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# The Impact of Water Intake on Aiming Weight Control

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ABSTRACT

This study examines whether Korean adults have adequate water intake, and then how the adequate water intake is associated with aiming the goal for weight control based on the data of the Korea National Health and Nutrition Examination Survey (KNHANES) for 2019 - 2020. A total of 8,957 adults aged over 19 years participated in this study in consideration of demographic variables, health status, health behavior, and nutritional intake variables. A chi-square test was conducted to compare the differences in distribution of dependent variables according to independent variables, a logistic regression analysis including covariate was performed to analyze the relationships between the adequate water intake status and the achievement for aiming weight control, also a stratified analysis was used to determine the relationships between the adequate water intake status and the achievement for aiming weight control according to control variables. The results of above analyses are as follows. Only a little over half of Korean adults only have adequate water intake, the adequate water intake is associated with the aiming weight control, furthermore the adequate water intake from people being obesity or high physical activity is strongly associated with the aiming weight control. Thus, these results suggest it needs to encourage the water intake and this can be a strategy for the weight management.

## 1. Introduction

According to the 2022 report from the World Health Organization (WHO), compared to the 2000s, global life expectancy increased from 66.8 years to 73.3 years by 2019. Healthy life expectancy also rose from 58.3 years to 63.7 years. Deaths due to non-communicable diseases, the leading

cause of death, increased from 60.8% to 73.6% (WHO, 2022). Major risk factors for non-communicable diseases include overweight, obesity, lack of physical activity, unhealthy diet, smoking, and excessive alcohol consumption, all of which are linked to lifestyle choices. This suggests that prevention and management of non-communicable diseases are achievable through lifestyle changes (WHO, 2013). Implementing lifestyle interventions such as maintaining a healthy weight, adopting a healthy diet, and promoting adequate physical activity can bring about significant changes in addressing non-communicable diseases. Maintaining a healthy weight through dietary choices during adulthood forms the cornerstone of preventing non-communicable diseases and promoting healthy aging (Fontana et al., 2014).

Adequate fluid intake is generally recommended by experts as a weight management strategy (Chang et al., 2016; Goodman et al., 2013). The amount of fluid needed is determined by individual factors such as metabolic rate, body surface area, and weight (Chang et al., 2016). Several studies describe the relationship between weight management and adequate water intake, highlighting the necessity of proper hydration (Laja Garcia et al., 2019; Lee et al., 2014). However, studies analyzing fluid intake among citizens in countries such as South Korea (Han et al., 2021), the United States (Goodman et al., 2013), Spain (Nissensohn et al., 2016), and China (Zhang et al., 2019) report that a significant portion of the population consumes insufficient fluids. This deficiency in fluid intake can lead to increased consumption of high-calorie beverages like sugary drinks, raising the risk of obesity and causing health issues such as dehydration, low blood pressure, fatigue, muscle weakness, dizziness, and headaches (Zhang et al., 2019). Given these implications, experts advocate for initiatives to encourage adequate fluid intake to improve overall health (Goodman et al., 2013). In response, the United States has actively promoted water intake. Initiatives such as the “Let’s Move” campaign led by President Obama in 2010 highlighted drinking water as one of the easiest ways to enhance wellness and recommended increased water consumption (Ministry of Health and Welfare, 2018; Obama, 2013). Additionally, the USDA in 2011 provided free drinking water to students participating in the national school meal program, further encouraging water consumption (USDA, 2010). In contrast, South Korea lacks widespread national campaigns or public education programs focused on water intake. Given the importance of adequate fluid intake not only for weight management but also for health promotion (Goodman et al., 2013), there is a need to assess fluid intake levels, analyze their relationship with weight management, and promote water intake to enhance public health.

