ISSN (electrónico): 1699-5198 - ISSN (papel): 0212-1611 - CODEN NUHOEQ S.V.R. 318

ARÁN

Nutrición Hospitalaria

Revisión

Effect of water consumption on weight loss: a systematic review

Efecto del consumo de agua sobre la pérdida de peso: revisión sistemática

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Abstract

Water intake has been proposed for weight loss; however, the evidence of its efficacy is limited. The aim of this study was to systematically review the randomized clinical trials that assessed the effect of water consumption on weight with a follow up ≥ 12 weeks. A systematic query-based search was performed on PubMed, EBSCO, and Cochrane Library to identify eligible records that quantitatively measured body weight change after interventions. This review included six RCTs that reported different strategies for weight loss achievement: increasing daily water intake, replacement of caloric beverages with water, and premeal waterload. All the studies showed a weight loss effect after follow-up, ranged from -0.4 kg to -8.8 kg with a mean percentage of weight loss of 5.15%. The most effective intervention among the studies was the replacement of caloric beverages with water. The quality of the evidence for the primary outcome of weight loss was rated low to moderate. The main limitation of these results is the short-term follow up-period. In conclusion, despite 5.15% of weight loss, the low to moderate quality of evidence and the short term of follow-up are limitations to support evidence-based recommendations of water consumption for weight loss.

Key words:

Water consumption. Weight loss. Non-nutritive sweeteners. Obesity. Systematic review.

Resumen

El consumo de agua se ha propuesto como medida para la pérdida de peso; sin embargo, la evidencia de su eficacia es limitada. El objetivo de este estudio fue revisar sistemáticamente los ensayos clínicos aleatorizados que han evaluado el efecto del consumo de agua en el peso corporal con un periodo de seguimiento ≥ 12 semanas. Se realizó una búsqueda sistemática en cadena en PubMed, EBSCO y Cochrane Library para identificar estudios elegibles que midieran cuantitativamente el cambio de peso corporal después de sus intervenciones. Esta revisión incluye seis ECA que reportan diferentes estrategias para alcanzar la pérdida de peso: incremento del consumo diario de agua, reemplazo de bebidas calóricas por agua y sobrecarga con agua previa a las comidas. Todos los estudios mostraron un efecto de pérdida de peso después del seguimiento, con un rango de -0.4 kg a -8.8 kg y con un porcentaje promedio de pérdida de peso del 5.15%. La intervención más efectiva entre los estudios fue el reemplazo de bebidas calóricas por agua. La calidad de la evidencia para el resultado primario de pérdida de peso fue calificada de baja a moderada. La principal limitación de estos resultados es el corto periodo de seguimiento. En conclusión, a pesar de encontrarse una pérdida de peso del 5.15%, la calidad de la evidencia baja a moderada y el corto periodo de seguimiento son limitaciones para sustentar una recomendación basada en la evidencia sobre el consumo de agua para la pérdida de peso.

Palabras clave:

Consumo de agua. Pérdida de peso. Endulzantes no nutritivos. Obesidad. Revisión sistemática.

Received: 19/06/2019 • Accepted: 16/09/2019

Bracamontes Castelo G, Bacardí Gascón M, Jiménez Cruz A. Effect of water consumption on weight loss: a systematic review. Nutr Hosp 2019;36(6):1424-1429

DOI: http://dx.doi.org/10.20960/nh.02746

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INTRODUCTION

Over the past 50 years, the prevalence of obesity has increased to pandemic proportions all over the world (1), representing an important global health and economic problem (2). It was also considered, between 1975 and 2014, the most common nutritional disorder in the United States (2). The worldwide prevalence of obesity (BMI ≥ 30 kg/m²) increased from 3.2% in 1974 to 10.8% in 2014 among adult men, and from 6.4% to 14.9% in adult women over the same period (1,3).

Excess weight has been reported to be associated with various negative effects such as cardiovascular disease, hypertension, diabetes, cancer, and chronic renal disease, among others, and also with early mortality (2,4).

In response to the growing epidemic of obesity and obesity-related chronic diseases, over the last four years numerous guidelines and position statements have been published (5). Some authors have indicated that the fundamental goal in the treatment of overweight and obesity is weight loss, indicated to individuals with BMI ≥ 30 or ≥ 27 kg/m^2 in the presence of weight-related comorbidity (6).

Evidence-based treatments for weight loss include lifestyle intervention, pharmacotherapy, and bariatric surgery (6). However, there are inconsistent results regarding the effectiveness of some of these strategies (lifestyle intervention, pharmacotherapy) in the long-term maintenance of weight (7-8).

Water is essential for life (9). It comprises about 60% of human body weight and is critical for life; without water, humans can survive for just 2-4 days (10). Beverage consumption recommendations, motivated by the large increase in unhealthy weight patterns in the United States over the past 20 years, suggest water as the gold-standard beverage for optimal health (11).

Increasing water intake has been proposed as an important tool for reducing weight. However, the evidence of its efficacy is limited (12-13). Epidemiologic and clinical studies suggest that energy intake is significantly lower in water drinkers than in non-water drinkers, which may contribute to weight loss and consequently to obesity prevention (14-18).

