



Centers for Disease  
Control & Prevention  
Republic of Korea

**ORIGINAL ARTICLE**

# Relationship Between Water Intake and Metabolic/Heart Diseases: Based on Korean National Health and Nutrition Examination Survey

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Received: April 28,  
2016  
Revised: June 30, 2016  
Accepted: August 22,  
2016

**KEYWORDS:**

drinking water,  
heart disease,  
KNHANES,  
metabolic disease,  
water intake

**Abstract**

**Objectives:** The aim of this study was to identify the correlation between adequate water intake and the prevalence of metabolic/heart diseases.

**Methods:** We analyzed the data from the 2012 Korea National Health and Nutrition Examination Survey. All participants were divided into Group Above Adequate Intake ( $n = 736$ ) and Group Below Adequate Intake ( $n = 4,819$ ) according to water intake. The thresholds were 1.8 L for men and 1.4 L for women based on the World Health Organization report findings. Logistic regression analyses were performed to verify the correlation between water intake and prevalence of hypertension, diabetes mellitus, dyslipidemia, myocardial infarction, and angina pectoris.

**Results:** There were significant differences between the two groups in terms of the following variables: age, smoking, alcohol, stress, dietary supplements, body weight, physical activity, total calorie intake, water intakes from food, and sodium intake. Participants in Group Above Adequate Intake showed a higher prevalence of hypertension [odds ratio (OR) = 1.22; 95% confidence interval (CI), 0.58–2.55], diabetes mellitus (OR = 1.38; 95% CI, 0.51–3.73), angina pectoris (OR = 0.94; 95% CI, 0.47–1.86), and myocardial infarction (OR = 5.36; 95% CI, 0.67–43.20) than those in Group Below Adequate Intake, whereas the latter showed a slightly higher prevalence of dyslipidemia (OR = 2.25; 95% CI, 0.88–57.84) than the former.

**Conclusion:** There was no statistically significant association between water intake and any of the metabolic/heart diseases. However, further studies on water intake are needed to confirm our findings.

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## 1. Introduction

Water (H<sub>2</sub>O), which accounts for approximately 60–70% of the weight of the human body, is essential for digestion, absorption, transfer, excretion, and circulation of biomolecules, as well as regulation of body temperature. If the body's water content decreases by 10%, physiological abnormalities can result, whereas a 20% water loss can result in death [1]. Accordingly, water is very significant, but consensus is lacking about adequate water intake (AI).

Studies have provided different calculations that consider various factors such as sex, age, weight, or climate [2]. Dietary Reference Intakes in the United States and Canada state that AI is 3.7 L/d for men and 2.7 L/d for women [3,4]. Approximately 81% of this fluid intake consists of drinking water, which equates to 3.0 L and 2.2 L for men and women, respectively, whereas the remaining 19% may be provided by food. The 2010 Dietary Reference Intake for Koreans, by contrast, provides lower AI levels, in which men and women are advised to drink 2.1–2.6 L/d and 1.8–2.1 L/d, respectively [5].

The Dietary Reference Intake references of Germany, Austria, and Switzerland depend on calorie consumption and suggest that seniors drink more water than male adults, who consume approximately 1 mL/kcal of water [6]. In fact, Westerterp et al [7] suggest an average AI of 1.14 mL/kcal or a range of 0.83–1.5 mL/kcal for elderly individuals.

A previous study suggested that AI consumption depends on weight, whereas Chernoff [8] argued that an adult should consume 30 mL of water/1 kg of weight or at least 1,500 mL/d. Skipper [9] provides another intake reference based on body weight, suggesting 100 mL/kg for the first 10 kg and 50 mL/kg for the next 10 kg. Beyond this point, an additional 15 mL/kg is suggested.

According to World Health Organization (WHO) reports, various factors such as climate and pregnancy as well as sex and age are considered in calculations of the required amounts of water to maintain hydration. Under standard conditions, the recommended daily AI is 1.0 L for children, 2.9 L for men, and 2.2 L for women. With increased physical activity or in hot temperatures, all lost fluids must be replaced. Approximately one-third of the recommended amount can be consumed through food [2].

The aim of this study is to examine the effectiveness of the daily recommended water intake in prevention of metabolic and heart diseases. We chose to study metabolic and heart diseases because a sufficient water level is known to control arginine vasopressin, a hormone that triggers blood vessel contraction [10]. This study was designed to analyze the projected correlation between the presence of the corresponding disease and a habit of drinking more water than recommended using the Korea National Health and Nutrition Examination Survey (KNHANES).

## 2. Methods

### 2.1. Study participants

This study used materials from the 3<sup>rd</sup> year of the fifth KNHANES project, which included the full months of January to December 2012. Among the 10,069 persons included in the 2012 KNHANES, 8,058 participated in at least two surveys (among national health, physical examination, and/or nutritional); of this total, 6,293 who were aged  $\geq 19$  years were selected as study participants.

### 2.2. Adequate water intake

This study used the reference of the report on Domestic Water Quantity, Service Level and Health by the WHO to determine AI. According to the WHO report, AI under standard conditions was 2.9 L/d for men and 2.2 L/d for women. One-third of water intake was consumed via food; thus, the remaining daily AI was 1,933.3 mL for men and 1,467.7 mL for women.

Water intake of the KNHANES was based on metering of 1 cup (200 mL). Therefore, this study assigned individuals aged  $\geq 19$  years who consumed  $>9$  cups (1,800 mL) and  $>7$  cups (1,400 mL) of water for men and women, respectively, into Group Above AI, and those who consumed  $<9$  cups (1,800 mL) and  $<7$  cups (1,400 mL) for men and women, respectively, into Group Below AI.

### 2.3. Study variables

The study aimed to examine the difference in prevalence between metabolic and heart diseases of Group Above AI and Group Below AI. The 2012 KNHANES included hypertension, dyslipidemia, diabetes mellitus, myocardial infarction, and angina pectoris. Prior to the prevalence examination, this study examined intergroup differences in factors that could potentially affect water intake, such as alcohol consumption, smoking, and physical activity. Logistic regression analysis was then used to investigate whether water intake affects the prevalence of metabolic and heart diseases.

Figure 1 shows an overview of the study.

### 2.4. Statistical analyses

The chi-square test was used to examine the following variables: age groups, sex, smoking, alcohol, stress, dietary supplements, hypertension, diabetes mellitus, dyslipidemia, myocardial infarction, and angina pectoris. The *t* test was used to examine weight, sleeping hours, severe physical activity, moderate physical activity, total calorie intake, water intake (cup), water intakes from food, and sodium intake.

A three-step logistic regression analysis model was used to examine the correlation between water intake with ailments such as hypertension, dyslipidemia, diabetes mellitus, myocardial infarction, and angina

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