Based on a review of previous studies on fluid intake and weight management, several studies have been conducted domestically in South Korea. These studies have explored factors related to low fluid intake among adolescents (Lee et al., 2014), the health and nutritional status of underweight women in their 20s, establishment of fluid intake guidelines for Koreans (Lee & Kim, 2020), and the status of beverage and fluid intake among Korean adults (Han, 2021). However, these studies often have limitations such as restricted age groups and small sample sizes, making generalization of their findings challenging. Moreover, most studies focused on independent aspects of fluid intake or weight status, making it difficult to establish a clear association between fluid intake and weight management. In contrast, overseas research has more directly investigated the relationship between fluid intake and weight management. For instance, Pan

et al. (2013) found a negative correlation between increased water consumption (one additional cup per day over four years) and weight gain among U.S. adults. While this study had the advantage of long-term follow-up, its generalizability was limited as the majority of participants were educated Caucasian U.S. adults. Similarly, Vij and Joshi (2014) demonstrated weight loss effects when overweight women consumed more than 1.5 liters of water daily for eight weeks, although the study was limited by a relatively small sample size and lack of control over diet and physical activity. The scarcity of direct and specific studies on fluid intake levels and their impact on weight management globally (Pan et al., 2013) underscores the need for further research. Therefore, this study aims to assess whether Korean adults are consuming adequate amounts of fluids and analyze whether adequate fluid intake influences achieving weight management goals. By doing so, it seeks to provide foundational data for proposing health promotion policies and educational programs aimed at improving fluid intake and intervening in weight management from a health promotion perspective.

## 2. Methods

### *2.1 Research data and participants*

This cross-sectional study utilized data from the Korea National Health and Nutrition Examination Survey (KNHANES) VIII conducted during 2019-2020. KNHANES is a nationally representative survey conducted annually by the Korea Disease Control and Prevention Agency (KDCA), assessing the health status, health behaviors, food intake, and nutrition status of individuals aged 1 year and older. KDCA employs a two-stage stratified cluster sampling method to select households and survey areas, ensuring national representativeness. In 2019, 8,110 individuals and in 2020, 7,359 individuals participated in the survey, totaling 15,469 participants. For this study, adults aged 19 years and older were selected as participants. Respondents who did not provide responses regarding achievement of weight management goals and adequate fluid intake were excluded from the study. Additionally, respondents with missing data on other covariate variables included in the study were also excluded. Ultimately, a total of 8,957 participants were included in the final analysis. This study used publicly available secondary data and is not subject to research ethics review according to the ‘Enforcement Regulations of the Bioethics and Safety Act.

### *2.2 Variables*

#### *2.2.1 Dependent variable: achievement of weight management goals*

The type of weight management goal was categorized based on responses to the question: “Have you made efforts to control your weight in the past year by your own will?” Responses were categorized into weight loss, weight maintenance, and weight gain categories: “tried to reduce,” “tried to maintain,” and “tried to increase,” respectively. Weight change was determined based on responses to the question: “Have there been changes in your weight compared to the previous

year?" Responses were categorized into no change, weight loss, and weight gain categories: "no change," "weight decreased," and "weight increased," respectively.

The participants were classified into two groups:

- Yes (Achieved): Participants whose stated weight management goal type matched their actual weight change.
- No (Not Achieved): Participants whose stated weight management goal type did not match their actual weight change.

Participants who reported never having made efforts to control their weight were considered to have achieved their weight management goal if they reported no change in weight. This approach allowed for categorization of participants based on their self-reported weight management efforts and actual weight outcomes, providing insights into the achievement of weight management goals among the study population.

*2.2.2 Independent variable: adequacy of fluid intake*

The adequacy of water intake was categorized based on the '2020 Korean Dietary Reference Intakes' published by the Ministry of Health and Welfare and the Korean Nutrition Society (Ministry of Health and Welfare, 2020). The adequacy of daily water intake varies by gender and age group. For men, it is reported as 1,200ml for ages 19-49, 1,000ml for ages 50-74, and 1,100ml for those aged 75 and above. For women, it is reported as 1,000ml for ages 19-64, 900ml for ages 65-74, and 1,000ml for those aged 75 and above. According to age-specific recommendations for sufficient water intake, participants were classified into two groups:

- Below Adequate Intake: Participants whose reported water intake was below the recommended amount for their age group.
- Adequate Intake or Above: Participants whose reported water intake met or exceeded the recommended amount for their age group.

