Clin Nutr Res. 2018 Oct;7(4):291-296
https://doi.org/10.7762/cnr.2018.7.4.291
pISSN 2287-3732·eISSN 2287-3740

cnr
CLINICAL NUTRITION RESEARCH

Original Article

Effect of Pre-meal Water Consumption on Energy Intake and Satiety in Non-obese Young Adults

Ji Na Jeong

Department of of Health Management, Jeonju University, Jeonju 55069, Korea

Received: Jul 26, 2018
Revised: Sep 30, 2018
Accepted: Oct 3, 2018

Correspondence to
Ji Na Jeong
Department of Health Management, Jeonju University, 303 Cheonjam-ro, Wansan-gu, Jeonju 55069, Korea.
E-mail: naji2004@jj.ac.kr

ORCID iDs
Ji Na Jeong
https://orcid.org/0000-0003-1946-1387

Conflict of Interest
The author declares that they have no competing interests.

ABSTRACT

I determined whether water consumption reduces energy intake and affects satiety in non-obese young adults. The final subjects consisted of 15 individuals (8 women and 7 men) with average ages of 26.4 and 23.5 years for women and men, respectively. When subjects drank water before eating a test meal, they ate a lower amount of the test meal compared to eating test meals under waterless and postload water conditions (preload water: 123.3 g vs. waterless: 161.7 g or postload water: 163.3 g, $p < 0.05$). Water consumption after eating a test meal did not affect energy intake. When the subjects drank water before eating a test meal, despite consuming a lower amount, the subjects did not feel significantly less satiety than eating meals under waterless or postload water conditions. The finding that pre-meal water consumption led to a significant reduction in meal energy intake in young adults suggests that pre-meal water consumption may be an effective weight control strategy, although the mechanism of action is unknown.

Keywords: Water; Obesity; Energy intake; Satiation

INTRODUCTION

Obesity is a medical condition in which excess body fat has accumulated to the extent that it may bring negative effects on health. Obesity increases the risk of many physical and mental conditions [1]. These comorbidities are most commonly shown in metabolic syndrome, a combination of medical disorders which includes: diabetes mellitus type 2, high blood pressure, high blood cholesterol, and high triglyceride levels. Obesity is one of the leading preventable causes of death worldwide [2,3].

Increasing daily water consumption is widely recognized by the general public as a weight loss strategy [4]. Previous studies typically showed a reduction in energy intake when water was added to the diet [5,6]. Popkin and colleagues [7] reported that daily energy intake among habitual water drinkers in the general adult population was approximately 9% (194 kcal/day) less than those who did not drink water. There is a common belief among the public that water consumption suppresses hunger and reduce energy intake, and therefore water consumption is frequently recommended to facilitate weight control [8]. Recently, it was reported that water consumption has been found to reduce energy intake among non-obese

older adults, but not in younger adults [8,9]. These differences may be caused by age-related changes in gastrointestinal physiology and perceptions of satiety. The specific mechanism that is responsible for reduced energy intake after water consumption among older adults remains unknown, but it is suspected that delayed gastric emptying may contribute to promoting fullness and reducing hunger[8,10,11]. In this study, I determined whether water consumption reduces energy intake and affects satiety in non-obese young adults. I also observed whether water postload and preload had any effects on energy intake and satiety.

MATERIALS AND METHODS

Subjects were recruited via advertisement in a local newspaper. Recruited individuals were interviewed to ensure they met the following criteria: healthy, 20–30 years of age; body mass index (BMI) of 18–30 kg/m^2; not taking medication known to influence energy intake or appetite; not athletes in training; not pregnant or lactating; non-smokers; free from food allergies; stable in weight in the past 6 months; and not on a diet to gain or lose weight. The Eating Attitudes Test [12], which measures attitudes towards foods and eating, and the Zung Self-Rating Questionnaire [13], which assess symptoms of depression were also included in the criteria. Volunteers who scored less than 20 on the Eating Attitudes Test and less than 42 on the Zung Self-Rating Questionnaire were selected for participation. The study was approved by the Ethical Committee for Human Experimentation, Jeonju University, and was conducted in accordance with the Committee's rules and regulations (jjIRB-160919-HR-2016-0904). Before commencing study, subjects' height was measured using the DS-102 (Jenix Co., Seoul, Korea); their weight and body composition (body fat and lean body mass) were measured using the InBody 770 (Biospace Co., Seoul, Korea) while wearing light clothing. BMI (kg/m^2) was calculated as body weight (kg)/[height (m)]^2. Blood pressure was measured in a standardized fashion using a BP203RV blood pressure monitor (Colin, Komaki, Japan).

