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Aims and Scope

The *Korean Journal of Health Promotion (KJHP)* is an open access, multidisciplinary journal dedicated to publishing high-quality research in various areas of the medical, nursing, nutritional, physical educational, epidemiological, and public health sciences associated with health promotion and disease prevention. *KJHP*, which has been published continuously since 2001, is an official journal of the Korean Society for Health Promotion and Disease Prevention.

The aim of the *KJHP* is to advance and disseminate new knowledge and scientific information in all the areas associated with health promotion and disease prevention. KJHP publishes original articles, narrative reviews, systematic reviews and meta-analyses, letters to the editor, and perspectives in English.

Abbreviation
The correct abbreviation for abstracting and indexing purposes is *Korean J Health Promot*.

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Assessment of Weight Change and All-Cause Mortality Based on Body Mass Index Intervals in South Korea: A 12-Year Follow-Up of the Korean Longitudinal Study of Aging

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Abstract

Background: Obesity and weight loss are associated with increased mortality. Understanding the association between weight change and mortality is critical and can help inform effective prevention and intervention strategies. Therefore, this study aimed to investigate the association between weight change and mortality based on body mass index (BMI) intervals using data from a 12-year follow-up survey in Korea.

Methods: We used data from the Korean Longitudinal Study of Aging from 2006 to 2018. Individuals aged 45-69 years without a history of malignancy and chronic obstructive pulmonary disease at baseline were selected. Cox regression analysis was used to compare mortality based on body mass index and weight change.

Results: Compared with individuals with a body mass index of 20.0-25.0 kg/m^2 and an increase in body weight of <5 kg, mortality was 3.8 times higher in the group with a body mass index of <20.0 kg/m^2 and a weight loss of <5 kg, two times higher in the group with a body mass index of 20.0-25.0 kg/m^2 and weight loss of >10 kg, and 4.3 times higher in the group with a body mass index of ≥25.0 kg/m^2 and weight gain of ≥10 kg.

Conclusions: Weight loss in underweight or normal-weight individuals and weight gain in individuals with obesity increased the mortality rate compared with individuals with normal weight and less weight change. This suggests that body weight and the changes in the weight of individuals are crucial, and weight loss in patients with underweight and weight gain in patients with obesity are closely related to increased mortality.

Keywords: Body mass index, Mortality, Body weight changes, Obesity, Thinness

INTRODUCTION

Obesity is a chronic disease increasing worldwide, and its prevalence has doubled since 1980 in more than 70 countries and has continued to rise across other nations [1]. Obesity is a risk factor for other chronic diseases such as hypertension, diabetes, hyperlipidemia, cardiovascular disease, and various cancers [2-4]. Therefore, many countries have emphasized the research on their obesity rates and implementing policies to reduce them.

Currently, obesity is classified based on body mass index (BMI) (weight in kilograms divided by the square of height in meters). According to the World Health Organization (WHO), overweight in adults is defined as a BMI of ≥25 kg/m^2 and obesity as a BMI of ≥30.0 kg/m^2 [5]. In contrast, overweight in the

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adult population of the Asia-Pacific region is defined as a BMI of ≥23.0 kg/m^2 and obesity as a BMI of ≥25.0 kg/m^2 [6]. This lower categorization in the Asia-Pacific region is due to a higher prevalence of chronic diseases in individuals who are classified as overweight based on the WHO BMI definition. Additionally, underweight is defined as a BMI of <18.5 kg/m^2, and this is based on data indicating a slight increase in comorbidities in this BMI population [6]. Notably, criteria for obesity or underweight to date have been based on the presence of comorbidities.

Studies examining the association between BMI and mortality have revealed different results. A meta-analysis reported the lowest mortality in individuals with a BMI of 27.0–27.9 kg/m^2 in Europe and America [7]. However, in Asia, the lowest mortality rate was reported for individuals with a BMI of 23.0–24.9 kg/m^2 [8,9]. According to the Asian standards, a BMI between 23.0 kg/m^2 and 24.9 kg/m^2 is considered overweight. The data, therefore, suggest that people who are overweight or obese are less likely to die than those of normal weight.

Although the association between BMI and increased mortality risk is well established, intentional and unintentional weight loss and weight gain have been associated with higher mortality rates, thus indicating that weight change is related to mortality. In a meta-analysis of 26 prospective studies, unintentional weight loss was associated with higher mortality (risk ratio, 1.22; 95% confidence interval, 1.09–1.37; *P*=0.001) [10]. In another meta-analysis, increased risk for all-cause mortality was 67% with weight loss, 21% with weight gain, and 53% with weight fluctuation among adults 60 years and older [11]. In a Korean study, weight loss hazard ratio (HR)= 1.68 (1.65–1.72) and weight gain HR=1.10 (1.07–1.13) were compared with stable weight [12].

The relationship between weight change and mortality has important implications for public health policy and clinical practice, and the effects of weight gain in underweight and weight loss in overweight on mortality are expected to be complex. Understanding the association between weight change and mortality according to BMI intervals can help inform effective prevention and intervention strategies. Therefore, this study aimed to investigate the effect of weight change on mortality based on BMI intervals.

METHODS

We used the data from the Korean Longitudinal Study of Aging (KLoSA), which is a 12-year cohort survey that has been followed up since 2006 to prepare for the aging population [13]. The survey was delivered to 10,254 individuals aged ≥45 years residing in areas of South Korea other than Jeju Island. This study was approved by the Institutional Review Board (IRB) of the Keimyung University (IRB No: 2021-08-115). This survey has been performed with the appropriate participants' informed consent in compliance with the Helsinki Declaration. Data were collected through computer-assisted personal interviewing. In this method, the interviewer brings a laptop computer, reads the questions displayed on the computer screen to the participants, and then directly inputs their responses using the keyboard or mouse. In the survey, biological personal data, spouse information, social information, family information, health and ecological information, and medical insurance and labor information were recorded over 83 variables. In cases of death, the date and cause of death were investigated from the family members or acquaintances. The survey participants were followed up every 2 years from 2006. The latest survey data published was after the seventh follow-up in 2018.

We extracted data on death, BMI, medical history, exercise, smoking, and alcohol consumption from the KLoSA data for analysis. We selected individuals aged 45–69 years old with no history of malignancy and chronic obstructive pulmonary disease at the beginning of the study.

Categorical variables were analyzed using the χ^2 test and presented as frequencies and percentages. Continuous variables were analyzed using the independent t-test and presented as means and standard deviations. Cox regression analysis was used to compare mortality. Two-sided *P*<0.05 was considered statistically significant. All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) version 23.0 software (IBM Corp.).

RESULTS

A total of 7,205 participants aged 45–69 years without a history of malignancy and chronic obstructive pulmonary disease in 2006 were included. The average age of the sample was 57 years, with 3,244 male and 3,961 female. There were 167 underweight participants with a BMI of <18.5 kg/m^2, 427 participants with a BMI of 18.5–19.9 kg/m^2, 2,585 participants with a BMI of 20.0–22.9 kg/m^2, 2,249 participants with a BMI of 23.0–24.9 kg/m^2, 1,643 participants with a BMI of 25.0–29.9 kg/m^2, and 134 participants with a BMI ≥30.0 kg/m^2. Among those with a BMI of 18.5–19.9 kg/m^2, the youngest participant was 56.0 years old, whereas among those with a BMI <18.5 kg/m^2, the oldest participant was 58.8 years old. The rates of hypertension, diabetes, and heart disease were highest in individuals with a BMI of ≥30.0 kg/m^2, and cerebrovascular disease accounted for the highest proportions in those with a BMI of <18.5 kg/m^2. The proportion of individuals who exercised regularly was the highest among the BMI of 25.0–29.9 kg/m^2 group. The smoking rate was the highest among those with a BMI of <18.5 kg/m^2, and the drinking rate was the highest among those with a BMI of 23.0–24.9 kg/m^2 (Table 1).

A total of 830 individuals died during the follow-up period through to 2018. Compared with the participants with a BMI of 23.0–24.9 kg/m^2, mortality was 1.9 times higher for individuals with a BMI of <18.5 kg/m^2 and 1.5 times higher for those with a BMI of 18.5–19.9 kg/m^2 (Table 2). Mortality was 1.9 times higher in the group with a weight loss of >10 kg during the first 2 years than in the group with a weight gain of <5 kg. Additionally, mortality was 1.5 times higher in the group with a weight loss of 5.1–10 kg in the first 2 years than in the group with a weight gain <5 kg (Table 3).

The HR according to BMI interval was highest in the group with a BMI of <18.5 kg/m^2 and lowest in the group with a BMI of 23.0–24.9 kg/m^2 (Fig. 1). Compared with the group with a BMI of 20.0–25.0 kg/m^2 and an increase in body weight of <5 kg, mortality was 3.8 times higher in the group with a BMI of <20.0 kg/m^2 and a weight loss of >5 kg and 1.7 times higher in the group with a BMI of <20.0 kg/m^2 and weight loss of 0.1–5.0 kg. Mortality was two times higher in the group with a BMI of 20.0–25.0 kg/m^2 and weight loss of >10 kg and 1.5 times higher in the group with a BMI of 20.0–25.0 kg/m^2 and weight loss of 5.1–10.0 kg compared with the group with a BMI of 20.0–25.0 kg/m^2 and

Table 1. General characteristics

Variable	BMI range (kg/m^2)						*P*-value
	≤18.4 (n=167)	18.5–19.9 (n=427)	20.0–22.9 (n=2,585)	23.0–24.9 (n=2,249)	25.0–29.9 (n=1,643)	≥30.0 (n=134)	
Age (yr)	58.8±7.83	56.0±8.12	56.1±7.52	56.5±7.41	56.7±7.02	57.9±7.54	<0.001[a]
Sex							<0.001[b]
Male	58 (34.7)	161 (37.7)	1,142 (44.2)	1,106 (49.2)	744 (45.3)	33 (24.6)	
Female	109 (65.3)	266 (62.3)	1,443 (55.8)	1,143 (50.8)	899 (54.7)	101 (75.4)	
MMSE	25.1±5.66	26.9±3.71	26.9±3.77	27.2±3.44	26.8±3.71	25.7±4.37	<0.001
Hypertension	22 (13.2)	49 (11.5)	425 (16.4)	525 (23.3)	526 (32.0)	78 (58.2)	<0.001[b]
Diabetes	19 (11.4)	24 (5.6)	214 (8.3)	231 (10.3)	221 (13.5)	38 (28.4)	<0.001[b]
Liver disease	1 (0.6)	7 (1.6)	44 (1.7)	25 (1.1)	39 (2.4)	3 (2.2)	0.056[b]
Cardiac disease	6 (3.6)	10 (2.3)	69 (2.7)	82 (3.6)	74 (4.5)	9 (6.7)	0.006[b]
Cerebrovascular disease	9 (5.4)	8 (1.9)	52 (2.0)	48 (2.1)	53 (3.2)	3 (2.2)	0.111[b]
Regular exercise	50 (29.9)	149 (34.9)	1,064 (41.2)	970 (43.1)	764 (46.5)	44 (32.8)	<0.001[b]
Current smoker	46 (27.5)	103 (24.1)	572 (22.1)	483 (21.5)	334 (20.3)	16 (11.9)	0.013[b]
Alcohol consumption	58 (34.7)	171 (40.0)	1,071 (41.4)	1,003 (44.6)	712 (43.3)	41 (30.6)	0.002[b]

Values are presented as mean±standard deviation or number (%).
BMI, body mass index; MMSE, mini-mental state examination.
[a]Analyzed using analysis of variance; [b]Analyzed using the chi-square test.

Table 2. Cox regression analysis for mortality according to BMI (12 years follow-up)

BMI (kg/m^2)	Model 1		Model 2	
	Risk ratio	*P*-value	Risk ratio	*P*-value
≤18.4	1.910 (1.313–2.777)	0.001	1.631 (1.116–2.384)	0.012
18.5–19.9	1.534 (1.166–2.019)	0.002	1.582 (1.199–2.088)	0.001
20.0–22.9	1.121 (0.946–1.329)	0.187	1.156 (0.974–1.372)	0.097
23.0–24.9[a]	1.000	-	1.000	-
25.0–29.9	1.028 (0.846–1.249)	0.781	0.996 (0.819–1.212)	0.970
≥30.0	1.182 (0.712–1.962)	0.517	1.072 (0.643–1.787)	0.791

Values are presented as hazard ratio (95% confidence interval).
BMI, body mass index; Model 1, raw data; Model 2, adjusted by age, sex, hypertension, diabetes, liver disease, cardiac disease, cerebrovascular disease, regular exercise, current smoker, alcohol drink.
[a]Reference.

an increase in weight of <5 kg. Mortality was 4.3 times higher in the group with a BMI of ≥25.0 kg/m^2 and weight gain of ≥10 kg compared with the group with a BMI of 20.0–25.0 kg/m^2 and an increase in body weight of <5 kg (Fig. 2).

DISCUSSION

In our study, the BMI range with the lowest comorbidity was 18.5 to 19.9 kg/m^2. This is consistent with the existing data [6]. In the normal BMI group, the prevalence of comorbidities was the lowest, with comorbidities increasing with a decrease or increase in BMI. However, the overweight group (according to the Asian-Pacific WHO classification; BMI, 23.0–24.9 kg/m^2) had the lowest mortality, with mortality increasing with a decrease or increase in BMI. This result is consistent with results in other studies conducted on other races in Asia. In a Japanese cohort

Table 3. Cox regression analysis for mortality according to weight change for first 2 years (10 years follow-up)

Weight change	Risk ratio	*P*-value
>10.0 kg loss	1.859 (1.292–2.673)	0.001
–5.1 to –10.0 kg	1.495 (1.131–1.977)	0.005
–0.1 to –5.0 kg	1.059 (0.870–1.290)	0.565
+0 to 4.9 kg[a]	1.000	-
+5.0 to 9.9 kg	1.145 (0.778–1.685)	0.491
≥10.0 kg gain	1.228 (0.627–2.406)	0.549

Values are presented as hazard ratio (95% confidence interval).
[a]Reference.

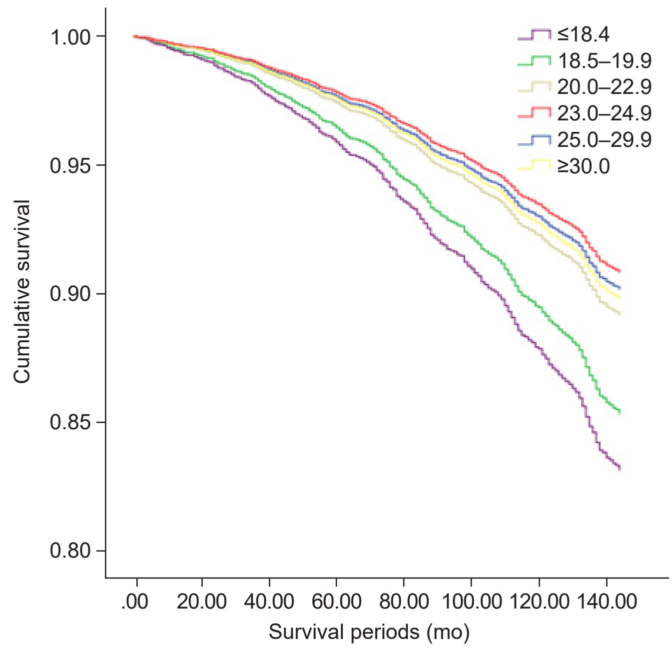

Fig. 1. Cumulative survival rate by Cox regression analysis (raw data).