Participants' water intake was assessed using the 24-hour recall method during face-to-face interviews, specifically focusing on water intake excluding fluids from food or beverages. The recall period for this assessment was 24 hours prior to the interview, and participants were asked about their usual water consumption. Responses were recorded in cups (200ml each). Beverages like barley tea, omija tea, corn silk tea, etc., which contain negligible nutrients, were considered for assessing water intake. Herbal teas and other beverages with symbolic food characteristics were excluded unless they were brewed lightly and consumed throughout the day as a substitute for water. This categorization allowed for analyzing the association between fluid intake adequacy and the achievement of weight management goals among the study participants.

*2.2.3 Control variables*

Gender, age, marital status, area of residence, education level, household income, presence of chronic diseases, BMI (Body Mass Index), current smoking status, monthly alcohol consumption, physical activity (Metabolic Equivalent of Task), nutritional status, and energy intake

are covariates in this study. By categorizing these variables according to the Anderson model (predisposing, enabling, and need factors), the validity of the variable selection rationale can be ensured.

The age of the survey subjects was categorized by decade, with 19-year-olds included in the 20s group and those aged 70 and above included in one group. Gender was divided into male and female. Marital status was classified into the 'single' group for those who answered "no" to the question "Have you ever been married?" and into 'married/cohabiting' or 'separated/widowed/divorced' groups based on responses to a follow-up question, "What is your current marital status?" The area of residence was initially divided into 17 cities and provinces, then broadly categorized into 'metropolitan areas' and 'other regions'. Education level was divided into 'middle school or less', 'high school graduate', and 'college graduate or higher'. Household income was determined by calculating the total income of all household members over the past year, then dividing it into quartiles: low, lower-middle, upper-middle, and high. Chronic disease status was classified as 'yes' if the individual had any of the following conditions: hypertension, dyslipidemia, stroke, myocardial infarction, angina, osteoarthritis, rheumatoid arthritis, osteoporosis, tuberculosis, asthma, thyroid disease, diabetes, cancer, hepatitis, kidney disease, or gout, and 'no' if none of these conditions were present. BMI (Body Mass Index) was calculated by dividing weight by the square of height, with underweight defined as less than 18.5 $kg/m^2$, normal weight as 18.5-23 $kg/m^2$, overweight as 23-25 $kg/m^2$, and obesity as over 25 $kg/m^2$ (Burns & Gavey, 2004; WHO, 2013). Smoking status distinguished between current smokers and non-smokers. Monthly alcohol consumption was categorized as 'Yes' for those who reported drinking "at least once a month" over the past year and 'No' otherwise. Physical activity was assessed using the Metabolic Equivalent (MET) Score based on the intensity of activities (walking, moderate, and vigorous), the number of days per week, and the duration per day (in minutes), and then classified as low, moderate, or high. Nutritional status was evaluated using the Mean Nutrient Adequacy Ratio (MAR), with a score of 0.75 or above considered 'good' and below 0.75 considered 'poor'. Energy intake was measured as the total nutrient intake from all foods consumed in a day, determined through a 24-hour recall method.

### *2.3 Analysis methods*

We conducted chi-square tests to compare the distribution differences of achievement of weight control goals according to adequate water intake. Logistic regression analysis, including covariates, was performed to examine the association between adequate water intake and achievement of weight control goals. Stratified analysis was conducted to explore the association between adequate water intake and achievement of weight control goals based on controlled variables such as personal characteristics and health status. Statistical significance was verified at $p < 0.05$, and associations were presented using Odds Ratios (OR) and 95% Confidence Interval (CI). All statistical analyses were performed using SAS statistical software package version 9.4 (SAS Institute Inc., Cary, NC, USA).

## 3. Results

### 3.1 General characteristics

Table 1 presents the general characteristics of the study participants. Among the total of 8,957 participants, 3,289 (36.7%) consumed less than adequate amounts of water, while 5,668 (63.6%) consumed adequate or more. Regarding achievement of weight control goals, 4,237 (47.3%) participants achieved their goals, whereas 4,720 (52.7%) did not. Among those who consumed less than adequate water (3,289 participants, 36.7%), 1,508 (45.8%) achieved their weight control goals, and 1,781 (54.2%) did not. Among those who consumed adequate or more water (5,668 participants, 63.3%), 2,729 (48.1%) achieved their weight control goals, and 2,939 (51.9%) did not. Additionally, among the 1,618 participants aged 70 and above (18.1%), 951 (58.8%) achieved their weight control goals, while 667 (41.2%) did not. Among the 350 participants classified as underweight (3.9%), 210 (60%) achieved their weight control goals, and 140 (40%) did not.

