. In addition, because only one year of data was analyzed, additional analysis using multi-year data is required in the future.

3. Suggestions

In this study, by identifying the relationship between oral health and obesity and by identifying the factors that affect oral health, basic data necessary for the systematic adult oral health project and obesity prevention project at the national level and for the promotion and maintenance of adult oral health, have been presented. In addition to this, a preventive approach through self-oral health care and expert oral health care is necessary for the intervention process for customized obesity prevention projects at the national level in order to build an integrated health project.

Notes

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Ethical approval

This study analyzed secondary data, it was approved for review exemption by the Institutional Bioethics Committee of Gangneung-Wonju National University (GWNUIRB-R2022-14).

Author contributions

Conceptualization: Jin-Ah Jung. Data acquisition: Jin-Ah Jung. Formal analysis: Jin-Ah Jung and Soo-Myoung Bae. Supervision: Jin-Ah Jung and Soo-Myoung Bae. Writing–original draft: Jin-Ah Jung and Soo-Myoung Bae. Writing–review & editing: Jin-Ah Jung and Soo-Myoung Bae.

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Data availability

The data from the KNHANES VIII-1 survey can be accessed and downloaded from the KNHANES homepage (URL:https://knhanes.kdca.go.kr/knhanes/sub03/sub03_02_05.do).

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