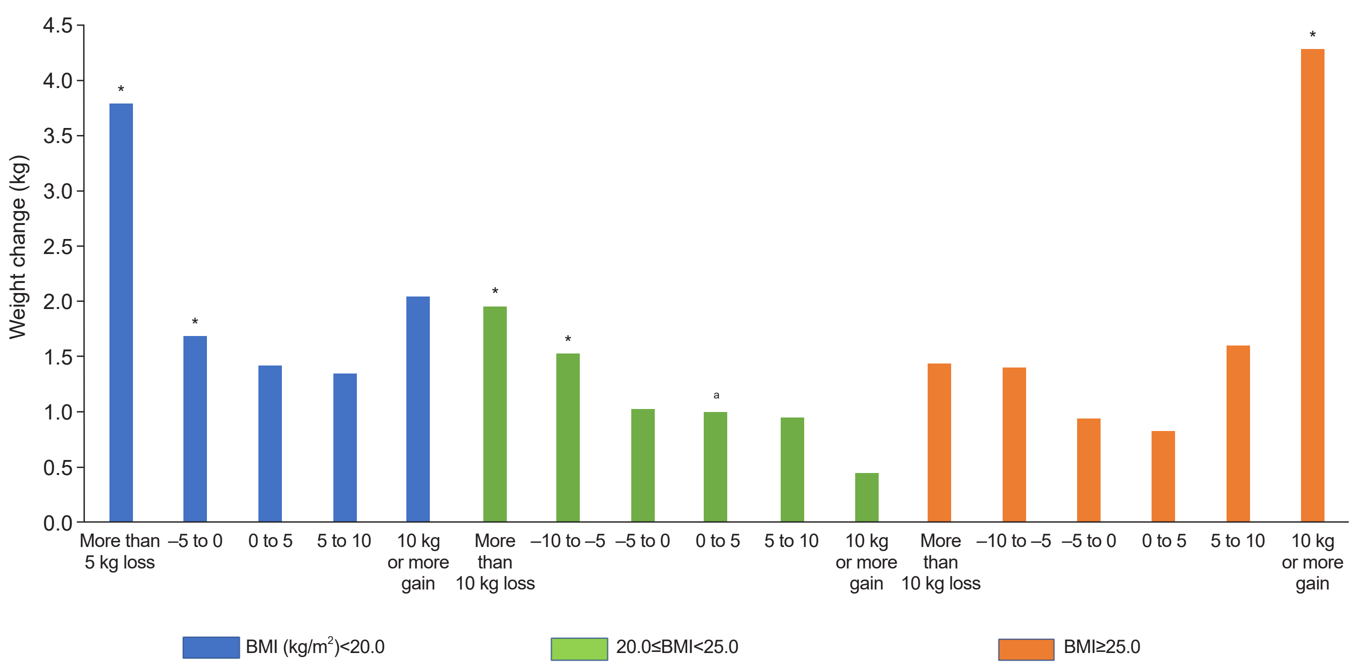

Fig. 2. Hazard ratio according to weight change for first 2 years by obesity degree (10 years follow-up mortality). BMI, body mass index. *Data with a *P*-value less than 0.05. [a]Reference of hazard ratio.

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study conducted from 1990 to 1999, individuals with a BMI of 23.0–24.9 kg/m^2 had the lowest mortality [9], which is also consistent with a prospective study in China, wherein the mortality was lowest among individuals with a BMI of 21.0–23.5 kg/m^2 [14].

Within the normal BMI range, the mortality in the group with a BMI of 18.5–19.9 kg/m^2 was 1.5 times higher than that in the group with a BMI of 23.0–24.9 kg/m^2. This suggests that attention should be paid to the high mortality in people with extreme BMIs and people with normal BMI of <20.0 kg/m^2.

In addition, we investigated the relationship between body weight change in 2 years and mortality over a 10-year follow-up as a post-hoc analysis to determine how changes in body weight affect mortality. The mortality increased more with weight loss than with weight gain. Mortality was 1.5 times higher in the group in which individuals lost 5.1–10.0 kg compared with the group in which individuals gained 0–5 kg. Mortality was also increased by 1.9 times in the group in which individuals lost ≥10 kg. This suggests that weight loss and being underweight are risk factors for death. To better understand these results, we divided BMI into three groups and then investigated the relationship between weight change and mortality in each BMI group (Fig. 2). In the group with a BMI of <20.0 kg/m^2, a statistically significant increase was observed in the mortality rate of all the individuals who lost weight. In the group with a BMI of ≥25.0 kg/m^2, the mortality rate was increased in individuals who gained ≥10 kg. In the group with a BMI of 20.0–25.0 kg/m^2, mortality was increased in those who lost ≥5.1 kg. These results suggest that, in Asian populations, weight loss increases the risk of death in individuals with a BMI <25.0 kg/m^2, and weight gain increases the risk of mortality in those with a BMI ≥25 kg/m^2.

In general, weight decreases with increasing age in older adults [15]. Previous studies have shown that weight loss in older adults is associated with cancer, chronic disease, thyroid disease, gastrointestinal disease, and mental illness, which are associated with increased mortality [16,17]. Additionally, low BMI and weight loss are closely associated with sarcopenia, which is further associated with mortality [18-22]. After middle age, weight loss can cause loss of muscle mass, which may increase mortality [23]. People within the normal range of BMI are usually not advised to change their weight. In underweight individuals, the mortality rate increased with either a decrease or increase in weight, and the mortality rate exhibited an increasing trend, although this was not statistically significant. These results may differ depending on whether there is an actual muscle mass increase or only a fat increase upon weight gain. Further research is needed to determine the effects of weight gain with increasing muscle mass on mortality in underweight individuals.

In our study, individuals with a BMI of ≥25.0 kg/m^2 exhibited a high mortality rate, but it was not statistically significant. However, excessive weight gain in the group with high BMI increased their mortality rate. These results are consistent with those of other studies involving Asians, implying that excessive weight gain in patients with obesity should be avoided [12,24].

The present study has some limitations. First, death data from the KLoSA was based on the memory of close family members and relatives; therefore, the date of death may not be accurate. Additionally, we cannot distinguish whether weight loss was intentional or unintentional. Notably, unintentional weight loss can be more dangerous than intentional weight loss [25]. Moreover, there are many diseases that can cause sarcopenia, including heart failure, tuberculosis, and thyroid disease, but our data did not include data on these conditions, so we were unable to control for confounding by these diseases. Therefore, further research is necessary to prove this hypothesis.

Despite these limitations, this study had strengths. KLoSA is a nation-wide dataset of 10,254 individuals aged ≥45 years, and this data was long-term, tracked for 12 years (2006–2018), thus providing credibility to the long-term effects of weight change on mortality.

Conclusion

This study revealed that weight loss in underweight individuals or those with normal weight and weight gain in overweight individuals increased their risk of mortality compared with individuals with normal weight and less weight change. This suggests that, in addition to body weight, changes in the weight of an individual are crucial, and weight loss in underweight patients or weight gain in patients with obesity are closely related to increased mortality. Obesity remains an important issue for community health. Paying increased attention to low body weight and weight loss among individuals is imperative to enhance healthcare in local communities.

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AUTHOR CONTRIBUTIONS

Dr. Seung Wan HONG had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: SWH. Data curation: SWH. Formal analysis: SWH. Funding acquisition: SWH. Investigation: SWH. Methodology: SWH. Project administration: SWH. Resources: SWH. Supervision: JHL. Writing–original draft: DHC. Writing–review & editing: JHL, SWH, YSS, and DHK.

CONFLICTS OF INTEREST

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

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DATA AVAILABILITY

The data presented in this study are available upon reasonable request from the corresponding author.

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Original Article

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Association between Salty Taste Preference and Dietary Behaviors Related to Sugar Intake among Adults

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Abstract

Background: Excessive sugar intake is a major global health concern, linked to elevated risks of obesity and various chronic diseases. Taste perception significantly influences dietary behaviors, yet the relationship between salty taste perception and sugar consumption remains underexplored. This study examines whether salty taste perception affects dietary behaviors related to sugar intake.

Methods: A total of 139 adults (35 males and 104 females) aged 19 and older participated. Salty taste recognition thresholds and preferences were evaluated using sensory tests involving salt solutions and soup samples with varying salt concentrations. Sugar-related dietary behaviors were assessed through a 10-item questionnaire survey and a semiquantitative food frequency questionnaire consisted of 18 sweet-tasting foods.

Results: Younger adults displayed higher sugar-related dietary scores and consumed sweet-tasting foods more frequently than middle-aged participants. While salty taste recognition thresholds showed no significant association, salty taste preferences were positively correlated with sugar-related dietary behaviors. Participants with a stronger salty taste preference exhibited a greater tendency to consume sweetened foods and beverages and preferred sugar-rich foods such as jelly, cakes, and ice cream. These correlations remained significant after adjusting for sex and age, emphasizing the link between salty taste preference and total sugar intake. Male participants consumed sugar-sweetened beverages and sweet dishes, such as bulgogi, more often than females, though no sex differences were found in overall sugar-related dietary scores.

Conclusions: These findings highlight a close relationship between salty and sweet taste preferences, suggesting that individuals who prefer salty tastes may be more likely to increase their sugar intake. Understanding this interaction can help develop strategies to address excessive sugar consumption and its associated health risks.

Keywords: Taste perception, Salty taste, Dietary sugars, Adult

INTRODUCTION

Excessive sugar intake has become a significant global public health issue. Epidemiological studies have shown strong associations between high sugar consumption and increased risks for various chronic diseases. For example, a meta-analysis reported that consuming 250 mL of sugar-sweetened beverages daily increases the risk of obesity by 12%, type 2 diabetes by 19%, and hypertension by 10% [1]. Additionally, a large prospective study involving a French cohort demonstrated a positive association between sugary drink consumption and the incidence of both breast cancer and overall cancer [2]. Moreover, higher intake of added sugars has been linked to an increased risk of all-cause mortality [3]. The metabolic effects of simple sugars, particular-

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ly fructose, further underline the health risks of excessive sugar consumption. Fructose is rapidly absorbed and metabolized, leading to metabolic disturbances such as insulin resistance, enhanced lipogenesis, and systemic inflammation [4].

Despite the well-documented health risks, sugar consumption has continued to rise in recent years. According to results from the recent Korea National Health and Nutrition Examination Survey (KNHANES), the average daily sugar intake among Korean adults was 58.0 g [5], exceeding the World Health Organization's recommendation of limiting sugar to less than 10% of daily caloric intake. Processed foods, particularly beverages, are the primary contributors to this increased intake, serving as major sources of added sugars [6]. Additionally, hidden sugars in processed foods such as bread, snacks, ice cream, and salad dressings further exacerbate daily sugar consumption. The ongoing rise in sugar intake and the negative health effects linked to high sugar consumption highlight the urgent need for effective strategies to reduce sugar consumption.

Taste perception plays an important role in one's dietary habits and nutrient intake. For example, sensitivity to bitter taste is often associated with the avoidance of cruciferous vegetables and lower consumption of antioxidant nutrients [7]. Further, it was shown that differences in sensitivity to the bitter taste was associated with preferences for sucrose and sweet-tasting foods and beverages in children [8], indicating perceptions of different tastes can interact each other. Additionally, genetic variations in the T1R2/T1R3 receptors, which are responsible for the sweet taste, have been shown to affect sensitivity to both fat and sweet tastes, as well as obesity in Indians [9]. Little is known, however, whether there is an interaction between preferences for the salty taste and the sweet taste.

Previous studies on factors influencing sugar intake have primarily focused on children and adolescents [10,11]. However, as obesity rates rise and processed foods become more prevalent, sugar consumption and its related health risks have gained significant importance for adults. In this study, we aimed to examine dietary behaviors associated with sugar intake among adults aged 20 and older. We also explored the relationship between these dietary behaviors and the perception of salty taste.

METHODS

Study participants

This study was conducted among students and staff members of Kyung Hee University in Seoul, Korea, who provided written informed consent after receiving a detailed explanation of the study's purpose, objectives, and procedures. Participants who had consumed alcohol within 24 hours prior to the sensory evaluation, as well as those who were pregnant or lactating, were excluded from the study. A total of 139 adults (35 males and 104 females) aged 19 years or older were included in the final analysis. Salty taste recognition thresholds and preferences were assessed through sensory evaluation. Dietary behaviors related to sugar consumption and the frequency of sweet-tasting food intake were collected using a survey questionnaire and a semiquantitative food frequency questionnaire, respectively. Anthropometric data were also recorded. The study protocol was approved by the Institutional Review Board (IRB) of Kyung Hee University (IRB No. KHSIRB-17-032(RA)).

Sensory evaluation

The salty taste recognition threshold was measured using a modified staircase method [12]. Twelve salt test solutions with concentrations ranging from 0.0045% to 0.3% were prepared and presented to participants in ascending order. If a participant detected a salty taste in two consecutive samples, the lower concentration of the two samples was recorded as the recognition threshold.

To assess salty taste preference, participants were asked to choose their preferred salt concentration in a clear soup made with soybean sprouts. Five soup samples were prepared with salt concentrations of 0.08%, 0.16%, 0.32%, 0.63%, and 1.25% [13]. The samples were presented in random order, and participants selected their preferred concentration after tasting each sample for approximately 10 seconds. All participants were instructed to abstain from alcohol for 24 hours and to avoid consuming food or brushing their teeth for at least 2 hours before the sensory evaluation.

Dietary assessment

Dietary behaviors related to sugar consumption were evaluated using a questionnaire comprising 10 items, based on Lee [14]. Participants responded on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Higher scores indicated a stronger tendency toward sweet eating behaviors. One question, 'I check the nutrition label for sugar content when I buy processed foods', was reverse-coded before calculating total scores. The maximum possible score was 50.

The frequency of sweet-tasting food consumption was assessed using a semiquantitative food frequency questionnaire developed based on a previous studies [14,15]. The questionnaire included 18 sweet-tasting foods categorized into six food groups. Participants recalled their weekly consumption frequency for each food over the past year, with frequency categories ranging from 0 (never) to 7 (seven times per week).

General and anthropometric characteristics

Anthropometric measurements, including height and weight, were obtained by trained staff. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2), with a BMI range of 18.5 to 23.0 kg/m^2 classified as normal. General characteristics such as age, sex, alcohol consumption, and smoking status were collected via a survey questionnaire. Participants were divided into young adults (20–29 years) and middle-aged adults (30–69 years) based on their age.

Statistical analysis

Continuous variables were presented as mean±standard deviation, while categorical variables were expressed as number (%). Differences in salty taste thresholds, preferences, and dietary behaviors by sex or age were analyzed using the Student's t-test or χ^2-test. Partial correlation analysis, adjusted for sex and age, was used to assess associations between salty taste thresholds and preferences, sugar-related dietary behaviors, and sweet-tasting food intake. Statistical analyses were performed using R Statistical Software (ver. 4.4.1; R Foundation for Statistical Computing), with a *P*-value <0.05 considered statistically significant.

RESULTS

General characteristics of the study participants are shown in Table 1. Among the 139 study participants, 55.4% were in their 20s, with a mean age of 35.6 years. Male participants comprised 25% of the total study participants, and there was no significant difference in mean age between the sexes. The mean BMI was 23.0 kg/m^2, and 47.5% of participants were within the normal weight range. Additionally, 7.2% of participants were current smokers, and 26.6% reported consuming alcohol at least once a week. The mean salty taste recognition thresholds for males and females were 0.11% and 0.10%, respectively; however, the difference between sexes was not statistically significant (Table 1).

The salty taste preferences of the study participants, stratified by sex and age groups, are shown in Table 2. Among the five different salt concentrations of bean sprout soup, 0.32% was the most preferred concentration in both sexes (48.6% in males and 46.2% in females), followed by 0.63% (20.0% in males and 31.7% in females). No statistically significant difference in salty

Table 1. General characteristics and salty taste threshold of the study participants

Variable	Total (n=139)	Male (n=35)	Female (n=104)	t or χ^2 (*P*-value)
Age (yr)	35.6±15.1	38.3±14.6	34.6±15.4	1.276 (0.207)
Height (cm)	163.5±7.7	172.9±5.3	160.3±5.5	11.990 (<0.001)
Weight (kg)	61.7±12.9	75.8±12.3	56.9±9.1	8.363 (<0.001)
Body mass index (kg/m^2)	23.0±4.0	25.4±4.0	22.2±3.7	4.120 (<0.001)
Drinking, yes[a]	37 (26.6)	16 (45.7)	21 (20.2)	9.149 (0.027)
Smoking, yes	10 (7.2)	9 (25.7)	1 (1.0)	20.467 (<0.001)
Salty taste threshold (%)	0.10±0.07	0.11±0.07	0.10±0.07	0.891 (0.375)
Salty taste preference (%)	0.40±0.25	0.35±0.24	0.42±0.25	−1.357 (0.177)

Values are presented as mean±standard deviation or number (%). *P*-values were calculated using Student's t-test or χ^2-test for differences between male and female.
[a]At least once a week.

Table 2. Salty taste preference of the study participants by sex and age groups

Salt concentration (%)	Total (n=139)	Sex		χ^2 (*P*-value)	Age groups[a]		χ^2 (*P*-value)
		Male (n=35)	Female (n=104)		Young adult (n=77)	Middle-aged (n=62)	
0.08	12 (8.6)	4 (11.4)	8 (7.7)	2.703 (0.609)	5 (6.5)	7 (11.3)	11.274 (0.024)
0.16	17 (12.2)	6 (17.1)	11 (10.6)		5 (6.5)	12 (19.4)	
0.32	65 (46.8)	17 (48.6)	48 (46.2)		41 (53.2)	24 (38.7)	
0.63	40 (28.8)	7 (20.0)	33 (31.7)		21 (27.3)	19 (30.6)	
1.25	5 (3.6)	1 (2.9)	4 (3.8)		5 (6.5)	0 (0.0)	

Values are presented as number (%). *P*-values were calculated using χ^2-test for differences by sex or age groups.
[a]Young adults: 20–29 years; Middle-aged adults: 30–69 years.

taste preference was observed between the sexes. However, a significant difference in salty taste preference was observed between age groups. Specifically, 53.2% of participants in the young adult group preferred the soup with a salt concentration of 0.32%, compared to 38.7% of participants in the middle-aged group. Additionally, 19.4% of participants in the middle-aged group preferred the soup with a salt concentration of 0.16%, whereas only 6.5% of participants in the young adult group showed a preference for this concentration.