**Table 1.** General characteristics

| Variables | Achievement of Target Weight Control | | | | | | |
|---|---|---|---|---|---|---|---|
| | Total | | Yes | | No | | p-value* |
| | N | % | N | % | N | % | |
| **Total** | 8,957 | 100.0 | 4,237 | 47.3 | 4,720 | 52.7 | |
| **Water Intake** | | | | | | | 0.1880 |
| Under Adequate | 3,289 | 36.7 | 1,508 | 45.8 | 1,781 | 54.2 | |
| Adequate | 5,668 | 63.3 | 2,729 | 48.1 | 2,939 | 51.9 | |
| **Sex** | | | | | | | 0.0015 |
| Male | 3,810 | 42.5 | 1,920 | 50.4 | 1,890 | 49.6 | |
| Female | 5,147 | 57.5 | 2,317 | 45.0 | 2,830 | 55.0 | |
| **Age** | | | | | | | <.0001 |
| 19-29 | 1,091 | 12.2 | 439 | 40.2 | 652 | 59.8 | |
| 30-39 | 1,245 | 13.9 | 490 | 39.4 | 755 | 60.6 | |
| 40-49 | 1,602 | 17.9 | 681 | 42.5 | 921 | 57.5 | |
| 50-59 | 1,686 | 18.8 | 794 | 47.1 | 892 | 52.9 | |
| 60-69 | 1,715 | 19.1 | 882 | 51.4 | 833 | 48.6 | |
| 70- | 1,618 | 18.1 | 951 | 58.8 | 667 | 41.2 | |
| **Marital Status** | | | | | | | <.0001 |
| Married | 6,108 | 68.2 | 2,976 | 48.7 | 3,132 | 51.3 | |
| Divorced/Widowed/ Separated | 1,289 | 14.4 | 639 | 49.6 | 650 | 50.4 | |
| Never Married | 1,560 | 17.4 | 622 | 39.9 | 938 | 60.1 | |
| **Residency Region** | | | | | | | 0.2982 |
| Metropolitan | 4,020 | 44.9 | 1,872 | 46.6 | 2,148 | 53.4 | |
| Else | 4,937 | 55.1 | 2,365 | 47.9 | 2,572 | 52.1 | |

Table 1. Cont.