The experiment was a randomized cross-over design. Subjects came to the laboratory on three separate days and were asked to keep their evening meals and activity levels as similar as possible on the days prior to each test day. They were also instructed to refrain from consuming any foods or energy-containing beverages before a test meal. Subjects reported to the laboratory for three test meals (Jeolpyeon, 500 g) in random order as follows: 1) without water, 2) with water (300 mL) before a test meal (water preload), and 3) with water (300 mL) after a test meal (water postload). Jeolpyeon is a type of Korean steamed rice cake made of non-glutinous rice flour. One piece of Jeolpyeon (20 g) contained 44 kcal, 9.56 g of carbohydrates, 0.16 g of fat, and 0.86 g of protein. Large servings (20 pieces or 400 g) were provided to ensure that the amount of food served does not limit food intake. Subjects were instructed to eat as much or as little of a meal as they desired. The test meal was provided between 9:00 am and 10:00 am as breakfast. Each test meal was weighed after serving to determine the amount consumed to within 0.1 g. Subjective satiety and thirst were measured by a conventional 100 mm visual analogue scale (VAS) rating. Subjects completed this rating 6 times: immediately before and after the meal, then every half-hour for 2 hours after the meal. Subjects rated how hungry or thirsty they felt by marking a cross on a scale of 0 to 100 mm. On the scale, 0 represented ‘not at all’ whilst 100 represented ‘very much.’ The pleasantness was also assessed using an additional 100 mm VAS prior to consumption. All statistical analyses were conducted using a repeated measure analysis of variance with one within subject factor and Bonferroni-adjusted pairwise comparisons entered into the SPSS program (ver. 12.0; SPSS Inc., Chicago, IL, USA). The results are reported as means ± standard error of the mean. Differences in means were considered significant at $p < 0.05$.

https://doi.org/10.7762/cnr.2018.7.4.291

Table 1. Subject characteristics

Characteristics	Subjects (n = 15)	
	Women (n = 8)	Men (n = 7)
Age, yr	26.4 ± 2.2	23.5 ± 1.7
Height, cm	160.4 ± 2.7	172.3 ± 2.9
Weight, kg	53.2 ± 4.9	65.4 ± 4.2
Body mass index	20.4 ± 3.7	21.9 ± 3.4
Systolic blood pressure, mmHg	117.8 ± 8.3	133.9 ± 5.6
Diastolic blood pressure, mmHg	71.8 ± 3.8	75.6 ± 3.2
Pulse, beats/min	95.8 ± 5.9	92.2 ± 4.4
Eating attitude score	12.4 ± 3.2	9.8 ± 1.6
Depression score	39.4 ± 4.3	38.7 ± 3.7

Values are mean ± standard error of the mean for 15 subjects. Eating attitude score was assessed by the Eating Attitude Test; Depression score was assessed by the Zung Self-Rating Questionnaire.

RESULTS

The subjects' characteristics are provided in **Table 1**. Sixteen adults were selected for participation in the study. One subject failed to complete the study. Thus, the final subjects consisted of 15 individuals (8 women and 7 men) with average ages of 26.4 and 23.5 years for women and men, respectively. The women had average heights and weights of 160.4 cm and 53.2 kg, respectively, whilst the men had average heights and weights of 172.3 cm and 65.4 kg, respectively. In addition, the mean scores for eating attitudes were 12.4 and 9.8 points for women and men, respectively, whilst the depression scores were 39.4 and 38.7 points for women and men, respectively. When subjects were asked to rate the pleasantness of the meal's taste, they indicated no significant differences among the 3 test meals (data not shown). **Figure 1** shows the consumption volume of test meals served with or without water. Subjects ate less of a test meal when they had imbibed water prior to eating, compared with waterless or postload water conditions (preload water: 123.3 g vs. waterless: 161.7 g or postload water: 163.3 g, $p < 0.05$). Water consumption after a test meal did not affect energy intake. Subjective satiety and thirst ratings on the test meals served