We evaluated participants' dietary behaviors concerning sugar consumption using a 10-item questionnaire, with each item rated on a 5-point Likert scale. The results showed no significant differences in total scores (the sum of all 10 items) between the sexes (Table 3). However, significant differences were found for two specific items: 'I eat sweeter bread like red bean bread, cream bread, etc. than white bread', and 'I drink fruit juice more often than fresh fruit' ($P<0.05$). In contrast, notable differences were evident across age groups. The total dietary behavior scores related to sugar consumption were significantly higher in the young adult group compared to the middle-aged group (24.70 vs. 20.60, respectively, $P<0.001$). Furthermore, scores for eight out of the 10 items were significantly higher in the young adult group than in the middle-aged group, highlighting age-related differences in dietary behaviors regarding sugar consumption.

Next, the consumption frequency of sweet-tasting foods was evaluated using a semiquantitative food frequency questionnaire (Table 4). Male participants reported consuming sugar-sweetened beverages—such as carbonated drinks, fruit juices/fruit-flavored juices, and sports drinks—more frequently than female participants. For example, the frequency of carbonated drinks consumption among males was approximately twice that of females (1.89 times/wk vs. 0.95 times/wk, respectively). Similarly, males consumed sports drinks nearly three times more often than females (0.86 times/wk vs. 0.28 times/wk, respectively). Additionally, male participants consumed dishes in sweet sauces, such as bulgogi and seasoned chicken, significantly more frequently than female participants. Conversely, no significant differences were found between males and females in the consumption frequencies of confectionaries, snacks, sweet breads, or sweetened milk and dairy products except for yogurt drink.

When comparing age groups, the young adult group consumed most sweet-tasting foods more frequently than the middle-aged group. Significant differences in consumption frequencies between the age groups were observed for carbonated drinks, sports drinks, yuza tea/Korean plum tea/rice punch, sweetened snacks, jelly, chocolate, cake/yellow sponge cake/muffin, sweetened milk, ice cream, seasoned chicken, and tteokbokki. The total frequency of sweet-tasting food consumption in the young adult group was 16.90 times per week, significantly higher than the middle-aged group, which had a consumption of 10.90 times per week ($P<0.001$).

To investigate whether salty taste preference or salty taste threshold is associated with dietary behaviors related to sugar consumption, correlation analyses were conducted while adjusting for sex and age (Table 5). Among the dietary behaviors related to sugar consumption, several items showed a positive

Table 3. Dietary behaviors related to sugar consumption by sex or age groups

Dietary behavior	Total	Sex		t (*P*-value)	Age groups[c]		t (*P*-value)
		Male	Female		Young adult	Middle-aged	
I usually eat my food sweetened.	2.40±0.92[a]	2.24±0.87	2.46±0.93	−1.158 (0.249)	2.55±0.96	2.21±0.83	2.189 (0.030)
I add syrup or sugar when I drink coffee.	1.72±1.01	1.70±1.02	1.72±1.01	−0.127 (0.899)	1.61±0.87	1.86±1.16	−1.467 (0.145)
I put a lot of jam or honey on bread or rice cakes.	2.22±1.10	2.33±0.96	2.18±1.14	0.702 (0.484)	2.43±1.18	1.93±0.92	2.686 (0.008)
I like to eat food with sweet sauces (e.g., tomato ketchup, honey, syrup, chocolate, etc.).	2.10±1.10	2.09±0.91	2.11±1.16	−0.081 (0.935)	2.34±1.18	1.79±0.89	2.948 (0.004)
I eat sweeter bread like red bean bread, cream bread, etc. than white bread.	2.65±1.21	3.03±1.19	2.52±1.20	2.112 (0.037)	2.92±1.24	2.29±1.08	3.071 (0.003)
I drink fruit juice more often than fresh fruit.	2.06±1.12	2.42±1.00	1.94±1.13	2.193 (0.030)	2.32±1.25	1.72±0.81	3.142 (0.002)
I drink processed milk more often than white milk.	1.92±1.19	1.76±0.87	1.97±1.28	−0.891 (0.374)	2.25±1.31	1.48±0.84	3.892 (<0.001)
I eat yogurt more often than milk.	2.30±1.23	2.09±0.91	2.37±1.31	−1.121 (0.264)	2.59±1.32	1.91±0.98	3.287 (0.001)
I drink soda or other beverages more often than water.	1.84±1.16	1.97±1.16	1.80±1.16	0.722 (0.471)	2.17±1.30	1.41±0.75	3.959 (<0.001)
I check the nutrition label for sugar content when I buy processed foods.[b]	3.71±1.37	3.82±1.24	3.67±1.41	0.526 (0.600)	3.53±1.48	3.95±1.18	−1.781 (0.077)
Total	22.90±6.24	23.40±4.76	22.70±6.66	0.568 (0.571)	24.70±6.57	20.60±4.92	4.017 (<0.001)

Values are presented as mean±standard deviation. *P*-values were calculated using Student's t-test for differences by sex or age groups.
[a]The 5-point Likert scale (strongly disagree=1, disagree=2, neutral=3, agree=4, strongly agree=5). [b]Reversely coded. [c]Young adults: 20–29 years; Middle-aged adults: 30–69 years.

Table 4. Frequency of sweet-tasting food consumption by sex and age groups

Category	Sweet-tasting foods	Total	Sex		t (*P*-value)	Age groups[b]		t (*P*-value)
			Male	Female		Young adult	Middle-aged	
Sugar-sweetened beverage	Carbonated drink	1.19±1.55[a]	1.89±2.00	0.95±1.30	3.175 (0.002)	1.64±1.74	0.63±1.06	4.001 (<0.001)
	Fruit juice/fruit-flavored drink	0.94±1.36	1.40±1.97	0.78±1.05	2.371 (0.019)	1.06±1.40	0.77±1.31	1.253 (0.213)
	Sports drink	0.42±0.93	0.86±1.33	0.28±0.70	3.285 (0.001)	0.58±1.09	0.23±0.64	2.289 (0.024)
	Yuza tea/Korean plum tea/rice punch	0.71±1.19	0.63±1.59	0.74±1.03	−0.468 (0.641)	0.53±0.96	0.94±1.40	−2.030 (0.044)
Confectionary	Candy	0.58±1.24	0.40±0.69	0.64±1.37	−1.009 (0.315)	0.73±1.44	0.40±0.91	1.541 (0.126)
	Caramel	0.22±0.67	0.29±0.89	0.20±0.58	0.638 (0.525)	0.22±0.58	0.23±0.78	−0.044 (0.965)
	Jelly	0.42±1.00	0.20±0.47	0.50±1.11	−1.543 (0.125)	0.60±1.25	0.21±0.48	2.308 (0.023)
	Chocolate	1.22±1.51	0.80±1.47	1.36±1.51	−1.899 (0.060)	1.48±1.63	0.89±1.29	2.337 (0.021)
Snack	Sweetened snack	1.37±1.55	1.46±1.63	1.34±1.52	0.398 (0.692)	1.83±1.70	0.79±1.10	4.171 (<0.001)
	Sweetened cereal	0.43±0.95	0.59±1.26	0.38±0.83	1.137 (0.258)	0.56±1.12	0.26±0.66	1.833 (0.069)
	Red bean bread, cream bread, etc.	0.75±1.00	1.03±1.15	0.65±0.93	1.935 (0.055)	0.77±1.06	0.73±0.93	0.236 (0.814)
	Cake/yellow sponge cake/ muffin	0.70±0.98	0.74±0.95	0.68±0.99	0.315 (0.754)	0.91±1.13	0.44±0.67	2.922 (0.004)
Sweetened milk & dairy products	Sweetened milk	0.62±1.13	0.83±1.32	0.54±1.06	1.293 (0.198)	0.87±1.30	0.31±0.78	2.992 (0.003)
	Yogurt drink	0.53±1.04	0.86±1.40	0.42±0.88	2.154 (0.033)	0.55±1.03	0.52±1.07	0.164 (0.870)
	Ice cream	0.71±1.07	0.69±0.96	0.72±1.11	−0.169 (0.866)	0.97±1.18	0.39±0.82	3.325 (0.001)
Dishes in sweet sauce	Marinated meat (bulgogi/ braised short ribs, etc.)	1.28±1.11	1.66±1.28	1.16±1.02	2.336 (0.021)	1.36±1.05	1.20±1.18	0.829 (0.409)
	Seasoned chicken	0.96±0.90	1.40±1.24	0.82±0.71	3.424 (0.001)	1.14±0.97	0.74±0.77	2.655 (0.009)
	Tteokbokki	0.94±1.06	0.97±1.10	0.93±1.05	0.186 (0.853)	1.21±1.20	0.61±0.75	3.408 (0.001)
Total		14.30±8.78	16.80±11.50	13.40±7.53	1.938 (0.055)	16.90±9.47	10.90±6.48	4.171 (<0.001)

Values are presented as mean±standard deviation. *P*-values were calculated using Student's t-test for differences by sex or age groups.
[a]Times per week. [b]Young adults: 20–29 years; Middle-aged adults: 30–69 years.

Table 5. Correlation of salty taste threshold and salty taste preference with dietary behaviors related to sugar consumption

Dietary behavior	r (*P*-value)	
	Threshold	Preference
I usually eat my food sweetened.	0.079 (0.369)	0.193 (0.027)
I add syrup or sugar when I drink coffee.	0.039 (0.660)	0.082 (0.347)
I put a lot of jam or honey on bread or rice cakes.	0.008 (0.925)	0.209 (0.016)
I like to eat food with sweet sauces (e.g., tomato ketchup, honey, syrup, chocolate, etc.).	0.072 (0.410)	0.262 (0.002)
I eat sweeter bread like red bean bread, cream bread, etc. than white bread.	0.106 (0.226)	0.078 (0.377)
I drink fruit juice more often than fresh fruit.	−0.036 (0.681)	0.254 (0.003)
I drink processed milk more often than white milk.	0.009 (0.914)	0.245 (0.005)
I eat yogurt more often than milk.	0.135 (0.123)	0.043 (0.626)
I drink soda or other beverages more often than water.	0.074 (0.401)	0.006 (0.949)
I check the nutrition label for sugar content when I buy processed foods.	−0.024 (0.783)	0.152 (0.081)
Total	0.085 (0.334)	0.280 (0.001)

P-values were calculated using partial correlation analysis adjusted for sex and age.

correlation with salty taste preference, including: 'I usually eat food sweetened', 'I put a lot of jam or honey on bread or rice cakes', 'I like to eat food with sweet sauces (e.g., tomato ketchup, honey, syrup, chocolate, etc.)', 'I drink fruit juice more often than fresh fruit', and 'I drink processed milk more often than white milk'. Furthermore, the total score of dietary behaviors related to sugar consumption was positively correlated with salty taste preference, suggesting that a stronger preference for salty tastes is associated with higher sugar consumption. In contrast, no significant relationship was observed between the salty taste threshold and dietary behaviors related to sugar consumption.

We also analyzed the correlation of salty taste preference and threshold with the consumption frequency of sweet-tasting foods, adjusted for sex and age (Table 6). Salty taste preference was positively correlated with the consumption of specific sweet-tasting foods, including jelly, cake/yellow sponge cake/

Table 6. Correlation of salty taste threshold and salty taste preference with frequency of sweet-tasting food intake

Category	Sweet-tasting foods	r (*P*-value)	
		Threshold	Preference
Sugar-sweetened beverage	Carbonated drink	0.036 (0.675)	0.133 (0.120)
	Fruit juice/fruit-flavored drink	−0.068 (0.429)	0.003 (0.972)
	Sports drink	−0.017 (0.840)	0.027 (0.757)
	Yuza tea/Korean plum tea/rice punch	−0.010 (0.905)	−0.001 (0.994)
Confectionary	Candy	0.020 (0.819)	0.158 (0.066)
	Caramel	0.103 (0.229)	−0.136 (0.113)
	Jelly	0.000 (0.997)	0.223 (0.009)
	Chocolate	0.066 (0.443)	0.089 (0.300)
Snack	Sweetened snack	−0.009 (0.913)	0.112 (0.192)
	Sweetened cereal	0.056 (0.515)	0.077 (0.372)
	Red bean bread, cream bread, etc.	0.093 (0.280)	0.057 (0.510)
	Cake/yellow sponge cake/muffin	−0.024 (0.784)	0.182 (0.033)
Sweetened milk & dairy products	Sweetened milk	0.143 (0.097)	0.029 (0.736)
	Yogurt drink	0.173 (0.044)	−0.002 (0.985)
	Ice cream	0.058 (0.499)	0.254 (0.003)
Dishes in sweet sauce	Marinated meat (bulgogi/braised short ribs, etc.)	0.120 (0.165)	−0.128 (0.140)
	Seasoned chicken	0.052 (0.545)	0.024 (0.784)
	Tteokbokki	0.095 (0.272)	0.171 (0.046)
Total		0.088 (0.317)	0.179 (0.040)

P-values were calculated using partial correlation analysis adjusted for sex and age.

muffins, ice cream, and tteokbokki. The salty taste threshold, however, was not significantly correlated with any sweet-tasting foods, except for yogurt drink. Furthermore, the preference for salty taste, but not threshold was positively associated with the total frequency of sweet-tasting food consumption, even after adjusting for sex and age (r=0.179, *P*=0.040). These findings underscore the potential influence of salty taste preference on sugar consumption behaviors.

DISCUSSION

In this study, we investigated dietary behaviors associated with sugar consumption and the frequency of sweet-tasting food intake among adults, stratified by sex and age groups. Additionally, we examined the correlation between salty taste recognition thresholds and preferences with sugar-related dietary behaviors and the frequency of sweet-tasting food intake. The findings revealed that age exerted a stronger influence on dietary behaviors related to sugar consumption and sweet-tasting food intake than sex. Specifically, young adults demonstrated a greater tendency to pursue and consume sweet-tasting foods compared to middle-aged individuals. Moreover, a higher preference for salty taste was significantly associated with elevated scores in dietary behaviors related to sugar consumption and more frequent sweet-tasting food intake. These results suggest a close link between a preference for salty taste and increased sugar consumption.

In this study, we demonstrated that salty taste preferences significantly influenced dietary behaviors related to sugar consumption, even after controlling for sex and age. Additionally, we found that a preference for salty taste was associated with the frequent consumption of sugar-rich snacks such as jelly, ice cream, and cake, likely contributing to increased overall sugar intake. This aligns with a recent study showing that habitual salt intake was positively correlated with more frequent consumption of sugar-containing foods among middle-school students [16]. Similarly, a study conducted in the US involving healthy children and their mothers [17] reported that the most preferred sucrose concentrations in water were significantly associated with the most preferred salt levels in broth for both children and mothers. Furthermore, dietary intake of added sugars was positively correlated with sodium intake. These findings corroborate our results, highlighting a strong relationship between salty taste preference and sugar consumption. They also suggest that modifying salty taste preferences may be an effective strategy for reducing sugar intake in adults.

In this study, we assessed participants' sensitivity to salty taste by measuring recognition thresholds using various concentrations of salt solutions. Interestingly, unlike the relationship observed with salty taste preference, no significant association was found between salty taste sensitivity and dietary behaviors related to sugar consumption. Taste acuity is known to be influenced by genetic predisposition [12,18-20] and may not directly correlate with taste preference [21]. For instance, frequent consumption of high-salt fast foods has been shown to enhance preferences for salty taste [22], suggesting that taste preferences are more closely linked to dietary habits than genetic factors.

The precise mechanism by which salty taste influences sugar intake remains unclear. Recent research by Yasumatsu et al. [23] identified a transduction pathway independent of the sweet taste receptor T1R2/T1R3 heterodimer. They demonstrated that a sodium-glucose cotransporter 1 (SGLT1) expressed in the apical membrane of sweet-sensitive taste cells plays a key role in detecting glucose-containing sugars in mice. Further research is needed to determine whether sodium-dependent sugar sensing mediated by SGLT1 also contributes to sweet taste perception in humans.