| Variables | Achievement of Target Weight Control | | | | | | |
|---|---|---|---|---|---|---|---|
| | Total | | Yes | | No | | p-value* |
| | N | % | N | % | N | % | |
| **Education Level** | | | | | | | <.0001 |
| Middle School or Less | 2,512 | 28.0 | 1,354 | 53.9 | 1,158 | 46.1 | |
| High School | 3,006 | 33.6 | 1,375 | 45.7 | 1,631 | 54.3 | |
| Colloge or over | 3,439 | 38.4 | 1,508 | 43.8 | 1,931 | 56.2 | |
| **Household Income Level** | | | | | | | 0.0004 |
| Low | 1,637 | 18.3 | 883 | 53.9 | 754 | 46.1 | |
| Medium-Low | 2,226 | 24.9 | 1,077 | 48.4 | 1,149 | 51.6 | |
| Medium-High | 2,409 | 26.9 | 1,099 | 45.6 | 1,310 | 54.4 | |
| High | 2,685 | 30.0 | 1,178 | 43.9 | 1,507 | 56.1 | |
| **Chronic Disease** | | | | | | | 0.0008 |
| No | 4,391 | 49.0 | 1,964 | 44.7 | 2,427 | 55.3 | |
| Yes | 4,566 | 51.0 | 2,273 | 49.8 | 2,293 | 50.2 | |
| **BMI** | | | | | | | <.0001 |
| Underweight | 350 | 3.9 | 210 | 60.0 | 140 | 40.0 | |
| Normal | 3,431 | 38.3 | 1,940 | 56.5 | 1,491 | 43.5 | |
| Overweight | 2,054 | 22.9 | 1,017 | 49.5 | 1,037 | 50.5 | |
| Obesity | 3,122 | 34.9 | 1,070 | 34.3 | 2,052 | 65.7 | |
| **Smoking** | | | | | | | 0.1337 |
| No | 7,540 | 84.2 | 3,540 | 46.9 | 4,000 | 53.1 | |
| Yes | 1,417 | 15.8 | 697 | 49.2 | 720 | 50.8 | |
| **Alcohol Intake** | | | | | | | 0.0463 |
| No | 4,346 | 48.5 | 2,119 | 48.8 | 2,227 | 51.2 | |
| Yes | 4,611 | 51.5 | 2,118 | 45.9 | 2,493 | 54.1 | |
| **MET (Metabolic Equivalent)** | | | | | | | 0.2434 |
| Low | 5,252 | 58.6 | 2,529 | 48.2 | 2,723 | 51.8 | |
| Moderate | 2,118 | 23.6 | 983 | 46.4 | 1,135 | 53.6 | |
| Hight | 1,587 | 17.7 | 725 | 45.7 | 862 | 54.3 | |
| **Nutrient Intake Status** | | | | | | | 0.5410 |
| Good | 4,887 | 54.6 | 2,308 | 47.2 | 2,579 | 52.8 | |
| Bad | 4,070 | 45.4 | 1,929 | 47.4 | 2,141 | 52.6 | |
| **Energe Intake** | Mean | SD | Mean | SD | Mean | SD | p-value** |
| | 1.83 | 0.01 | 1.82 | 0.01 | 1.84 | 0.12 | 0.5051 |

* weighted chi-square test
** weighted t-test

### *3.2 Association between water intake and achievement of weight control goals*

Table 2 analyzes the association between water intake levels and the achievement of weight control goals. According to the analysis, the group consuming ‘adequate or more’ water had a 14% higher likelihood of achieving their weight control goals compared to the group consuming

'less than adequate' water (OR: 1.14, 95% CI: 1.02 - 1.26). Regarding age, individuals aged 70 and above were 85% more likely to achieve their weight control goals compared to those aged 19-29 years (OR: 1.85, 95% CI: 1.34 - 2.57). In terms of education level, participants with a middle school education or less were 24% more likely to achieve their weight control goals compared to those with a bachelor's degree or higher (OR: 1.24, 95% CI: 1.04 - 1.47). Regarding BMI, individuals classified as underweight were 59% more likely to achieve their weight control goals compared to those with normal BMI (OR: 1.59, 95% CI: 1.20 - 2.11).

**Table 2.** Association between water intake and achievement of weight control goals

| Variables | Achievement of Target Weight Control | |
|---|---|---|
| | OR | 95% CI |
| **Water Intake** | | |
| Under Adequate | 1.00 | - |
| Adequate | 1.14 | (1.02 - 1.26) |
| **Sex** | | |
| Male | 1.00 | - |
| Female | 0.63 | (0.55 - 0.72) |
| **Age** | | |
| 19-29 | 1.00 | - |
| 30-39 | 0.93 | (0.73 - 1.18) |
| 40-49 | 1.08 | (0.82 - 1.42) |
| 50-59 | 1.30 | (0.98 - 1.72) |
| 60-69 | 1.49 | (1.11 - 2.00) |
| 70- | 1.85 | (1.34 - 2.57) |
| **Marital Status** | | |
| Married | 1.00 | - |
| Divorced/Widowed/Separated | 0.90 | (0.76 - 1.05) |
| Never Married | 0.74 | (0.60 - 0.92) |
| **Residency Region** | | |
| Metropolitan | 1.00 | - |
| Else | 1.07 | (0.97 - 1.18) |
| **Education Level** | | |
| Middle School or Less | 1.24 | (1.04 - 1.47) |
| High School | 1.02 | (0.90 - 1.15) |
| Colloge or over | 1.00 | - |
| **Household Income Level** | | |
| Low | 1.05 | (0.88 - 1.26) |
| Medium-Low | 1.03 | (0.90 - 1.17) |
| Medium-High | 1.07 | (0.95 - 1.20) |
| High | 1.00 | - |
| **Chronic Disease** | | |
| No | 1.00 | - |
| Yes | 0.96 | (0.84 - 1.09) |