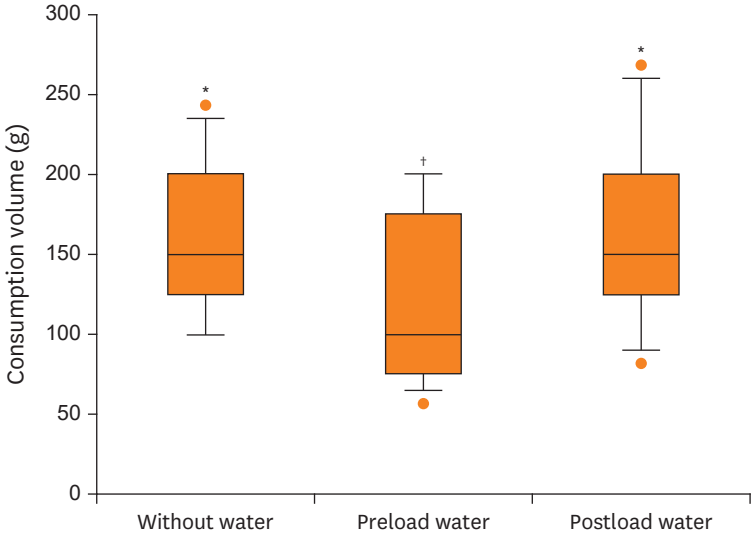

Figure 1. Consumption volume on test meals served with and without water. Each box plot is composed of 5 horizontal lines that display the 10th, 25th, 50th, 75th, and 90th percentiles, respectively. All values above the 90th and below the 10th percentiles are plotted separately.
The different marks indicate significant differences by a repeated measures analysis of variance followed by Bonferroni-adjusted pairwise comparisons.

https://doi.org/10.7762/cnr.2018.7.4.291

with and without water are presented in **Figure 2**. The initial ratings on satiety and thirst did not differ among the test meals served with or without water. As expected, satiety and thirst ratings changed significantly with time in response to meal ingestion. There was a significant difference in fullness between meal conditions. After eating a test meal, subjects reported significantly more fullness under the postload water condition than under the waterless condition (waterless: 66.5 mm vs. postload water: 86.4 mm, $p < 0.05$). There were no significant differences in satiety ratings between preload and postload water conditions for 2 hours after eating test meals. Even though subjects drank water before eating a test meal, despite consuming less, they did not feel significantly less satiety compared with waterless or postload water conditions. Water consumption had a significant effect on thirst ratings. When subjects ate a test meal with water (preload or postload), they felt significantly less thirst compared with the waterless condition ($p < 0.05$).