The assessment of salty taste thresholds and preferences using sensory testing in this study provides valuable insights as a proxy indicator for salt intake within populations. Although urinary sodium excretion is regarded as the gold standard for evaluating salt intake, its application is often limited in community-based studies due to its high cost and participant burden. Previous studies have shown that taste sensitivity and preferences can serve as reliable indirect markers for habitual dietary intake patterns [24,25], offering a feasible alternative for large-scale assessments. Similarly, the evaluation of dietary behaviors related to sugar consumption in this study provides valuable insights for estimating sugar intake. Direct measurement of sugar intake is challenging, primarily due to inaccuracies in nutrient databases, particularly concerning the sugar content of processed foods [26]. Consequently, dietary behavior questionnaires that are closely correlated with sugar consumption offer a practical and potentially more effective alternative for estimating sugar intake in population-based studies.

In our study, dietary behaviors related to sugar consumption and the frequency of sweet-tasting food intake were notably higher among the young adult group compared to the middle-aged group. In alignment with these findings, a recent study reported that the prevalence of US adults aged ≥19 years consuming more than 15% of total calories from added sugars was significantly lower among those aged ≥71 years compared to younger age groups [27]. The mean age of the middle-aged group in our study was 50.5 years, while that of the young adult group was 23.5 years. These results suggest that sugar consumption begins to decline earlier in adulthood, well before reaching older age. Supporting this, data from the KNHANES [5] revealed that the intake of sugar and its products is highest among adults in their 20s (11.3 g), gradually decreasing to 9.7 g, 8.0 g, and 5.8 g for individuals aged 30–49 years, 50–64 years, and ≥65 years, respectively.

Further, Lampuré et al. [28] found that age is inversely associated with a strong preference for sweet taste among French adults and reported that eating behaviors, such as cognitive restraint, uncontrolled eating, and emotional eating, also influence sweet taste preferences in both males and females. However, the relationship between sugar consumption and sex remains less clear, with conflicting results across studies [29]. In our study, the total scores for dietary behaviors related to sugar consumption did not differ significantly between males and females, although two out of ten questionnaire items scored higher among males. Certain types of foods, such as sugar-sweetened beverages, appear to be consumed more frequently by males than females, as observed in other studies [30,31].

The limitation of this study is the relatively small number of participants. However, the use of sensory evaluation to assess taste thresholds and preferences offers a significant advantage over large-scale surveys, which are unable to employ such measurements. Additionally, the inclusion of male and female participants spanning an age range from their 20s to their 60s provides a comprehensive perspective on salty taste preferences and their relationship to sugar intake across diverse demographic groups.

Further research is required to evaluate the impact of increased sugar intake associated with salty taste preferences on specific health parameters, such as BMI, blood lipid profiles, and other metabolic markers.

In conclusion, this study demonstrated a significant association between salty taste preference and dietary behaviors related to sugar consumption in adults. The findings provide valuable evidence of the interconnected nature of salty and sweet eating behaviors. These results could serve as a foundation for designing effective nutritional education strategies targeting adults, fostering a more integrated and efficient approach to modifying dietary behaviors and promoting healthier eating habits.

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AUTHOR CONTRIBUTIONS

Dr. Jayong CHUNG had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: JC. Methodology & Formal analysis: MN. Writing–original draft: MN and MY. Writing–review & editing: all authors.

CONFLICTS OF INTEREST

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

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DATA AVAILABILITY

The data presented in this study are available upon reasonable request from the corresponding author.

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Risk Factors for Dysfunctional Thinking about COVID-19 among Nurses Caring for Patients with COVID-19

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Abstract

Background: This study aims to identify factors influencing dysfunctional thinking about coronavirus disease 2019 (COVID-19) among nurses who have experience caring for COVID-19 patients.

Methods: A survey was conducted on a total of 152 nurses nationwide from March 11 to March 19, 2024. Data were analyzed using descriptive statistics, independent t-test, χ^2-test, or Fisher's exact test. Logistic regression analysis was performed to identify risk factors for dysfunctional thinking about COVID-19.

Results: There were 23 respondents (15.1%) with dysfunctional thinking about COVID-19. The posttraumatic growth score was 3.37±1.14. Risk factors influencing dysfunctional thinking about COVID-19 were age of 31 years or older (odds ratio [OR]=4.39, 95% confidence interval [CI]=1.30–14.87), chronic diseases of co-living family (OR=13.60, 95% CI=1.39–133.06), and nursing for confirmed patients within 1 month (OR=3.34, 95% CI=1.08–10.32).

Conclusions: This study identified risk factors that affect dysfunctional thinking about COVID-19 among nurses working in various-sized medical institutions in Korea. This is expected to be helpful for improving healthcare workers' psychosocial and environmental intervention during infectious disease pandemics in the future.

Keywords: COVID-19, Obsessive behavior, Psychological posttraumatic growth, Nurses

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a respiratory syndrome caused by SARS-CoV-2 infection that has spread rapidly around the world. The World Health Organization (WHO) declared a pandemic in March 2020, and South Korea downgraded the infectious disease classification of COVID-19 from level 1 to level 2 in April 2022 [1]. In May 2023, as the WHO lifted the 'Public Health Emergency of International Concern' for COVID-19, Korea also declared the end of the pandemic [2].

Personal hygiene has been emphasized since the COVID-19 pandemic, but this can increase the possibility of hypersensitivity, extreme behavior, obsessive-compulsive disorder, or worsen the disease [3]. Nurses reported anxiety, fear, stress, and depression about themselves, their family members, and acquaintances being infected or spreading COVID-19 [4]. This may lead to psychological obsession with COVID-19.

Obsession with COVID-19 refers to an individual's excessive and repetitive thoughts about COVID-19 [3]. Accordingly, a tool was developed to measure how much thoughts about

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COVID-19 occur while exposed to the ongoing COVID-19 pandemic [5]. This is an anxious thought that oneself or someone around oneself may be infected with COVID-19, and is related to anxiety, obsessive-compulsive disorder, and depression [6]. An international study reported that 19.4% of 248 doctors and nurses had problematic symptoms related to COVID-19 between October 2020 and May 2021 [7]. In a domestic study conducted on 137 nurses in August 2022, 14.6% were reported as potentially not thinking normally [8]. Although COVID-19 has been lowered to the 'alert' management level [2], healthcare institutions continued to receive confirmed COVID-19 cases. Therefore, nurses were exposed to COVID-19 at all times as they are performing COVID-19 infection control tasks in addition to their daily basic nursing duties. In other words, there is a need to identify factors affecting nurses' obsession with COVID-19, as they are likely to continue to treat COVID-19 patients even after the pandemic.

Posttraumatic growth (PTG) refers to positive psychological changes that an individual experiences after experiencing a traumatic event [9]. Most people who experience trauma do not show posttraumatic stress disorder, which is a negative outcome, and some show changes by experiencing PTG, which is a positive outcome [10]. In a domestic study, the PTG of nurses who cared for COVID-19 patients was 46.5 points out of 80 [11] and 37.0 points [12]. PTG may have positive effects on nurses who have experienced the COVID-19 pandemic, such as changes in cognition, interpersonal relationships, outlook on life, and optimism [13], which may affect the reduction of anxiety or fear of COVID-19 and thus reducing excessive and repetitive thoughts. However, the number of studies conducted is still small, and most studies were measured during the COVID-19 pandemic, so research is needed after the pandemic has ended.

Studies on obsession with COVID-19 or PTG are limited to a single hospital, making it difficult to generalize the results. In addition, it is thought that the degree of exposure to COVID-19 patients and the provision of protective equipment at each stage of the pandemic may differ depending on the type of medical institution. Therefore, this study was conducted to investigate the factors affecting post-pandemic obsession with COVID-19 among nurses working in medical institutions of various regions and sizes.

METHODS

Research design

This study was a descriptive research study that aimed to identify factors affecting obsession with COVID-19 among nurses who have experience caring for COVID-19 patients.

Participants

This investigation enrolled registered nurses from various clinical settings, including intensive care units, general wards, and emergency departments across national healthcare facilities. Eligible participants were those who had managed COVID-19 patients, comprehended the research objectives, and consented voluntarily to participate. Exclusion criteria included new nurses with less than 6 months of experience who were difficult to judge as being familiar with hospital work [14], nurses who had resigned from the medical institution at the time of the survey, and nurses in charge of education or administration who were not directly providing nursing care. A questionnaire was administered to 157 respondents, and a total of 152 respondents were analyzed after excluding five respondents with insufficient responses. In this study, the logistic regression model was finally calculated to have three significant independent variables, which met the requirement of 10 samples per independent variable, and the minimum sample size of 50 or more [15], therefore 152 was considered sufficient for the analysis.

Measures

General characteristics

General characteristics included sex, age, marital status, level of education, co-living family status and relationship, chronic diseases of the participants and cohabitant, length of employment, work area, hospital type, work unit, work shift type, and position.

Characteristics related to COVID-19 experience

Characteristics related to vaccination and diagnosis included mandatory COVID-19 vaccination, adverse reactions of vaccine, COVID-19 experience and symptoms, type and duration of isolation, and whether acquaintances were confirmed. Work-related characteristics included type of patient unit, number of COVID-19 patients and duration of nursing, unit transfer, COVID-19-related education before unit transfer, provision of adequate personal protective equipment, experience of caring emerging infectious diseases before COVID-19, willingness to participate in nursing emerging diseases in the future, turnover intention, and the experience of nursing for confirmed patients within 1 month.

Obsession with COVID-19 Scale

The Obsession with COVID-19 Scale (OCS), which was used to measure dysfunctional thinking, measures an individual's excessive and repetitive thoughts about COVID-19, and this study used a tool developed by Lee [5] and translated into Korean by Choi et al. [16]. Based on experiences over the past 2 weeks, the scale consists of four items, with a total score ranging from 0 (never) to 4 (almost every day for the past 2 weeks). The total score ranges from 0 to 16 and a higher score indicates more severe thoughts about COVID-19. A total score of 7 or higher indicates problematic symptoms and may require additional evaluation or treatment [16], which was defined as the dysfunctional thinking group in this study. This tool is made available to the public to encourage its use for clinical evaluation or research, and it is permitted to use the tool without official permission if the source is accurately cited. Cronbach's α in Lee [5] study was 0.83, and Cronbach's α in th is study was 0.84.

Post-Traumatic Growth Inventory

The Korea-Post Traumatic Growth Inventory (K-PTGI), which was validated by Song et al. [9] based on the Post-Traumatic Growth Inventory (PTGI) developed by Tedeschi and Calhoun [13], was used for measurement with the approval of both the original developer and the translator. The K-PTGI consists of 16 items in total, including six items on 'change in self-perception,' five items on 'increased depth of interpersonal relationships,' three items on 'discovery of new possibilities,' and two items on 'increased spiritual and religious interest.' It is a self-report questionnaire that measures the degree to which an individual agrees with positive changes after a traumatic experience. Each item is rated on a 6-point Likert scale from 0 (I did not experience this change) to 5 (I experienced it very much) regarding the degree of positive change. The total score for the 16 items ranges from 0 to 80, with a higher score indicating a higher degree of growth. Cronbach's α w as 0.92 in Tedeschi and Calhoun [13] study, and 0.94 in Song et al. [9] study, and in this study, Cronbach's α w as 0.93.

Data analysis

The collected data were analyzed using the SPSS ver. 28 program (IBM Corp.). The general characteristics of the subjects, characteristics related to the COVID-19 experience, OCS, and PTG were identified using frequencies, percentages, means, and standard deviations. The general characteristics, characteristics related to the COVID-19 experience, and PTG according to the two groups classified by whether the subjects' OCS scores were 7 or higher were analyzed using the t-test, χ^2-test, or Fisher's exact test, and the variables with *P*<0.1 [17] were entered into multivariate logistic regression analysis to identify risk factors.

Data collection and ethical considerations

This study received approval from the Institutional Review Board of Asan Medical Center (No. 2024-0328). A nationwide survey was conducted from March 11 to March 19, 2024, using an online platform, targeting nurses across various hospitals. Participants, after understanding the study's aim and method via the recruitment notice, provided informed consent electronically. The data obtained from the self-administered questionnaire, which required approximately 10 minutes to complete, were processed anonymously and utilized only for research purposes. Participants were provided with beverage vouchers through non-face-to-face method.

RESULTS

Dysfunctional thinking about COVID-19 and posttraumatic growth

In this study, 23 participants (15.1%) were categorized into the dysfunctional thinking group based on a total score of 7 or higher on the OCS. PTG was measured overall at 3.37±1.14 with subfactors including changed perception of self at 3.50±1.18, relationships with others at 3.46±1.21, new possibilities at 3.15±1.45, and spiritual-existential change at 3.06±1.69 (Table 1).

Comparison of general characteristics by groups according to dysfunctional thinking about COVID-19

In the comparison between the COVID-19 obsession group and the normal group, there were significant differences in being

Table 1. Scores of dysfunctional thinking about COVID-19 and posttraumatic growth (N=152)

Variable	Value
Dysfunctional thinking about COVID-19	0.89±0.73
No	129 (84.9)
Yes	23 (15.1)
Posttraumatic growth	3.37±1.14
Changed perception of self	3.50±1.18
Relation to others	3.46±1.21
New possibilities	3.15±1.45
Spiritual-existential change	3.06±1.69

Values are presented as mean±standard deviation or number (%).

over 30 years old (χ^2=6.39, *P*=0.011), marital status (*P*=0.007), co-living family with a chronic disease (*P*=0.025), and work shift type (χ^2=12.93, *P*=0.002) (Table 2).

Comparison of COVID-19-related characteristics by groups according to dysfunctional thinking about COVID-19

There were statistically significant differences between the COVID-19 obsession group and the normal group in terms of having received the mandatory COVID-19 vaccine (*P*=0.015), unit transfer (*P*=0.018), and nursing for confirmed patients within 1 month (χ^2=7.80, *P*=0.005) (Table 3).

Comparison of posttraumatic growth by groups according to dysfunctional thinking about COVID-19

There was no statistically significant difference in the PTG scores between the COVID-19 obsession and the normal

Table 2. Comparison of general characteristics by groups according to dysfunctional thinking about COVID-19 (N=152)

Variable	Category	Total	Non-dysfunctional thinking (n=129)	Dysfunctional thinking (n=23)	t/χ^2 (*P*)
Sex	Male	10 (6.6)	8 (6.2)	2 (8.7)	(0.648)[a]
	Female	142 (93.4)	121 (93.8)	21 (91.3)	
Age (yr)	≤30	83 (54.6)	76 (58.9)	7 (30.4)	6.39 (0.011)
	≥31	69 (45.4)	53 (41.1)	16 (69.6)	
Mean age (yr)		30.70±3.78			
Marital status	Yes	27 (17.8)	18 (14.0)	9 (39.1)	(0.007)[a]
	No	125 (82.2)	111 (86.0)	14 (60.9)	
Education	≤Bachelor	145 (95.4)	124 (96.1)	21 (91.3)	(0.286)[a]
	≥Master	7 (4.6)	5 (3.9)	2 (8.7)	
Co-living family	Yes	58 (38.2)	48 (37.2)	10 (43.5)	0.33 (0.569)
	No	94 (61.8)	81 (62.8)	13 (56.5)	
Parents	Yes	31 (20.4)	29 (22.5)	2 (8.7)	(0.166)[a]
	No	121 (79.6)	100 (77.5)	21 (91.3)	
Spouse	Yes	25 (16.4)	18 (14.0)	7 (30.4)	(0.066)[a]
	No	127 (83.6)	111 (86.0)	16 (69.6)	
Children	Yes	17 (11.2)	12 (9.3)	5 (21.7)	(0.141)[a]
	No	135 (88.8)	117 (90.7)	18 (78.3)	
Sibling	Yes	17 (11.2)	15 (11.6)	2 (8.7)	(1.000)[a]
	No	135 (88.8)	114 (88.4)	21 (91.3)	
Chronic diseases of respondents	Yes	6 (3.9)	4 (3.1)	2 (8.7)	(0.225)[a]
	No	146 (96.1)	125 (96.9)	21 (91.3)	
Chronic diseases of co-living family	Yes	5 (3.3)	2 (1.6)	3 (13.0)	(0.025)[a]
	No	147 (96.7)	127 (98.4)	20 (87.0)	
Total clinical career (yr)	<5	69 (45.4)	62 (48.1)	7 (30.4)	2.45 (0.118)
	≥5	83 (54.6)	67 (51.9)	16 (69.6)	
Current career (yr)	<3	88 (57.9)	77 (59.7)	11 (47.8)	1.13 (0.288)
	≥3	64 (42.1)	52 (40.3)	12 (52.2)	
Hospital type	Tertiary hospital	74 (48.7)	65 (50.4)	9 (39.1)	0.99 (0.320)
	General hospital	78 (51.3)	64 (49.6)	14 (60.9)	
Area	Seoul	87 (57.2)	71 (55.0)	16 (69.6)	2.09 (0.352)
	Metropolitan	45 (29.6)	41 (31.8)	4 (17.4)	
	Others	20 (13.2)	17 (13.2)	3 (13.0)	
Work unit	Medical ward	90 (59.2)	75 (58.1)	15 (65.2)	1.62 (0.805)
	Surgical ward	25 (16.4)	22 (17.1)	3 (13.0)	
	Emergency room	10 (6.6)	8 (6.2)	2 (8.7)	
	ICU	21 (13.8)	18 (14.0)	3 (13.0)	
	COVID isolation ward/ICU	6 (3.9)	6 (4.7)	0 (0.0)	
Work shift type	2-shift	12 (7.9)	6 (4.7)	6 (26.1)	12.93 (0.002)
	3-shift	135 (88.8)	118 (91.5)	17 (73.9)	
	Day shift	5 (3.3)	5 (3.9)	0 (0.0)	
Position	Staff nurse	140 (92.1)	120 (93.0)	20 (87.0)	(0.393)[a]
	≥Charge nurse	12 (7.9)	9 (7.0)	3 (13.0)	

Values are presented as number (%) or mean±standard deviation.
ICU, intensive care unit.
[a]Fisher's exact test.