Table 2. Cont.

| Variables | Achievement of Target Weight Control | | |
|---|---|---|---|
| | OR | 95% CI | |
| **BMI** | | | |
| Underweight | 1.59 | (1.20 - | 2.11) |
| Normal | 1.00 | - | |
| Overweight | 0.62 | (0.55 - | 0.71) |
| Obesity | 0.31 | (0.27 - | 0.36) |
| **Smoking** | | | |
| No | 1.00 | - | |
| Yes | 1.08 | (0.93 - | 1.25) |
| **Alcohol Intake** | | | |
| No | 1.00 | - | |
| Yes | 0.95 | (0.85 - | 1.06) |
| **MET (Metabolic Equivalent)** | | | |
| Low | 1.04 | (0.91 - | 1.20) |
| Moderate | 1.03 | (0.88 - | 1.19) |
| Hight | 1.00 | - | |
| **Nutrient Intake Status** | | | |
| Good | 0.93 | (0.82 - | 1.05) |
| Bad | 1.00 | - | |
| **Energe Intake*** | 1.02 | (0.95 - | 1.10) |

* weighted multiple logistic regression

### *3.3 Association between water intake and achievement of weight control goals by gender, age, BMI, exercise, and nutrition*

Table 3 presents the results of stratified analysis to examine the association between water intake levels and achievement of weight control goals across various control variables. According to the analysis, across all age groups except for those in their 50s, there was a significant association between consuming ‘adequate or more’ water and achieving weight control goals. Specifically, individuals in their 30s who consumed ‘adequate or more’ water were 36% more likely to achieve their weight control goals (OR: 1.36, 95% CI: 1.03 - 1.78). Regarding BMI, individuals classified as obese were 22% more likely to achieve their weight control goals if they consumed ‘adequate or more’ water (OR: 1.22, 95% CI: 1.01 - 1.47). Exercise level showed a consistent association where individuals in the ‘adequate or more’ water intake group had higher likelihoods of achieving weight control goals regardless of exercise intensity. Particularly, individuals with higher exercise levels were 37% more likely to achieve their weight control goals (OR: 1.37, 95% CI: 1.06 - 1.76), indicating a strong association between increased exercise and both water intake levels and weight control achievement.

Table 3. Association between water intake and achievement of weight control goals by gender, age, BMI, exercise, and nutrition

| Variables | Achievement of Target Weight Control | | |
|---|---|---|---|
| | Under Adequate | Adequate | |
| | OR | OR | 95% CI |
| **Sex** | | | |
| Male | 1.00 | 1.15 | (0.98 - 1.35) |
| Female | 1.00 | 1.11 | (0.95 - 1.30) |
| **Age** | | | |
| 19-29 | 1.00 | 1.09 | (0.81 - 1.47) |
| 30-39 | 1.00 | 1.36 | (1.03 - 1.78) |
| 40-49 | 1.00 | 1.20 | (0.94 - 1.53) |
| 50-59 | 1.00 | 0.97 | (0.77 - 1.22) |
| 60-69 | 1.00 | 1.21 | (0.95 - 1.53) |
| 70- | 1.00 | 1.12 | (0.87 - 1.44) |
| **BMI** | | | |
| Underweight | 1.00 | 1.00 | (0.56 - 1.77) |
| Normal | 1.00 | 1.15 | (0.97 - 1.36) |
| Overweight | 1.00 | 1.00 | (0.80 - 1.26) |
| Obesity | 1.00 | 1.22 | (1.01 - 1.47) |
| **MET (Metabolic Equivalent)** | | | |
| Low | 1.00 | 1.04 | (0.90 - 1.21) |
| Moderate | 1.00 | 1.24 | (0.99 - 1.55) |
| Hight | 1.00 | 1.37 | (1.06 - 1.76) |
| **Nutrient Intake Status** | | | |
| Good | 1.00 | 1.11 | (0.96 - 1.27) |
| Bad | 1.00 | 1.17 | (1.00 - 1.37) |