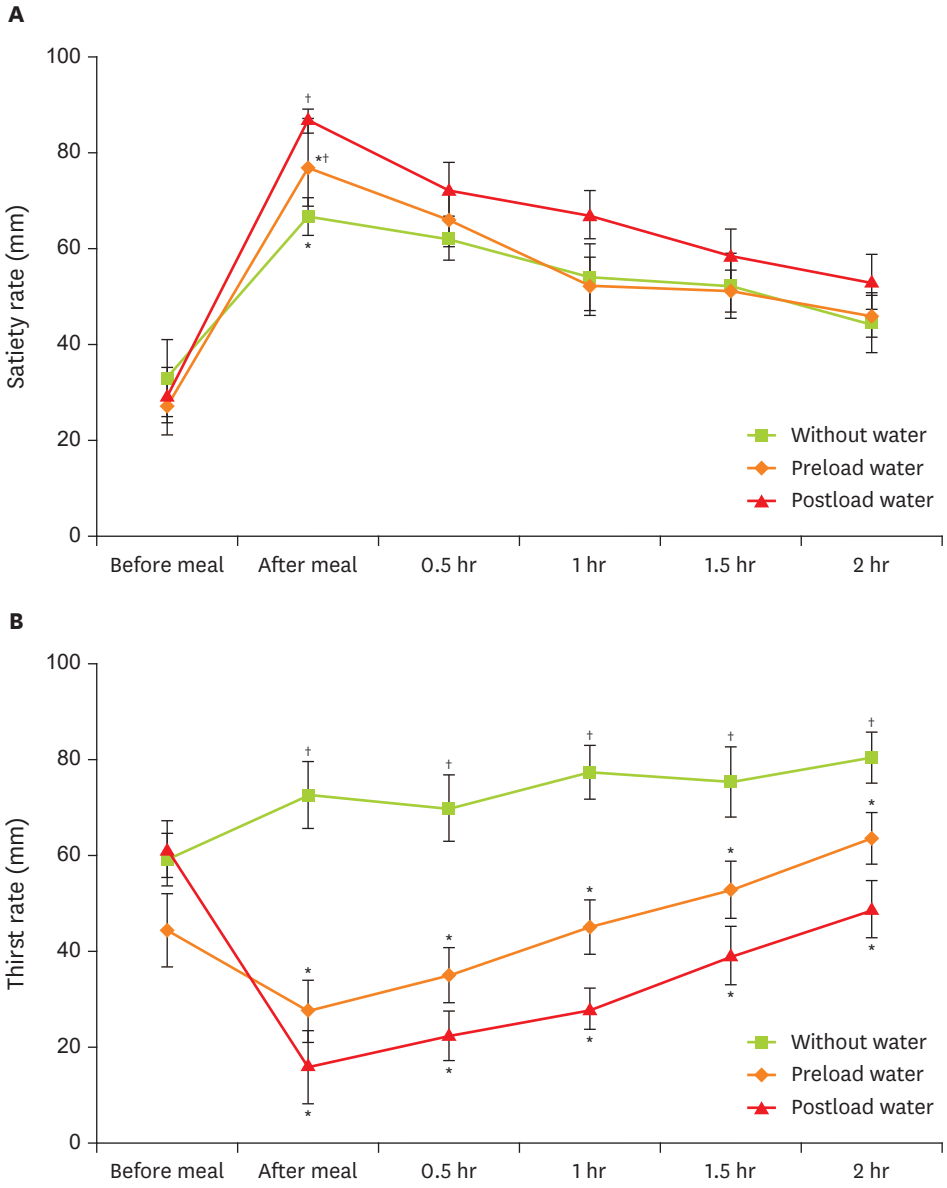

Figure 2. (A) Hunger and (B) thirst ratings on test meals served with and without water. Values are means ± standard error of the mean for 15 subjects. Data were analyzed with a repeated measure analysis of variance followed by Bonferroni-adjusted pairwise comparisons.

https://doi.org/10.7762/cnr.2018.7.4.291

DISCUSSION

It was found that pre-meal water consumption, indeed, reduced energy intake among the non-obese young adults. An acute reduction in energy intake following water ingestion was observed. Low-energy, high-volume preloads, including specific formulations of soups and salads, reduce hunger before a meal and reduce overall energy intake compared to a condition without preloading [14,15]. The effect of beverage consumption on energy intake has been of interest, because it has been suggested that liquid foods are less satiating than solid foods [16]. 2 small laboratory studies identified by a systemic review [17] had specifically investigated whether preload water would lead to a reduction in energy intake. Both laboratory studies compared a group of participants who were given preload of water before a test meal to a group of participants who were not given the preload and found that overall energy intake from the meal was lower in the preload group than in the other group [8,9]. More test meal studies have shown that consuming water prior to and during meals increases satiety and causes changes in the subjective sensations of satiety associated with reduced energy intake [4,6,8,9]. Water consumption after a meal, however, did not have an effect on energy intake. Whether the reduction in energy intake results in weight loss is unclear, although the recent study by Dennis et al. [4] suggests that this might be the case at least in the short term. The mechanism responsible for the observed effects of preloading is unclear, but one potential explanation was proposed, that consuming water before a meal reduces the energy density of stomach contents [18]. Previous cohort studies and controlled trials have shown that consumption of lower energy density foods could have an effect on body weight in the short term, but this effect may not be maintained in the longer term [19-21]. It is important to assess whether or not the short-term weight loss effect of preload water consumption will maintain its effect in a longer time frame. The results of this study are consistent with the expectation that water consumption may promote weight loss by lowering total energy intake. A present study also suggests that immediate pre-meal water ingestion might be a viable strategy that could help facilitate weight management among young adults [22].

My finding that pre-meal water consumption led to a significant reduction in meal energy intake in the young suggests that this may be an effective weight control strategy, even though the mechanism of action remains unknown. Future studies should involve investigation of the effects of immediate pre-meal water ingestion in overweight/obese young subjects, as well as long-term weight loss effects of this dietary strategy.

REFERENCES

1. Strissel KJ, Stancheva Z, Miyoshi H, Perfield JW 2nd, DeFuria J, Jick Z, Greenberg AS, Obin MS. Adipocyte death, adipose tissue remodeling, and obesity complications. Diabetes 2007;56:2910-8.
PUBMED | CROSSREF
2. Lee MJ, Wu Y, Fried SK. Adipose tissue heterogeneity: implication of depot differences in adipose tissue for obesity complications. Mol Aspects Med 2013;34:1-11.
PUBMED | CROSSREF
3. Ayyad C, Andersen T. Long-term efficacy of dietary treatment of obesity: a systematic review of studies published between 1931 and 1999. Obes Rev 2000;1:113-9.
PUBMED | CROSSREF
4. Dennis EA, Dengo AL, Comber DL, Flack KD, Savla J, Davy KP, Davy BM. Water consumption increases weight loss during a hypocaloric diet intervention in middle-aged and older adults. Obesity (Silver Spring) 2010;18:300-7.
PUBMED | CROSSREF