Table 3. Comparison of COVID-19 related characteristics by groups according to dysfunctional thinking about COVID-19 (N=152)

Variable	Category	Total	Non-dysfunctional thinking (n=129)	Dysfunctional thinking (n=23)	t/χ^2 (*P*)
Mandatory COVID-19 vaccination	Yes	132 (86.8)	116 (89.9)	16 (69.6)	(0.015)[a]
	No	20 (13.2)	13 (10.1)	7 (30.4)	
Adverse reactions of vaccine	Yes	50 (32.9)	39 (30.2)	11 (47.8)	2.74 (0.098)
	No	102 (67.1)	90 (69.8)	12 (52.2)	
Experience of COVID-19	Yes	102 (67.1)	83 (64.3)	19 (82.6)	2.95 (0.086)
	No	50 (32.9)	46 (35.7)	4 (17.4)	
Symptoms of COVID-19	Yes	79 (52.0)	63 (48.8)	16 (69.6)	3.36 (0.067)
	No	73 (48.0)	66 (51.2)	7 (30.4)	
Types of isolation[b] (n=102)	Hospital	6 (5.9)	3 (3.6)	3 (15.8)	4.71 (0.095)
	Community treatment centers	3 (2.9)	2 (2.4)	1 (5.3)	
	Home	93 (91.2)	78 (94.0)	15 (78.9)	
Duration of isolation (day)[b] (n=102)		5.75±1.96	5.61±1.71	6.32±2.81	1.41 (0.161)
	≤5	72 (70.6)	59 (71.1)	13 (68.4)	0.05 (0.818)
	>5	30 (29.4)	24 (28.9)	6 (31.6)	
Confirmed case of acquaintance	Yes	87 (57.2)	73 (56.6)	14 (60.9)	0.15 (0.702)
	No	65 (42.8)	56 (43.4)	9 (39.1)	
Type of COVID-19 patient unit	Ward	89 (58.6)	77 (59.7)	12 (52.2)	4.86 (0.182)
	Emergency room	19 (12.5)	18 (14.0)	1 (4.3)	
	Intensive care unit	19 (12.5)	16 (12.4)	3 (13.0)	
	Community treatment centers	25 (16.4)	18 (14.0)	7 (30.4)	
Number of COVID-19 patients		10.42±6.42	10.30±6.25	11.09±7.37	0.54 (0.591)
Duration of nursing (mo)	<10	86 (56.6)	75 (58.1)	11 (47.8)	0.85 (0.358)
	≥10	66 (43.4)	54 (41.9)	12 (52.2)	
Unit transfer	Yes	16 (10.5)	10 (7.8)	6 (26.1)	(0.018)[a]
	No	136 (89.5)	119 (92.2)	17 (73.9)	
COVID-19 education before unit transfer	Yes	130 (85.5)	112 (86.8)	18 (78.3)	(0.332)[a]
	No	22 (14.5)	17 (13.2)	5 (21.7)	
Provision of adequate personal protective equipment	Yes	146 (96.1)	125 (96.9)	21 (91.3)	(0.225)[a]
	No	6 (3.9)	4 (3.1)	2 (8.7)	
Experience of caring emerging infectious disease	Yes	61 (40.1)	50 (38.8)	11 (47.8)	0.67 (0.414)
	No	91 (59.9)	79 (61.2)	12 (52.2)	
Willingness to participate in nursing emerging infectious disease	Yes	125 (82.2)	107 (82.9)	18 (78.3)	(0.562)[a]
	No	27 (17.8)	22 (17.1)	5 (21.7)	
Turnover intention	Yes	76 (50.0)	63 (48.8)	13 (56.5)	0.46 (0.497)
	No	76 (50.0)	66 (51.2)	10 (43.5)	
Nursing for confirmed patients within 1 month	Yes	48 (31.6)	35 (27.1)	13 (56.5)	7.80 (0.005)
	No	104 (68.4)	94 (72.9)	10 (43.5)	

Values are presented as number (%) or mean±standard deviation.
[a]Fisher's exact test. [b]The results were from 102 respondents who were isolated, 83 in the non-dysfunctional thinking and 19 in the dysfunctional thinking.

groups for both the overall and subfactors (Table 4).

Risk factors for dysfunctional thinking about COVID-19

Logistic regression analysis was performed to identify factors affecting dysfunctional thinking. Age, marital status, chronic diseases of co-living family, mandatory COVID-19 vaccination, adverse reactions of vaccine, experience of COVID-19, types of isolation, unit transfer, and nursing for confirmed patients within 1 month, which were found to have significant differences at a significance level of <0.1 between the characteristics of dysfunctional thinking, were entered using the backward LR (likelihood ratio) method. The regression model was statistically significant (χ^2=15.14, *P*=0.002), and the explanatory power was 22.3% as a Nagelkerke coefficient of determination. Hosmer-Lemeshow test indicated that the model fit was good (χ^2=2.01, *P*=0.571). The results of logistic regression analysis showed that age of 31 years or older (odds ratio [OR]=4.39, 95% confidence interval [CI]=1.30–14.87, *P*=0.018), chronic diseases of co-living family (OR=13.60, 95% CI=1.39–133.06, *P*=0.025), and nursing for confirmed patients within 1 month (OR=3.34,

Table 4. Comparison of posttraumatic growth by groups according to dysfunctional thinking about COVID-19 (N=152)

Variable	Non-dysfunctional thinking (n=129)	Dysfunctional thinking (n=23)	t (*P*)
Posttraumatic growth	3.33±1.17	3.57±0.99	−0.93 (0.353)
Changed perception of self	3.49±1.18	3.54±1.22	−0.17 (0.863)
Relation to others	3.42±1.24	3.70±1.03	−1.13 (0.267)
New possibilities	3.06±1.48	3.62±1.24	−1.71 (0.061)
Spiritual-existential change	3.02±1.74	3.28±1.36	−0.82 (0.420)

Values are presented as mean±standard deviation.

95% CI=1.08–10.32, *P*=0.036) were risk factors for dysfunctional thinking (Table 5).

Table 5. Multivariate logistic regression analysis for the group with dysfunctional thinking about COVID-19 (N=152)

Variable	OR	95% CI	*P*-value
Age (yr)	1		
≤30	1 (reference)		
≥31	4.39	1.30–14.87	0.018
Chronic diseases of co-living family			
No	1 (reference)		
Yes	13.6	1.39–133.06	0.025
Nursing for confirmed patients within 1 month			
No	1 (reference)		
Yes	3.34	1.08–10.32	0.036

CI, confidence interval; OR, odds ratio.

DISCUSSION

In this study, the mean OCS score was 0.89. In previous studies using the same measurement tool, the mean OCS score ranged from 0.80 to 5.18 depending on the respondents and time of the survey [7,8,18]. Although it is difficult to conclude due to the limited number of studies, it is likely that the proportion of nurses with excessive and recurrent thoughts about COVID-19 decreased as the COVID-19 pandemic gradually moved from a pandemic to a management phase. In this study, 15.1% of the subjects had an obsession with COVID-19, that is, had dysfunctional thoughts, which was similar to the previous study's 14.6–19.4% [7,8,18]. In a previous study targeting healthcare workers and trainees [19], nurses had the highest score among medical personnel. This reflects the nature of their work that performs infection control in the healthcare setting and cares for patients most closely. Therefore, it is necessary to understand the work of nurses, periodically measure OCS scores, identify the proportion of nurses with excessive COVID-19 thinking, and provide psychological support and job transitions for them.

In this study, the average PTG score was 3.37, which was higher than the average total score of 2.91 [11], 2.41 [20], and 1.76 [12] converted to the average score of previous studies using the same measurement frequency. Most of the previous studies were surveys conducted until 2022, so it is thought to be different from the infection control situation in medical institutions right before the crisis stage in which this survey was conducted was downgraded from the alert stage to the concern stage [21]. An individual's basic belief system may have changed in the process of caring for a significant number of COVID-19 patients for a long period [22]. In addition, it is thought that the PTG score increased as the repeated difficult situations under the pandemic gave rise to a new perspective through reflection [22].

As a result of analyzing the risk factors of the group with dysfunctional thinking through multivariate logistic regression analysis, age over 31 years, chronic diseases of co-living family, and nursing for confirmed patients within 1 month significant variables. In a previous study investigating the mental problems of healthcare workers [23], most of them included depressive symptoms, anxiety symptoms, and insomnia, and studies on obsession, which represents excessive thinking, were rare, making an accurate comparison difficult. In a previous study of the general population, the OCS score was higher in older people [18]. However, other studies targeting medical personnel did not reach significant conclusions about age [7,19]. Since previous studies were conducted during the COVID-19 pandemic and are thought to be different from this study conducted during the stabilization period, it is necessary to repeatedly study the OCS score according to the demographic characteristics of the subjects.

Although it was difficult to find studies that included the question of nursing for confirmed patients within 1 month, which was significant in the results of this study, there was a previous study that stated that nursing COVID-19 patients was correlated with obsessive thoughts, but no papers supporting this study result were found [7]. Most of the domestic and international studies were qualitative, asking nurses about their experiences while caring for patients, so it was still difficult to find results to support group differences in OCS scores. A study [24] that investigated the mental wellbeing of nurses during the COVID-19 pandemic stated that directly caring for confirmed patients causes fear, but providing clear instructions, information, and protective equipment was a factor that reduced fear. Based on the results of a previous study that OCS is positively correlated with COVID-19 anxiety [16], it can be thought that anxiety about caring for COVID-19 patients causes fear. Therefore, it is important to provide adequate protective gear and updated guidance as appropriate when caring for COVID-19 patients. Furthermore, repeated studies on the relationship between patient care situations and OCS are needed.

In this study, the mean scores for all factors of PTG were higher in the group with dysfunctional thinking, but this was not statistically significant. It was difficult to find articles that studied the relationship between COVID-19 and PTG, and a previous study of the relationship between psychosocial wellbeing and OCS scores in nurses who experienced the COVID-19 pandemic reported that higher OCS scores were associated with poorer psychosocial wellbeing [8], which contradicts these findings. The PTG scores in this study were measured after the end of the pandemic, and it is possible that multiple factors, such as strengthened infection control guidelines in medical institutions and changes in individual beliefs, may have had a complex effect. There is some variation in sample size between the two groups, which may have led to an insufficient number of significant variables [22]. Future studies with larger sample sizes using both OCS and other psychosocial health measures are warranted to explore differences.

This study investigated demographic characteristics, COVID-19-related characteristics, obsession with COVID-19, and PTG of nurses working in various medical institutions nationwide. The limitation of this study is that it did not identify the influence of institutional characteristics and PTG on obsession with COVID-19. However, by examining obsession with COVID-19 during the routine phase of the pandemic, this study provides foundational data that can be used as a basis for understanding the long-term effect of the pandemic and the effectiveness of related policies.

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AUTHOR CONTRIBUTIONS

Dr. Yeon-Hwan PARK had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: all authors. Data curation: HRC. Formal analysis: all authors. Investigation: HRC. Methodology: all authors. Writing–original draft: HRC. Writing–review & editing: all authors.

CONFLICTS OF INTEREST

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

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DATA AVAILABILITY

The data presented in this study are available upon reasonable request from the corresponding author.

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Effects of Sleep Duration on Prevalence of Metabolic Syndrome and Metabolic Syndrome Components in Korean Adults

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Abstract

Background: This study examines the impact of sleep duration on the incidence of metabolic syndrome in Korean adults.
Methods: A total of 11,721 participants (5,263 male 6,458 female) aged 19–64 years from the 8th Korea National Health and Nutrition Examination Survey were included. Sleep duration was categorized as less than 7 hours, 7 to less than 9 hours, and 9 or more hours. Metabolic syndrome was defined using the National Cholesterol Education Program Adult Treatment Panel-III criteria. Chi-square tests and logistic regression analysis were conducted to assess associations.
Results: The prevalence of metabolic syndrome was 28.4%, higher in male (34.4%) than female (23.6%). The average sleep duration was 6.79±1.75 hours. In male, sleeping less than 6 hours increased the risk of metabolic syndrome by 1.54 times (95% confidence interval [CI]: 1.30–1.82) and abdominal obesity by 1.51 times (95% CI: 1.29–1.77). In premenopausal female, sleep under 7 hours increased the risk of metabolic syndrome by 1.28 times (95% CI: 1.06–1.55) and abdominal obesity by 1.41 times (95% CI: 1.20–1.66).
Conclusions: Shorter sleep duration is linked to a higher risk of metabolic syndrome and abdominal obesity, highlighting the importance of adequate sleep for metabolic health.

Keywords: Sleep duration, Metabolic syndrome, Obesity

INTRODUCTION

The life expectancy of Koreans has steadily increased due to advancements in medical technology and improved living standards. However, the incidence of chronic diseases has risen due to factors such as stress, irregular eating habits, sleep disorders, and sedentary lifestyles. In particular, circulatory diseases and cancer have shown a marked increase, which is closely associated with metabolic syndrome. Metabolic syndrome is defined as a cluster of metabolic abnormalities, including abdominal obesity, hypertension, hyperglycemia, elevated triglycerides, and low high-density lipoprotein (HDL) cholesterol levels, and is known to significantly increase the risk of cardiovascular diseases and diabetes [1,2].

Over the past two decades, the prevalence of metabolic syndrome among Korean adults has increased from 27.1% to 33.2%. The rise has been particularly dramatic in male, where prevalence surged from 25.8% to 40.0%, primarily driven by increased abdominal obesity and hyperglycemia. These findings underscore the importance of early detection and prevention of

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metabolic syndrome [3].

Mental health and lifestyle factors play critical roles in the onset of metabolic syndrome, with sleep duration being a particularly important variable. Short sleep duration can stimulate the sympathetic nervous system, leading to increased heart rate and blood pressure, elevated secretion of cortisol—a stress hormone—and the exacerbation of insulin resistance and metabolic abnormalities [4-6]. Studies suggest that the relationship between sleep duration and the prevalence of metabolic syndrome follows a U-shaped curve, with both short and long sleep durations posing risks [7-9].

In female, menopause induces significant metabolic changes, increasing the risk of abdominal obesity, elevated triglycerides, and hyperglycemia. Consequently, the prevalence of metabolic syndrome rises sharply in postmenopausal female. This highlights the need for studies analyzing the relationship between sleep duration and metabolic syndrome while considering sex and physiological conditions [10,11].

This study utilized data from the 8th Korea National Health and Nutrition Examination Survey (KNHANES) to examine the association between sleep duration and the prevalence of metabolic syndrome in Korean adults. Specifically, it assessed the risks of short sleep duration (<6 hours) in male and compared the prevalence of individual metabolic syndrome components between premenopausal and postmenopausal female. The findings aim to provide a foundation for the development of preventive and management strategies for metabolic syndrome that account for sex and physiological differences.

METHODS

Study population

This study was conducted using data from the 8th KNHANES (2019–2021). Of the 22,559 participants in the KNHANES, individuals aged 18 years or younger and those aged 65 years or older (n=9,245) were excluded. Consequently, 13,314 adults aged 19 to 64 years were initially selected for analysis. Among these, 780 participants with missing data on sleep duration and 795 individuals with incomplete information required for the diagnosis of metabolic syndrome-such as blood pressure, blood glucose, triglycerides, HDL cholesterol, or waist circumference-were excluded. Additionally, 18 participants with missing occupational data were removed. Ultimately, a total of 11,721 participants (5,263 male and 6,458 female) were included in the final analysis (Fig. 1).