## 4. Discussion

This study utilized the 2019-2020 Korea National Health and Nutrition Examination Survey data to investigate whether Korean adults are consuming adequate amounts of water. It aimed to analyze the association between water intake levels and the achievement of weight control goals, providing evidence to support health promotion policies and educational programs for encouraging sufficient water intake and interventions in weight management. The findings revealed that approximately 4 out of 10 Korean adults consume inadequate amounts of water, highlighting the need for nationwide encouragement of adequate water intake. Moreover, the study found that adults who consume adequate or more water are more likely to achieve their weight control goals compared to those who consume inadequate amounts, indicating a close relationship between sufficient water intake and successful weight control. Particularly, the obese group and the highly active group that consumed less than the recommended amount of water had a lower likelihood of weight control. However, when consuming

the recommended amount of water, they showed a higher likelihood of weight control, suggesting that water intake can be an effective intervention for weight management.

The statement discusses various findings from previous studies that support the benefits of adequate water intake in weight management. Studies (Laja Garcia et al., 2019; Pan et al., 2013; Vij & Joshi, 2014) have shown that consuming adequate amounts of water is helpful for weight loss, reducing BMI, and decreasing fat accumulation (Keller et al., 2003). Conversely, inadequate water intake has been associated with underweight, overweight, and obesity (Lee et al., 2014). These effects are attributed to water intake reducing the consumption of sugary and high-calorie beverages, thereby lowering overall energy intake (Pan et al., 2013). Furthermore, adequate water intake increases satiety, suppresses appetite (Vij & Joshi, 2014), stimulates sympathetic nervous system activity leading to increased metabolic rate and energy expenditure (Jordan et al., 1999; Pan et al., 2013; Vij & Joshi, 2014). For weight management and obesity prevention, sufficient water intake is crucial. While most previous studies have focused on weight maintenance and reduction, the promotion of healthy weight also involves gaining to achieve normal weight in underweight individuals. Although direct comparisons are challenging in the context of weight gain, sufficient water intake is associated with better body composition (Laja Garcia et al., 2019). It's noted that in cases of underweight, increased energy expenditure with adequate water intake can lead to weight gain (Kim et al., 2013), indicating that sufficient water intake may facilitate energy expenditure and ultimately support gaining to achieve normal weight.

These analyses suggest that interventions promoting adequate water intake could be an attractive strategy for weight control, emphasizing its potential benefits across various aspects of weight management and health promotion. The analysis conducted aimed to investigate whether there is a relationship between water intake levels as controlled variables and the achievement of weight control goals. It was found that the age, BMI, and level of physical activity of the study participants were associated with water intake levels. It was observed that adequate water intake above a certain threshold was associated with achieving weight control goals across all age groups, except for those in their 50s, where this association was not significant. Particularly high correlation was found in the 30s age group. As individuals age, dehydration symptoms tend to occur, necessitating increased water intake (Hooper et al., 2014). It is emphasized that beyond dehydration levels, especially for those in their 50s who face increased dehydration risks, the importance of adequate water intake should be underscored. It is recommended that active encouragement for hydration among those in their 50s be coupled with careful consideration when calculating "age-specific sufficient water intake" within the 'Korean Dietary Reference Intakes'. The highest correlation between achieving weight control goals and adequate water intake above a certain threshold in the 30s age group can be explained by prior studies analyzing stress perception rates among Koreans across their lifecycles (Jeon & Choi, 2017). It was found that the proportion of individuals perceiving stress as "very much" or "a lot" was highest among those in their 30s. Cortisol, a hormone secreted in response to stress, is associated with weight gain and increased abdominal fat (Hewagalamulage et al., 2016). Experimental studies measuring cortisol levels based on water intake levels (Kim & Lee, 2022) indicate that groups consuming more than adequate water daily showed significantly reduced cortisol levels compared to those who did not, and cortisol levels decreased after recovering