https://doi.org/10.7762/cnr.2018.7.4.291

5. DellaValle DM, Roe LS, Rolls BJ. Does the consumption of caloric and non-caloric beverages with a meal affect energy intake? Appetite 2005;44:187-93.
PUBMED | CROSSREF
6. Lappalainen R, Mennen L, van Weert L, Mykkänen H. Drinking water with a meal: a simple method of coping with feelings of hunger, satiety and desire to eat. Eur J Clin Nutr 1993;47:815-9.
PUBMED
7. Popkin BM, Barclay DV, Nielsen SJ. Water and food consumption patterns of U.S. adults from 1999 to 2001. Obes Res 2005;13:2146-52.
PUBMED | CROSSREF
8. Van Walleghen EL, Orr JS, Gentile CL, Davy BM. Pre-meal water consumption reduces meal energy intake in older but not younger subjects. Obesity (Silver Spring) 2007;15:93-9.
PUBMED | CROSSREF
9. Davy BM, Dennis EA, Dengo AL, Wilson KL, Davy KP. Water consumption reduces energy intake at a breakfast meal in obese older adults. J Am Diet Assoc 2008;108:1236-9.
PUBMED | CROSSREF
10. Rolls BJ, Dimeo KA, Shide DJ. Age-related impairments in the regulation of food intake. Am J Clin Nutr 1995;62:923-31.
PUBMED | CROSSREF
11. Sturm K, Parker B, Wishart J, Feinle-Bisset C, Jones KL, Chapman I, Horowitz M. Energy intake and appetite are related to antral area in healthy young and older subjects. Am J Clin Nutr 2004;80:656-67.
PUBMED | CROSSREF
12. Garner DM, Olmsted MP, Bohr Y, Garfinkel PE. The eating attitudes test: psychometric features and clinical correlates. Psychol Med 1982;12:871-8.
PUBMED | CROSSREF
13. Knight RG, Waal-Manning HJ, Spears GF. Some norms and reliability data for the State--Trait Anxiety Inventory and the Zung Self-Rating Depression scale. Br J Clin Psychol 1983;22:245-9.
PUBMED | CROSSREF
14. Rolls BJ, Bell EA, Castellanos VH, Chow M, Pelkman CL, Thorwart ML. Energy density but not fat content of foods affected energy intake in lean and obese women. Am J Clin Nutr 1999;69:863-71.
PUBMED | CROSSREF
15. Rolls BJ, Roe LS, Meengs JS. Salad and satiety: energy density and portion size of a first-course salad affect energy intake at lunch. J Am Diet Assoc 2004;104:1570-6.
PUBMED | CROSSREF
16. Almiron-Roig E, Chen Y, Drewnowski A. Liquid calories and the failure of satiety: how good is the evidence? Obes Rev 2003;4:201-12.
PUBMED | CROSSREF
17. Daniels MC, Popkin BM. Impact of water intake on energy intake and weight status: a systematic review. Nutr Rev 2010;68:505-21.
PUBMED | CROSSREF
18. Parretti HM, Aveyard P, Blannin A, Clifford SJ, Coleman SJ, Roalfe A, Daley AJ. Efficacy of water preloading before main meals as a strategy for weight loss in primary care patients with obesity: RCT. Obesity (Silver Spring) 2015;23:1785-91.
PUBMED | CROSSREF
19. Du H, van der A DL, Boshuizen HC, Forouhi NG, Wareham NJ, Halkjaer J, Tjønneland A, Overvad K, Jakobsen MU, Boeing H, Buijsse B, Masala G, Palli D, Sørensen TI, Saris WH, Feskens EJ. Dietary fiber and subsequent changes in body weight and waist circumference in European men and women. Am J Clin Nutr 2010;91:329-36.
PUBMED | CROSSREF
20. Rolls BJ, Roe LS, Beach AM, Kris-Etherton PM. Provision of foods differing in energy density affects long-term weight loss. Obes Res 2005;13:1052-60.
PUBMED | CROSSREF
21. Lowe MR, Tappe KA, Annunziato RA, Riddell LJ, Coletta MC, Crerand CE, Didie ER, Ochner CN, McKinney S. The effect of training in reduced energy density eating and food self-monitoring accuracy on weight loss maintenance. Obesity (Silver Spring) 2008;16:2016-23.
PUBMED | CROSSREF
22. Corney RA, Sunderland C, James LJ. Immediate pre-meal water ingestion decreases voluntary food intake in lean young males. Eur J Nutr 2016;55:815-9.
PUBMED | CROSSREF