Variable definitions

Dependent variable

The dependent variable in this study was metabolic syndrome, defined based on the revised 2005 National Cholesterol Education Program Adult Treatment Panel-III criteria and the waist circumference thresholds suggested by the Korean Society for the Study of Obesity [12].

Metabolic syndrome was diagnosed if an individual met three or more of the following five criteria:

- Abdominal obesity: Waist circumference ≥90 cm for male and ≥85 cm for female.
- Hypertriglyceridemia: Triglycerides ≥150 mg/dL or currently taking medication for dyslipidemia.
- Hypertension: Systolic blood pressure ≥130 mmHg or diastolic blood pressure ≥85 mmHg, or currently taking antihypertensive medication.
- Low HDL cholesterol: HDL cholesterol <40 mg/dL for male and <50 mg/dL for female.
- Hyperglycemia: HbA1C ≥5.7% was used as an indicator instead of fasting blood glucose, and individuals taking diabetes medication were also included [13].

Independent variable

The independent variable was average daily sleep duration, measured based on the "weekday sleep duration" item from the

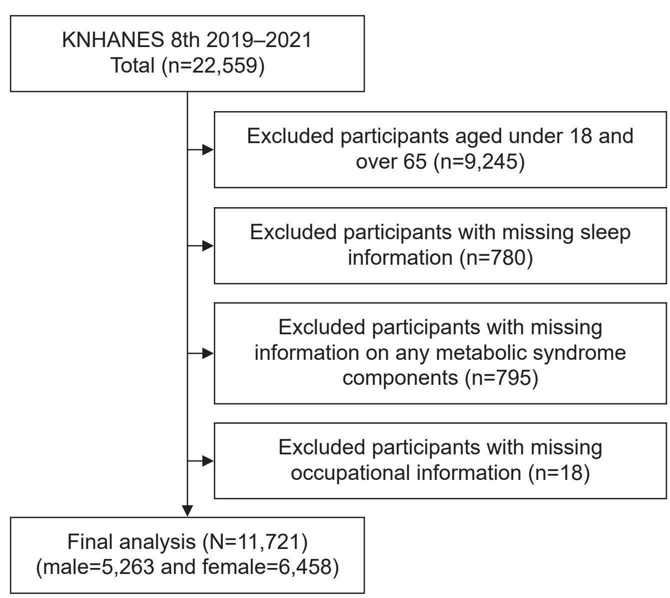

Fig. 1. Flow-chart for study participants selection. KNHANES, Korea National Health and Nutrition Examination Survey.

Mental Health section of the KNHANES (2019–2021). Participants were asked to report their average bedtime and wake-up time on weekdays, and these were used to calculate their daily sleep duration. For this study, sleep duration was categorized into three groups:

- Short sleep duration: Less than 7 hours.
- Optimal sleep duration: 7 hours to less than 9 hours.
- Excessive sleep duration: 9 hours or more [14,15].

For male, a further stratification was made to analyze the impact of very short sleep duration (<6 hours) on the risk of metabolic syndrome. This additional classification (less than 6 hours, 6 to less than 7 hours, 7 to less than 9 hours, and 9 hours or more) aimed to provide a more precise understanding of how short sleep duration affects the components of metabolic syndrome in male.

This classification was based on prior studies reflecting the characteristics of the Korean population and the guidelines recommended by the National Sleep Foundation in the United States [16].

Covariates

a. Sociodemographic Characteristics: Sociodemographic characteristics included sex, age, income level, and educational attainment, all of which were self-reported. Age was categorized into five groups based on the KNHANES data: 19–29 years, 30– 39 years, 40–49 years, 50–59 years, and 60–64 years. Marital status was classified as "single," "married," or "without a spouse" (separated, divorced, or widowed). Educational attainment was grouped into four categories: "elementary school graduate or lower," "middle school graduate," "high school graduate," and "college graduate or higher." Income level was divided into four groups: "high," "upper middle," "lower middle," and "low."

b. Health Behavior Characteristics: Health behavior characteristics included smoking status, alcohol consumption, physical activity, sleep duration, and obesity. Smoking status was classified into "non-smoker," "former smoker," and "current smoker," with non-smokers defined as those who had smoked fewer than 100 cigarettes in their lifetime. Alcohol consumption was grouped into three categories: "less than once per month," "1–4 times per month," and "twice or more per week." Physical activity was assessed based on the weekly accumulation of at least 150 minutes of moderate-intensity activity or 75 minutes of vigorous-intensity activity. Obesity was defined as a body mass index (BMI) ≥25 kg/m^2. For female, menopausal status (absence of menstruation for 12 consecutive months) was also considered.

c. Occupational Characteristics: Occupational characteristics included shift work status and average weekly working hours. Shift work was classified as either "daytime work" or "shift work." Daytime work referred to jobs performed exclusively during regular daytime hours, while shift work included evening work, night work, rotating shifts (including day and night rotations), 24-hour shifts, split shifts, irregular shifts, and any work schedule involving nighttime or non-daytime hours. Average weekly working hours were categorized as "40 hours or fewer" and "more than 40 hours."

Statistical analyses

Statistical analyses were conducted using SPSS version 29.0 (IBM Corp.), and the significance level was set at P<0.05. The specific analytical methods employed in this study were as follows:

First, descriptive statistics were performed to examine the general and health behavior characteristics of the study population. Frequencies and percentages were presented for categorical variables, while means and standard deviations were reported for continuous variables.

Second, chi-squared tests (χ^2-tests) were used to assess differences in the prevalence and statistical significance of metabolic syndrome and its components across sleep duration categories.

Third, logistic regression analysis was performed to evaluate the effect of sleep duration on the prevalence of metabolic syndrome. Odds ratios and 95% confidence intervals (CIs) were calculated to quantify the associations.

Ethics statement

This study was exempted from approval by the Institutional Review Board because this study was a secondary data analysis of existing data.

RESULTS

Metabolic syndrome by general characteristics

This study analyzed the prevalence of metabolic syndrome and its associated factors among 5,263 male and 6,458 female. The prevalence of metabolic syndrome was 34.4% in male and 23.6% in female, and it increased with age. The highest prevalence was observed in the 60–64 age group, with rates of 50.6% in male and 54.4% in female.

Shorter sleep duration was associated with a higher prevalence of metabolic syndrome. Among those sleeping less than 6 hours per night, the prevalence was 43.6% in male and 29.9% in female. Additionally, the prevalence of metabolic syndrome was significantly higher in individuals who were obese, had lower educational attainment, lower income, or no spouse. Lifestyle factors such as smoking, alcohol consumption, shift work, and working more than 40 hours per week were also associated with increased prevalence.

Among individuals who did not engage in regular exercise, the prevalence of metabolic syndrome was 39.1% in male and 25.8% in female. Obese individuals exhibited the highest prevalence, with 56.5% in male and 56.3% in female (Table 1).

Metabolic syndrome by sleep duration

In male, shorter sleep duration was associated with a higher prevalence of metabolic syndrome. The prevalence was 37.8% in male sleeping less than 7 hours, 31.9% in those sleeping 7

Table 1. Characteristics of the study population

Characteristic	Category	Male			Female		
		Metabolic syndrome		χ^2 (*P*)	Metabolic syndrome		χ^2 (*P*)
		Yes (n=1,809)	No (n=3,454)		Yes (n=1,521)	No (n=4,937)	
Age (yr)	19–29	117 (11.2)	930 (88.8)	434.81 (<0.001)	57 (5.5)	980 (94.5)	926.86 (<0.001)
	30–39	263 (26.9)	715 (73.1)		125 (10.7)	1,048 (89.3)	
	40–49	496 (39.8)	750 (60.2)		253 (16.1)	1,322 (83.9)	
	50–59	565 (44.7)	700 (55.3)		582 (33.3)	1,164 (66.7)	
	60–64	368 (50.6)	359 (49.4)		504 (54.4)	423 (45.6)	
Marital status	Single	334 (19.8)	1,355 (80.2)	241.68 (<0.001)	110 (8.1)	1,249 (91.9)	264.76 (<0.001)
	Spouse (+)	1,340 (40.6)	1,963 (59.4)		1,168 (26.3)	3,274 (73.7)	
	Spouse (–)	135 (49.3)	139 (50.7)		243 (37.0)	414 (63.0)	
Education	Elementary	99 (51.8)	92 (48.2)	66.48 (<0.001)	249 (60.9)	160 (39.1)	590.28 (<0.001)
	Middle	153 (50.3)	151 (49.7)		227 (45.0)	277 (55.0)	
	High	685 (32.4)	1,430 (67.6)		611 (24.3)	1,902 (75.7)	
	University	872 (32.9)	1,781 (67.1)		434 (14.3)	2,598 (85.7)	
House income	Low	164 (35.4)	299 (64.6)	6.35 (0.096)	210 (37.1)	356 (62.9)	111.04 (<0.001)
	Mid-low	411 (37.4)	689 (62.6)		425 (27.9)	1,096 (72.1)	
	Mid-high	535 (33.1)	1,079 (66.9)		455 (22.6)	1,562 (77.4)	
	High	699 (33.5)	1,387 (66.5)		431 (18.3)	1,923 (81.7)	
Weekday sleep (hr)	<6	362 (43.6)	468 (56.4)	44.01 (<0.001)	282 (29.9)	662 (70.1)	34.20 (<0.001)
	6 to <7	534 (34.8)	1,001 (65.2)		418 (25.0)	1,255 (75.0)	
	7 to <9	846 (31.8)	1,811 (68.2)		742 (21.8)	2,656 (78.2)	
	≥9	72 (28.5)	181 (71.5)		84 (18.7)	365 (81.3)	
Shift work	None	187 (33.0)	379 (67.0)	7.74 (0.021)	528 (27.8)	1,372 (72.2)	29.11 (<0.001)
	Daytime	1,379 (35.4)	2,519 (64.6)		841 (22.2)	2,945 (77.8)	
	Shift	243 (30.4)	556 (69.6)		152 (19.7)	620 (80.3)	
Working time (hr)	None	186 (33.0)	377 (67.0)	9.60 (0.008)	528 (27.8)	1,374 (72.2)	32.74 (<0.001)
	≤40	780 (32.5)	1,621 (67.5)		681 (20.8)	2,591 (79.2)	
	>40	843 (36.7)	1,456 (63.3)		312 (24.3)	972 (75.7)	
Smoking	Current	690 (37.0)	1,174 (63.0)	89.54 (<0.001)	99 (25.5)	289 (74.5)	0.84 (0.656)
	Former	728 (39.7)	1,107 (60.3)		89 (22.7)	303 (77.3)	
	Never	391 (25.0)	1,173 (75.0)		1,334 (23.5)	4,345 (76.5)	
Alcohol use (times)	<1	514 (35.5)	935 (64.5)	28.37 (<0.001)	974 (28.8)	2,409 (71.2)	108.33 (<0.001)
	1–4	632 (30.3)	1,454 (69.7)		394 (17.7)	1,831 (82.3)	
	≥5	663 (38.4)	1,065 (61.6)		153 (18.0)	697 (82.0)	
Physical activity	Yes	774 (29.6)	1,841 (70.4)	52.50 (<0.001)	587 (20.7)	2,249 (79.3)	22.88 (<0.001)
	No	1,035 (39.1)	1,613 (60.9)		934 (25.8)	2,688 (74.2)	
Menopause	Yes	-	-	-	902 (41.3)	1,281 (58.7)	578.16 (<0.001)
	No	-	-		619 (14.5)	3,656 (85.5)	
BMI (kg/m^2)	<25.0	439 (15.5)	2,401 (84.5)	978.33 (<0.001)	514 (11.0)	4,154 (89.0)	1,471.10 (<0.001)
	≥25.0	1,370 (56.5)	1,053 (43.5)		1,007 (56.3)	783 (43.7)	

Values are presented as number (%) with appropriate units unless stated otherwise.
BMI, body mass index.

to less than 9 hours, and 28.5% in those sleeping 9 hours or more (*P*<0.001). Abdominal obesity was most prevalent in male sleeping less than 7 hours (43.5%), followed by those sleeping 7 to less than 9 hours (37.1%) and those sleeping 9 hours or more (37.9%) (*P*<0.001). Similarly, hyperglycemia was most prevalent in male sleeping less than 7 hours (44.9%), compared to 40.4% in those sleeping 7 to less than 9 hours, and 29.6% in those sleeping 9 hours or more (*P*<0.001).

In female, shorter sleep duration was also associated with a higher prevalence of metabolic syndrome. The prevalence was 26.6% in female sleeping less than 7 hours, 21.8% in those sleeping 7 to less than 9 hours, and 18.7% in those sleeping 9 hours or more (*P*<0.001). Abdominal obesity was most prevalent in female sleeping less than 7 hours (29.9%), followed by those sleeping 9 hours or more (24.7%) and those sleeping 7 to less than 9 hours (22.6%) (*P*<0.001). Hyperglycemia was also most prevalent in female sleeping less than 7 hours (42.1%) (*P*<0.001) (Table 2).

Relationship between sleep duration and metabolic syndrome

Association between sleep duration and metabolic syndrome and its components

Logistic regression analysis revealed that in male, insufficient sleep (less than 7 hours) was associated with a 1.27-fold higher risk of metabolic syndrome (95% CI: 1.12–1.43) and a 1.29-fold higher risk of abdominal obesity (95% CI: 1.15–1.45) compared to optimal sleep duration (7 to less than 9 hours).

In female, insufficient sleep increased the risk of abdominal obesity by 1.34 times (95% CI: 1.19–1.52), but no significant association was observed with the overall risk of metabolic syndrome (Table 3).

Insufficient sleep was a significant common factor associated with increased risk of abdominal obesity in both male and female.

Association between metabolic syndrome and categorized sleep duration in male

When sleep duration was further categorized, male sleeping less than 6 hours exhibited a 1.54-fold higher risk of metabolic syndrome (95% CI: 1.30–1.82) compared to those with optimal sleep (7 to less than 9 hours). Additionally, this group showed the highest risk of abdominal obesity, with a 1.51-fold increase (95% CI: 1.29–1.77) (Table 4).

Prevalence of metabolic syndrome and its components before and after menopause

Postmenopausal female exhibited a metabolic syndrome prevalence of 41.3%, approximately 2.8 times higher than the 14.5% observed in premenopausal female. Among its key components, abdominal obesity increased from 20.5% before menopause to 35.9% after menopause, hypertension from 14.8% to 43.3%, and hyperglycemia from 24.2% to 64.3% (all *P*<0.001) (Table 5).

Notably, the prevalence of hyperglycemia showed the largest increase, with postmenopausal female exhibiting a prevalence

Table 2. Prevalence of metabolic syndrome and its components

Variable	Sleep duration			*P*-value
	<7 hr	7 to <9 hr	≥9 hr	
Male (n)	2,358	2,652	253	
Metabolic syndrome	891 (37.8)	846 (31.9)	72 (28.5)	<0.001
Central obesity	1,026 (43.5)	994 (37.1)	96 (37.9)	<0.001
High blood pressure	980 (41.6)	1,022 (38.5)	83 (32.8)	0.007
High triglyceride	1,094 (46.4)	1,180 (44.5)	99 (39.1)	0.060
Low HDL-cholesterol	523 (22.2)	573 (21.6)	53 (20.9)	0.834
Hyperglycemia	1,058 (44.9)	1,060 (40.4)	75 (29.6)	<0.001
Female (n)	2,611	3,398	449	
Metabolic syndrome	695 (26.6)	742 (21.8)	84 (18.7)	<0.001
Central obesity	780 (29.9)	768 (22.6)	111 (24.7)	<0.001
High blood pressure	728 (27.9)	755 (22.2)	94 (20.9)	<0.001
High triglyceride	726 (27.8)	874 (25.7)	102 (22.7)	0.037
Low HDL-cholesterol	761 (29.1)	992 (29.2)	130 (29.0)	0.994
Hyperglycemia	1,100 (42.1)	1,215 (35.8)	124 (27.6)	<0.001

Values are presented as number (%) with appropriate units unless stated otherwise.
HDL, high-density lipoprotein.