from underweight to normal weight. This suggests that adequate water intake may help alleviate stress in the 30s, aiding in achieving weight control goals. Furthermore, it was confirmed that for individuals classified as obese, consuming more than adequate water is most beneficial for achieving weight control goals compared to those with normal or underweight BMI (Foster et al., 1997). This finding reinterprets that more than adequate water intake is more closely associated with weight loss than weight maintenance or gain, possibly due to the increased dehydration risk with higher body weight (Rosinger et al., 2016). Studies have shown that consuming more than adequate water increases metabolic rates, leading to increased energy expenditure and aiding in weight and obesity management (Lubis et al., 2022; Pan et al., 2013; Vij & Joshi, 2014). In addition, in relation to physical activity, strong correlations were found between consuming more than adequate water and increased physical activity levels in achieving weight control goals. Increased physical activity increases sweating (Mallett et al., 2021), affects mechanisms regulating electrolyte balance in response to changes in body water content (Thornton, 2010), and maintains homeostasis in the body (Mallett et al., 2021), thereby increasing metabolic rates. Energy acquired by the body is consumed through physical activity, sweat-induced thermoregulation, or adaptive thermogenesis due to food intake (Kim et al., 2003). A change in body temperature by 1°C increases metabolic rates by 1.1 times, and during exercise, metabolic rates increase significantly due to increased catecholamine levels in the blood and enhanced respiratory rate (Kim et al., 2003). Exercise acts as physical stress, promoting secretion of stress hormones and experiments on the influence of water intake on stress hormones during prolonged exercise showed that groups not consuming water had significantly increased levels of adrenocorticotropic hormone, cortisol, epinephrine, and norepinephrine, whereas groups consuming adequate water did not, showing statistically significant differences. Thus, our study corroborates the strong association between high levels of physical activity and achieving weight control goals through adequate water intake. In summary, based on these findings, adequate water intake above a certain threshold is closely related to achieving weight control goals. Therefore, there is a need for intervention programs promoting water intake and governmental interventions. Particularly, more proactive management is required for weight loss among obese individuals and weight gain among underweight individuals.

This study holds significance as it analyzes the association between adequate water intake and weight control more directly, based on the nationally representative and reliable Korean National Health and Nutrition Examination Survey data. Therefore, the findings can be generalized to Korean adults aged 19 and above. It is pioneering in its approach, given the focus on ensuring the representativeness and reliability of Korean data, which is crucial for extrapolating results to the broader population. Moreover, while many studies domestically and internationally concentrate on overweight and obesity, primarily addressing weight maintenance or loss, this study stands out for addressing weight gain in underweight individuals, an area relatively under-researched. This distinctive focus contributes to the differentiation of this study from others. The findings of this research can serve as foundational evidence for health policies and educational programs encouraging adequate water intake and interventions in weight management, both domestically and internationally. Ultimately, it is hoped that this study will contribute to enhancing public health by providing evidence-based support for such initiatives.

However, this study has several limitations. Firstly, being a cross-sectional study utilizing data from the Korean National Health and Nutrition Examination Survey, the causal relationship between water intake levels and achieving weight control goals is unclear. Secondly, the analysis only used data from the initial two years of the ongoing 8th wave of the survey. In future research, it will be essential to complement this study by conducting clinical studies that can explain the causal relationship between water intake and achieving weight control goals. Additionally, once the 8th wave of the Korean National Health and Nutrition Examination Survey is completed, analyzing the entire dataset will provide more definitive results from the 8th wave and accumulating annual data thereafter will enrich the available information.

## 5. Conclusion

Water intake can significantly impact weight management. Especially for adults who are obese or have high levels of physical activity, recommending sufficient water intake can be used as an effective intervention for weight control. Therefore, health and wellness centers or hospitals can incorporate water intake as part of lifestyle care prescriptions. Since weight management forms the basis for preventing non-communicable diseases and promoting healthy aging, it is necessary to encourage water intake through nationwide campaigns and educational programs in schools, health centers, and other institutions to promote water consumption as part of weight management interventions. This underscores the need for proactive responses from relevant authorities to promote healthy weight management and contribute to improving public health.

## Conflicts Interest

No author has any other conflict of interest to declare.

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