Table 3. Odds ratios of metabolic syndrome and its components

Variable	Sleep duration		
	<7 hr	7 to <9 hr	≥9 hr
Male (n)	2,365	2,657	253
Metabolic syndrome	1.27 (1.12–1.43)	Ref	1.10 (0.81–1.50)
Metabolic syndrome components			
Central obesity	1.29 (1.15–1.45)	Ref	1.23 (0.93–1.61)
High blood pressure	1.08 (0.96–1.22)	Ref	0.96 (0.71–1.30)
High triglyceride	1.04 (0.92–1.17)	Ref	1.00 (0.76–1.32)
Low HDL-cholesterol	1.02 (0.89–1.17)	Ref	1.03 (0.74–1.42)
Hyperglycemia	1.12 (0.99–1.27)	Ref	0.86 (0.62–1.19)
Female (n)	2,617	3,398	449
Metabolic syndrome	1.12 (0.98–1.27)	Ref	1.04 (0.79–1.38)
Metabolic syndrome components			
Central obesity	1.34 (1.19–1.52)	Ref	1.28 (1.00–1.63)
High blood pressure	1.11 (0.97–1.27)	Ref	1.27 (0.95–1.68)
High triglyceride	0.90 (0.80–1.03)	Ref	0.99 (0.76–1.29)
Low HDL-cholesterol	0.91 (0.81–1.02)	Ref	0.96 (0.76–1.21)
Hyperglycemia	1.07 (0.95–1.21)	Ref	0.92 (0.71–1.19)

Values are presented as odds ratio (confidence interval) with appropriate units unless stated otherwise. Adjusted for age, marital status, education, household income, shift work, working time, alcohol drinking, smoking status, physical activity, body mass index, high blood pressure, high triglyceride, low HDL-cholesterol, hyperglycemia only (menopausal status: female only).
HDL, high-density lipoprotein; Ref, reference.

Table 4. Odds ratios of metabolic syndrome and its components by four sleep duration in male

Variable	Sleep duration			
	<6 hr	6 to <7 hr	7 to <9 hr	≥9 hr
Male (n)	830	1,535	2,675	253
Metabolic syndrome	1.54 (1.30–1.82)	1.14 (0.99–1.31)	Ref	1.11 (0.81–1.51)
Metabolic syndrome components				
Central obesity	1.51 (1.29–1.77)	1.19 (1.04–1.35)	Ref	1.22 (0.93–1.61)
High blood pressure	1.11 (0.94–1.32)	0.96 (0.84–1.11)	Ref	0.97 (0.71–1.33)
High triglyceride	1.14 (0.96–1.35)	0.89 (0.82–1.07)	Ref	1.01 (0.76–1.35)
Low HDL-cholesterol	1.13 (0.93–1.36)	0.88 (0.75–1.03)	Ref	1.06 (0.76–1.47)
Hyperglycemia	1.12 (0.94–1.34)	1.12 (0.97–1.29)	Ref	0.86 (0.62–1.19)

Values are presented as odds ratio (confidence interval) with appropriate units unless stated otherwise. Adjusted for age, marital status, education, household income, shift work, working time, alcohol drinking, smoking status, physical activity, body mass index, high blood pressure, high triglyceride, low HDL-cholesterol, hyperglycemia only.
HDL, high-density lipoprotein; Ref, reference.

Table 5. Prevalence of metabolic syndrome and its components according to menopausal status

	Premenopause (n=4,275)	Postmenopause (n=2,183)	*P*-value
Metabolic syndrome	619 (14.5)	902 (41.3)	<0.001
Metabolic syndrome components			
Central obesity	875 (20.5)	784 (35.9)	<0.001
High blood pressure	631 (14.8)	946 (43.3)	<0.001
High triglyceride	767 (17.9)	935 (42.8)	<0.001
Low HDL-cholesterol	1,115 (26.1)	768 (35.2)	<0.001
Hyperglycemia	1,036 (24.2)	1,403 (64.3)	<0.001

Values are presented as number (%) with appropriate units unless stated otherwise.
HDL, high-density lipoprotein.

approximately 2.7 times higher than premenopausal female.

Association between sleep duration and metabolic syndrome in premenopausal and postmenopausal female

Logistic regression analysis was conducted to examine the relationship between sleep duration and metabolic syndrome and its components in premenopausal and postmenopausal female (Table 6).

In premenopausal female, insufficient sleep (less than 7 hours) was associated with a 1.28-fold higher risk of metabolic syndrome (95% CI: 1.06–1.55) and a 1.41-fold higher risk of abdominal obesity (95% CI: 1.20–1.66) compared to optimal sleep duration (7 to less than 9 hours).

In postmenopausal female, insufficient sleep was associated with a 1.26-fold higher risk of abdominal obesity (95% CI: 1.05–1.52) compared to optimal sleep.

In both premenopausal and postmenopausal female, insufficient sleep significantly increased the risk of abdominal obesity. However, the risk of metabolic syndrome increased with insufficient sleep only in premenopausal female.

DISCUSSION

This study analyzed the relationship between sleep duration and metabolic syndrome, considering sex and menopausal status, using data from the 8th Korea National Health and Nutrition Examination Survey (KNHANES, 2019–2021). The main findings revealed that shorter sleep duration significantly increased the risk of metabolic syndrome in male, with the highest risk observed in those sleeping less than 6 hours. Among female, the association between sleep duration and the components of metabolic syndrome differed based on menopausal status. These findings suggest that sleep duration is a critical factor in the development of metabolic syndrome and highlight the study's novelty in providing more detailed analysis by sex and physiological state compared to previous studies.

Shorter sleep duration increases the risk of metabolic syndrome due to physiological mechanisms such as sympathetic nervous system hyperactivation, increased cortisol secretion, and worsened insulin resistance. These mechanisms are well-documented in the literature and support this study's results that short sleep is associated with increased risks of metabolic abnormalities and abdominal obesity [1,6]. In particular, this study further subdivided male participants into a group sleeping less than 6 hours, revealing that very short sleep durations significantly exacerbate the risk of metabolic syndrome. Unlike most prior studies that dichotomized sleep duration into "short" and "adequate," this study offers insights into the specific risks posed by extremely short sleep durations [3,4].

The rapid increase in the risk of metabolic syndrome in post-

Table 6. Odds ratios of metabolic syndrome by sleep duration according to menopausal status

	Sleep duration		
	<7 hr	7 to <9 hr	≥9 hr
Premenopause (n)	1,613	2,316	349
Metabolic syndrome	1.28 (1.06–1.55)	Ref	1.11 (0.76–1.61)
Metabolic syndrome components			
Central obesity	1.41 (1.20–1.66)	Ref	1.33 (0.99–1.78)
High blood pressure	1.19 (0.98–1.45)	Ref	1.27 (0.87–1.87)
High triglyceride	0.91 (0.76–1.09)	Ref	1.00 (0.72–1.39)
Low HDL-cholesterol	0.93 (0.80–1.08)	Ref	0.96 (0.73–1.26)
Hyperglycemia	1.04 (0.88–1.23)	Ref	0.85 (0.61–1.18)
Postmenopause (n)	1,004	1,082	100
Metabolic syndrome	0.96 (0.82–1.18)	Ref	0.99 (0.65–1.54)
Metabolic syndrome components			
Central obesity	1.26 (1.05–1.52)	Ref	1.25 (0.81–1.94)
High blood pressure	1.03 (0.86–1.24)	Ref	1.31 (0.85–2.02)
High triglyceride	0.89 (0.74–1.07)	Ref	0.98 (0.64–1.51)
Low HDL-cholesterol	0.86 (0.72–1.04)	Ref	0.93 (0.60–1.46)
Hyperglycemia	1.10 (0.92–1.33)	Ref	1.05 (0.67–1.64)

Values are presented as odds ratio (confidence interval) with appropriate units unless stated otherwise. Adjusted for age, marital status, education, household income, shift work, working time, alcohol drinking, smoking status, physical activity, body mass index, high blood pressure, high triglyceride, low HDL-cholesterol, hyperglycemia only.
HDL, high-density lipoprotein; Ref, reference.

menopausal female is primarily attributed to decreased estrogen levels, which lead to changes in fat distribution and worsened insulin sensitivity. This study showed that premenopausal female with shorter sleep durations (<7 hours) had a 1.41-fold increased risk of abdominal obesity, while postmenopausal female exhibited a similar trend with a 1.26-fold increased risk. Notably, postmenopausal female demonstrated higher prevalence rates of metabolic syndrome components such as abdominal obesity, hypertension, and hyperglycemia. These findings suggest that short sleep durations can exacerbate metabolic abnormalities in postmenopausal female [7,8].

The observed prevalence of hyperglycemia in postmenopausal female is particularly noteworthy. This increase reflects physiological changes in postmenopausal female, such as worsened insulin resistance and impaired glucose regulation. Previous studies have identified these changes as major contributors to the heightened risk of metabolic syndrome in postmenopausal female. This study builds on these findings, demonstrating that short sleep durations may further increase the risk of hyperglycemia in this population. These results emphasize the importance of developing tailored preventive strategies for metabolic syndrome in postmenopausal female [9,10].

Compared to previous studies, this research has several significant strengths. First, it analyzed the relationship between sleep duration and metabolic syndrome by accounting for sex and menopausal status. While most prior studies either broadly examined the relationship or only divided participants by sex, this study provides a detailed comparison of metabolic syndrome prevalence rates and component-specific risks based on premenopausal and postmenopausal status. Second, it subdivided male's sleep durations to include a group sleeping less than 6 hours, providing a more precise analysis of the risks associated with very short sleep durations. This contrasts with prior studies that often defined short sleep as less than 7 hours. Third, this study used data from KNHANES, ensuring large-scale representativeness and high reliability through the use of the most recent data.

The findings of this study offer several important implications. First, for male, extremely short sleep durations (less than 6 hours) significantly increase the risk of metabolic syndrome. This highlights the need for education and interventions aimed at maintaining adequate sleep duration (7–9 hours). Second, for female, the risk factors for metabolic syndrome vary before and after menopause. Tailored management strategies considering menopausal status are essential, especially for postmenopausal female, where increased fat accumulation and decreased insulin sensitivity are major contributors to metabolic abnormalities. Third, this study demonstrates the importance of detailed categorization of sleep durations in assessing the risk of metabolic syndrome. Future studies should move beyond simple dichotomization of "short" and "long" sleep durations to include more precise classifications of very short sleep.

Despite its strengths, this study has several limitations. First, sleep duration was self-reported, which may lead to recall bias or under- or over-reporting. Second, this study focused solely on sleep duration without accounting for qualitative factors such as sleep disorders (e.g., insomnia, sleep apnea) or stress levels, which may influence the results. Third, the cross-sectional design limits the ability to determine causal relationships between sleep duration and metabolic syndrome. Future research should adopt longitudinal designs to address these limitations and incorporate multidimensional analyses, including qualitative assessments of sleep.

In conclusion, this study confirms that sleep duration significantly impacts the risk of metabolic syndrome and highlights the differences by sex and menopausal status. These findings provide critical evidence for the development of tailored strategies for the prevention and management of metabolic syndrome based on sex and physiological state.

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AUTHOR CONTRIBUTIONS

Dr. Byung-sun CHOI had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: all authors. Data curation: JP. Formal analysis: JP. Investigation: JP. Methodology: all authors. Writing–original draft: JP. Writing–review & editing: all authors.

CONFLICTS OF INTEREST

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

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DATA AVAILABILITY

The data presented in this study are available upon reasonable request from the corresponding author.

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Met Care Needs for Living and Life Satisfaction among Disabled Older People in the Community: Secondary Data Analysis Using the Disability Life Dynamic Panel Survey

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Abstract

Background: This study aimed to identify factors influencing life satisfaction with a focus on met or unmet care needs for living in older adults with disabilities.

Methods: This study analyzed the data of 2,220 disabled older people, using the fourth wave of the Disability Life Dynamic Panel Survey from the Korea Disables people's Development Institute. We used descriptive statistics, t-tests, ANOVA, Pearson's correlation coefficient, and multiple regression for our analyses.

Results: Social factors, employment status, and levels of depression influenced the life satisfaction of disabled older adults. Various social factors, including meeting social/leisure activity care need, having a higher number of close people, more frequent meetings with them, and engaging in social activities, significantly influenced better life satisfaction. This regression model explained 26% of the variance in life satisfaction.

Conclusions: This study highlights the influence of social factors, particularly the addressed social participation care needs, on the life satisfaction of older people with disabilities. Therefore, enhancing social networks and community-based programs is essential to help individuals sustain their social connections. Additionally, providing care to those who face challenges in participating will enable their ongoing engagement in social activities.

Keywords: Personal satisfaction, Health services needs and demand, Disabled persons, Aged

INTRODUCTION

As society ages, the prevalence of older adults with disabilities is steadily increasing. The Disability Survey by the Ministry of Health and Welfare indicated that those aged 65 and older represent 54.3% of the disabled population. This represents the highest percentage among all age groups with disabilities. This signifies an increase from 49.9% in 2020, underscoring the tendency to age within the disabled demographic [1]. Advanced age is associated with negative changes in physical, mental, and social functions, frequently resulting in a decline in quality of life and overall life satisfaction [2]. Older people with disabilities encounter compounded obstacles stemming from both age-related and disability-related issues, making them more vulnerable and requiring more social care [3].

A complex interaction of physical, social, and emotional fac-

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tors influences life satisfaction in older adults. Previous studies have shown that various elements, such as social support, depression, physical health, and the ability to engage in activities of daily living (ADL), greatly influence life satisfaction in older adults [4]. Among these, ADL [5] and social relationships [4,6] are two of the most important for life satisfaction.

The deterioration of daily living abilities in older adults increases dependency on others, which negatively influences both physical function and social connections. This frequently results in social isolation, depression, and a subsequent decline in quality of life [7]. Older people with disabilities encounter substantial and prolonged limitations in performing daily living [8]. Over 30% of individuals with disabilities reportedly require assistance with daily living, and over 40% consider their support insufficient [9]. As a result, older individuals with disabilities are more prone to reduced life satisfaction, underscoring the need for specific interventions.

Social factors are another critical determinant of life satisfaction in later life [4,6]. As individuals age, their social networks typically diminish [10]. Older individuals with disabilities face several challenges, including physical limitations, social isolation, depression, and other difficulties [11,12]. Such challenges have a particularly adverse influence on their life satisfaction. The findings indicate that supporting care needs for living and fostering social relationships play crucial roles in improving life satisfaction among older individuals with disabilities. While these factors are essential for promoting independent living and preserving physical and emotional well-being, research on the relationship between care needs for living and life satisfaction in older individuals with disabilities remains insufficient. Therefore, this study aims to identify whether the care needs for living are met in older individuals with disabilities (Aim 1) and to identify the factors influencing their life satisfaction, with a particular focus on met or unmet care needs for living (Aim 2).

METHODS

Study design

This study is a secondary analysis using the 4th wave of Disability Life Dynamic Panel Survey [13] to investigate the factors influencing life satisfaction, with a focus on met or unmet care needs for living for older individuals with disabilities.

Data and ethical considerations

The Korea Disabled People's Development Institute has performed the Disability Life Dynamic Panel Survey annually since 2018. It involves individuals who registered their disabilities with the Ministry of Health and Welfare from 2015 to 2017, along with their household members. Trained investigators conducted one-on-one, face-to-face interviews. In 2018, a panel of 6,121 participants was chosen to complete the first wave of the survey. Data can be acquired by submitting a request via the Disability Statistics Data Portal.

The participants in this study were 2,220 older adults aged 60 years and above who participated in the 4th survey conducted in 2021. This analysis included data that had no missing values for the key variables. This study was conducted with the approval from the Institutional Review Board (IRB) at the Gachon University (IRB No. 1044396-202410-HR-182-01).

Measurements

Life satisfaction

The overall life satisfaction was measured using a question with a 10-point Likert scale, ranging from "very dissatisfied=1" to "very satisfied=10."

Influencing factors

Met care needs for living were assessed as follows.

The presence of a caregiver was assessed using a question asking, "Who assists with your living?" In this study, we classified those who answered "none" as "no caregiver," while those who selected a spouse, parents, child, or others as "has caregiver."

Met care needs for living were measured using questions about the degree of care needs required and the actual level of care received in living activities (such as washing and personal hygiene, mobility, eating, dressing, healthcare, and social/leisure activity participation). The degree of assistance required was measured with the question, "Please indicate the types and levels of living activities where you need assistance," using a 4-point Likert scale from "no assistance needed=1" to "completely need assistance=4." The degree of actual assistance received was measured with the question, "What areas do you mainly receive help with?" using a Likert scale from "no assistance received=1" to "completely assisted=4." This study reclassified the items of washing and personal hygiene, mobility, eating, and dressing as ADL.

Met care needs for living were created by calculating the difference between the two questions (the degree of care needs required and the actual level of care received), categorizing as either "met" or "unmet." If the difference between the two questions was 0 or less, it was classified as "met," and if the difference was greater than 0, it was classified as "unmet." For ADL, if any of the four sub-items were unmet, it was classified as "unmet."

General characteristics include demographic and social factors. Demographic factors were measured using variables such as age, gender, education level, severity of disability, employment status, and depression. Depression was assessed using the Center for Epidemiological Studies-Depression Scale-11. This scale consists of 11 items rated on a 4-point Likert scale from "rarely or none=1" to "most or all of the time=4." The total score is calculated by summing the responses to the 11 items, with higher scores indicating greater levels of depression [14]. Social factors were measured by the number of close people, frequency of meetings, and participation in social activities. The number of close people was assessed by asking the question: "How many close friends, neighbors, and acquaintances do you have (people you can talk about personal concerns, family issues, and other matters)?" The frequency of meetings was measured with the question: "How often do you meet the friends, neighbors, and acquaintances mentioned above?" Participation in social activities was determined based on responses to questions about participation in activities such as religious activities, social gatherings, leisure activities, volunteer work, or political/organizational activities at least once a month. If the respondent answered "yes" to any of these activities, they were classified as "participation"; otherwise, they were classified as "no participation."

Data analysis

The general characteristics and status of care needs for living were analyzed using descriptive statistics. The characteristics of life satisfaction by general characteristics were identified using t-test and ANOVA. The relationships between depression, the number of close people, and life satisfaction were analyzed using Pearson's correlation coefficient. Multiple regression was used to identify factors influencing life satisfaction.

RESULTS

General characteristics

Among the participants, 54.3% were man, and 45.7% were woman. The highest proportion of participants (45.9%) were high school graduates or above. Approximately 78% of participants stated that they were not working at the moment. The average score of depression was 18.99, with 57.6% categorized as having mild disabilities. Regarding social factors, the average number of close persons was 2.06, and the most common frequency of meeting others was 1–2 times per year (33.7%). A total of 62.6% of participants responded that they did not engage in any social activities (Table 1).

Met care needs for living

Approximately 66.8% of the participants reported having a caregiver. The prevalence of those who met ADL care needs was 62.1%. For health care and social/leisure activity participation, 83.8% and 79.2% of participants reported receiving sufficient care, respectively (Table 1). Table 2 displays the degree of care needed and the actual level of care received for daily living. Among ADL items, the care needs were highest for eating (44.9%) and social/leisure activity participation (36.5%), followed by mobility (34.8%). Similarly, ADL items that received

Table 1. General characteristics (N=2,220)

Category	Subcategory	Value
Age (yr)	60–69	1,795 (80.9)
	≥70	425 (19.1)
Gender	Man	1,206 (54.3)
	Woman	1,014 (45.7)
Education level	≤Elementary	661 (29.8)
	Middle	540 (24.3)
	≥High	1,019 (45.9)
Employment status	Yes	481 (21.7)
	No	1,739 (78.3)
Depression (score range, 11–44)		18.99±6.25
Disability severity	Mild	1,278 (57.6)
	Severe	942 (42.4)
Number of close people		2.06±2.18
Frequency of meetings with close people	Nearly every day	113 (5.1)
	1–2 times a week	406 (18.3)
	1–2 times a month	618 (27.8)
	1–2 times every 3 months	335 (15.1)
	1–2 times or less per year	748 (33.7)
Social activities	Yes	831 (37.4)
	No	1,389 (62.6)
Caregivers	Yes	1,482 (66.8)
	No	738 (33.2)
Met care needs for activities of daily living	Met	1,379 (62.1)
	Unmet	841 (37.9)
Met care needs for healthcare	Met	1,861 (83.8)
	Unmet	359 (16.2)
Met care needs for social/leisure activity participation	Met	1,758 (79.2)
	Unmet	462 (20.8)
Life satisfaction (score range, 1–10)		5.32±1.86

Values are presented as number (%) or mean±standard deviation.

Table 2. Care needs for living (N=2,220)

	Washing and personal hygiene	Mobility	Eating	Dressing	Healthcare	Social/leisure activity participation
No care received	1,437 (64.7)	1,310 (59.0)	1,093 (49.2)	1,524 (68.6)	1,376 (62.0)	1,246 (56.1)
Rarely receive care	360 (16.2)	274 (12.3)	249 (11.2)	351 (15.8)	371 (16.7)	283 (12.7)
Some care received	268 (12.1)	386 (17.4)	609 (27.4)	242 (10.9)	324 (14.6)	437 (19.7)
Completely receive care	155 (7.0)	250 (11.3)	269 (12.1)	103 (4.6)	149 (6.7)	254 (11.4)
No requires care	1,232 (55.5)	1,064 (47.9)	796 (35.9)	1,351 (60.9)	1,184 (53.3)	1,001 (45.1)
Hardly requires care	480 (21.6)	384 (17.3)	429 (19.3)	491 (22.1)	522 (23.5)	410 (18.5)
Generally requires care	326 (14.7)	483 (21.8)	694 (31.3)	259 (11.7)	355 (16.0)	510 (23.0)
Completely requires care	182 (8.2)	289 (13.0)	301 (13.6)	119 (5.4)	159 (7.2)	299 (13.5)

Values are presented as number (%).

the highest actual level of care were eating (39.5%), mobility (28.7%), and social/leisure activity participation (31.1%).

Life satisfaction

The average score of life satisfaction was 5.32 (Table 1). Differences in life satisfaction according to the general characteristics are as follows (Table 3). Significant differences were found in gender (t=2.19, P=0.029), education level (F=12.73, P<0.001), employment status (t=12.21, P<0.001), and disability severity (t=8.76, P<0.001). The frequency of meetings with close people (F=71.25, P<0.001) and social activity participation (t=12.62, P<0.001) were significantly related to life satisfaction.

As for met care needs for living, having a caregiver (t=−4.10, P<0.001), met care needs for ADL (t=4.87, P<0.001), healthcare (t=3.48, P=0.001), and social/leisure activity (t=5.31, P<0.001) made significant differences in how satisfied older adults were with their lives (Table 3). Life satisfaction was negatively correlated with depression (r=−0.50, P<0.001). The number of close people was positively correlated with life satisfaction (r=0.30, P<0.001) (Table 4).

Factors influencing life satisfaction

Multiple regression was used to identify factors influencing life satisfaction. This regression model explained 26% of the variance in quality of life. The variance inflation factor values ranged from 1.08 to 3.48, all of which were below 10. This indicates that no multicollinearity problems exist among the predictor variables. The multiple regression analysis revealed that meeting social/leisure activity care needs led to higher life satisfaction (ß=0.04, P=0.018). Having a job (ß=0.12, P<0.001), lower levels of depression (ß=−0.37, P<0.001), a higher number of close people (ß=0.07, P<0.001), more frequent meetings with them (almost daily meetings: ß=0.15, P<0.001), and engaging in social activities (ß=0.09, P<0.001) were all associated with higher life satisfaction (Table 5).

DISCUSSION

This study was conducted to assess the met care needs for living and the factors affecting the life satisfaction of older individuals with disabilities in the community. This study revealed that the life satisfaction of older adults with disabilities was 5.32 out of 10, indicating a moderate level. This result is similar to previous studies on the life satisfaction of older individuals with disabilities, which reported a score of 3.22 out of 5 [3], but lower than the life satisfaction score of non-disabled older adults, recorded at 3.6 out of 5 [15]. However, the participants were older adults aged 60 or older, so there is a limitation in directly comparing the results with those of studies conducted on older adults aged 64 or older.

Various factors, such as social support, depression, physical health, and the ability to perform ADL, influence life satisfaction [4]. Previous studies indicate that social relationships [4,6], depression [16], and the ability to perform ADL [5] are significant factors influencing life satisfaction. People with disabilities face an elevated risk of encountering not only physical function limits but also social isolation [11] and depression [12], which may adversely affect their overall life satisfaction. Therefore, providing more opportunities for social participation and emotional support is necessary to improve the life satisfaction of individuals with disabilities.

In this study, the life satisfaction of older adults with disabilities also showed significant differences based on social factors, employment status, and depression. Specifically, the study revealed that various social factors significantly influence the life satisfaction of disabled older adults. An increased number of close friends, neighbors, or acquaintances, along with regular interactions and engagement in social activities, correlates positively with life satisfaction. This finding is consistent with previous studies, which indicated that life satisfaction rises with the frequency of contact with friends, family, and neighbors [4,6,17].

Table 3. Differences in life satisfaction according to the general characteristics (N=2,220)

Category	Subcategory	Mean±SD	t or F	*P*-value
Age (yr)	60–69	5.33±1.75	0.89	0.374
	≥70	5.24±1.92		
Gender	Man	5.40±1.90	2.19	0.029
	Woman	5.22±1.80		
Education level	≤Elementary[a]	5.08±1.77	12.73	<0.001
	Middle[b]	5.21±1.79		a=b≤c
	≥High[c]	5.53±1.93		
Employment status	Yes	6.20±1.54	12.21	<0.001
	No	5.07±1.86		
Disability severity	Mild	5.61±1.75	8.76	<0.001
	Severe	4.92±1.92		
Frequency of meetings with close people	Nearly every day[a]	6.17±2.09	71.25	<0.001
	1–2 times a week[b]	6.02±1.83		a=b>c=d>e
	1–2 times a month[c]	5.66±1.66		
	1–2 times every 3 months[d]	5.40±1.61		
	1–2 times or less per year[e]	4.49±1.78		
Social activities	Yes	5.94±1.72	12.62	<0.001
	No	4.95±1.84		
Caregivers	Yes	5.20±1.92	−4.10	<0.001
	No	5.54±1.71		
Met care needs for ADL	Met	5.47±1.82	4.87	<0.001
	Unmet	5.07±1.89		
Met care needs for health care	Met	5.38±1.83	3.48	0.001
	Unmet	5.01±1.96		
Met care needs for social/leisure activity participation	Met	5.42±1.86	5.31	<0.001
	Unmet	4.91±1.79		
post-hoc test: Duncan test				

ADL, activities of daily living; SD, standard deviation.

Table 4. Correlation among depression, the number of close persons, and life satisfaction (N=2,220)

Variable	r (*P*)		
	Life satisfaction	Depression	Number of close people
Life satisfaction	1		
Depression	−0.50 (<0.001)	1	
Number of close people	0.30 (<0.001)	−0.28 (<0.001)	1

Older adults often encounter a decline in social interactions and a decrease in social activities [10], and individuals with disabilities are more prone to experience greater social isolation compared to their non-disabled counterparts [11]. This study revealed a higher life satisfaction among those currently employed. Older adults view employment not only as an economic factor but also as a crucial element in enhancing social relationships [18]. Therefore, we expect older adults with disabilities to experience accelerated social isolation, which could lead to a higher risk of reduced life satisfaction. To improve life satisfaction, it is essential to provide tailored social participation programs for elderly individuals with disabilities and implement strategies to prevent social isolation by helping them maintain existing social relationships.

Furthermore, this study's findings suggest a close relationship between met care needs for living are and overall life satisfaction. A significant difference in life satisfaction existed based on whether care needs for living were met or unmet. Participants who met their care needs for social/leisure activities, ADL, and healthcare demonstrated higher life satisfaction compared to those who did not. The availability of support for social/leisure participation was recognized as an important factor influencing life satisfaction.

The percentage of participants who needed care to participate in social or leisure activities was higher than those who actually received care. The rate of unmet care needs for participation in social/leisure activity was also high. There are few studies addressing the issue of met care needs. The findings were similar

Table 5. Factors influencing life satisfaction (N=2,220)

Variable (reference)	Unstandardized coefficients		Standardized coefficients	t	*P*-value
	B	SE	ß		
Gender (woman)	0.06	0.06	0.02	0.98	0.329
Education level: middle (≤elementary)	−0.13	0.10	−0.03	−1.37	0.172
Education level: ≥high (≤elementary)	0.14	0.08	0.04	1.69	0.091
Employment status (no)	0.47	0.07	0.12	7.12	<0.001
Depression	−0.12	0.01	−0.37	−22.65	<0.001
Disability severity (severe)	0.19	0.06	0.05	3.07	0.002
Frequency of meetings: 1–2 times every 3 months (1–2 times or less per year)	0.18	0.12	0.04	1.57	0.116
Frequency of meetings: 1–2 times a month (1–2 times or less per year)	0.30	0.11	0.08	2.76	0.006
Frequency of meetings: 1–2 times a week (1–2 times or less per year)	0.68	0.11	0.16	6.03	<0.001
Frequency of meetings: nearly every day (1–2 times or less per year)	1.09	0.15	0.15	7.40	<0.001
Social activities (no)	0.34	0.06	0.09	5.72	<0.001
Number of close people	0.06	0.01	0.07	4.24	<0.001
Caregiver (yes)	−0.21	0.06	−0.06	−3.43	0.001
Met care need: ADL (unmet)	0.01	0.07	0.01	0.22	0.829
Met care need: healthcare (unmet)	−0.05	0.09	−0.01	−0.49	0.623
Met care need: social/leisure activity participation (unmet)	0.19	0.08	0.04	2.38	0.018
R^2=0.27, adjusted R^2=0.26, F (*P*)=70.02 (<0.001)					

ADL, activities of daily living; SE, standard error.

to the 27% unmet needs for social activities reported among community-dwelling older adults with dementia [19]. Such a high rate of unmet needs is likely to be a significant factor in reducing the life satisfaction of older individuals with disabilities.

As previously discussed, social participation plays a significant role in life satisfaction [2,20]. Enhancing their engagement in leisure activities or social participation could improve their life satisfaction. The fact that life satisfaction significantly increased when non-physical care, such as social/leisure participation, was adequately provided emphasizes the need for an integrated approach that supports overall living, not just physical care. This suggests that, in addition to meeting basic physical needs, social and emotional support play a crucial role in enhancing the life satisfaction of older individuals with disabilities.

Depression is an important influencing factor in this study. This shows similar results to previous studies, indicating that depression has an influence on life satisfaction [16]. This highlights the importance of managing depression in older adults. Since social activity support is known to play a key role in reducing depression [21], it would be crucial to promote social participation, which emerged as an important influencing factor in this study.

This study has several limitations. First, it did not consider the type of disability. Future research should examine the differences based on disability types and severity levels to identify factors influencing life satisfaction. Secondly, this study solely examined the existence or non-existence of a caregiver because it relied on secondary data. The quality of the relationship between caregivers and older adults may influence their life satisfaction, necessitating further research.

Additionally, we used secondary data in this study, categorizing the age in 10-year intervals. In this study, we defined older adults as over 60 years rather than over 65 years old. Comparing the findings of this study with those of other research presents a challenge. However, this study holds significance as it evaluates how the satisfaction of older adults with disabilities is influenced by their met care needs. Based on this study, the following recommendations are made: Firstly, we need to improve the quality of care for individuals. It is necessary to provide tailored support that reflects individual needs, going beyond physical assistance. In particular, care provision should focus not only on ADL but also on healthcare and social/leisure activity participation. Second, it is important to create an environment that fosters social relationships. We should activate community-based programs to prevent social isolation among older individuals with disabilities and strengthen their social networks. Furthermore, we should provide care to individuals who struggle with participation, ensuring their continued engagement in social activities for disabled older people.

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AUTHOR CONTRIBUTIONS

Dr. Young KO had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: all authors. Formal analysis: SYH. Writing–original draft: YK. Writing–review & editing: all authors.

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

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Public data was used, and the URL is https://koddi.or.kr/stat/html/user/main/main.

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Findings: In this meta-analysis of 15 randomized controlled trials, intermittent high-dose vitamin D supplementation showed no beneficial effect in the prevention of falls and fractures and even showed a harmful effect in the high-quality trials.

Meaning: Our findings support that intermittent high-dose vitamin D supplementation for the prevention of falls and fractures should be discouraged.

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If necessary, persons who have contributed to the article but whose contributions do not meet authorship standards may be appreciated through acknowledgment section. Clearly state their contributing role for acknowledgement. For example, data collection, financial support, statistical analysis, analysis of experiment, and so forth. Authors should notify that their names will be in the Acknowledgement and are responsible for obtaining permission from persons acknowledged.

Author Contributions
What authors have done for the study should be described in this section. To qualify for authorship, all contributors must meet at least one of the seven core contributions by CRediT (conceptualization, methodology, software, validation, formal analysis, investigation, data curation), as well as at least one of the writing contributions (original draft preparation, review, and editing).

The submitting author is responsible for completing this information at submission, and it is expected that all authors will have reviewed, discussed, and agreed to their individual contributions ahead of this time.

<Example>
Dr. MYUNG had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: SKM.
Data curation: SWO and YJC.
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Writing - review & editing: SKM, SWO, and YJC.

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