Drinking water has been proposed to increase energy expenditure and rates of lipolysis (19-21). Some studies have concluded that drinking water, compared to intake of caloric beverages, lowers total energy intake (22-25). Absolute increases in drinking water may promote weight loss by altering metabolism and by a slight increase in satiety, thus promoting weight loss. Very few studies have been conducted to assess the long-term effects of drinking water on changes in body weight (13, 26).

A previous systematic review that analyzed the effect of water intake on body weight outcomes in an adult population, published in 2013, concluded that studies of individuals dieting for weight loss or maintenance suggest a weight-reducing effect of increased water consumption, whereas studies in general mixed-weight populations yielded inconsistent results (27). However, the weight loss effect was marked as low evidence because the quality of the studies was poor. In addition, the review included only one randomized clinical trial with a follow up of 12 weeks, one non-randomized trial, and a few more with observational periods of a few days, several of them cross-sectional in design.

Therefore, the aim of this review was to systematically summarize all the existing evidence from randomized clinical trials that evaluated the effect of water consumption on weight or body mass index in adult and adolescent populations with a follow-up equal or greater than 12 weeks.

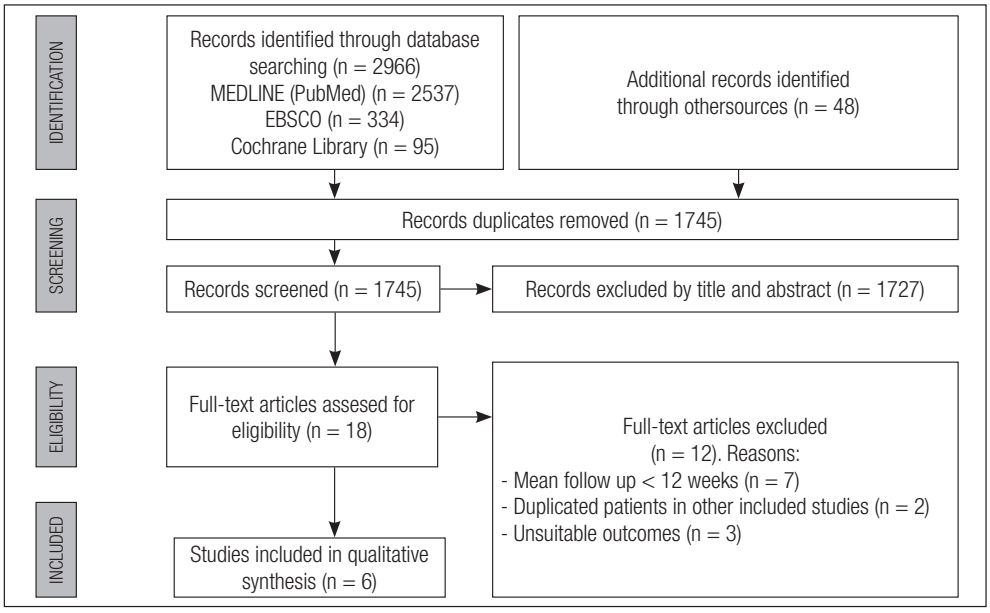

Figure 1.
Flow diagram of selected studies.

MATERIALS AND METHODS

This systematic review was conducted following the PRISMA guidelines.

IDENTIFICATION OF RECORDS

A systematic query-based PubMed search was performed to identify eligible records that quantitatively measured body weight change after interventions regarding water consumption. The search terms used were the following: ("water consumption OR "water intake" OR "drinking water" OR "beverages" OR "plain water") AND ("adults" OR "adolescents") AND ("body weight" OR "body mass index" OR "weight loss" OR "weight outcomes" OR "obesity" OR "overweight").

Searches using the keywords "water intake," "obesity," and "weight loss" were performed in EBSCO, Web of Science, and Google Scholar to identify additional publications. To maximize the number of studies assessing body composition outcomes, we included all studies found in the literature that met the inclusion criteria. The last search was conducted on March 8th, 2019.

The article selection process is presented in a flow diagram in figure 1.

INCLUSION/EXCLUSION CRITERIA

Randomized clinical trials of the effects of water consumption on body weight were selected, including the following criteria: 1. Any language full-text articles, adolescent and adult population above 12 years old; 2. Articles with a follow-up of at least 12 weeks; 3. Retention rate of at least 70%; 4. Studies that reported baseline and post-intervention measurements of body weight or BMI or both; and 5. Studies that reported the amount of water intake. Studies attending populations with comorbidities were included if these were related to overweight and obesity. We excluded published letters, comments, reviews, abstracts only, and duplicated studies.

SCREENING AND ELIGIBILITY

We identified 2,966 articles through the initial database research. Title screening was performed by one researcher to exclude clearly irrelevant and duplicated studies; 1,221 records were excluded. Screening on abstract was performed by three researchers, who excluded 1,727 records. Full-text screening of the remaining 18 records was initially performed by one researcher, and any eligible records with uncertain data were discussed with a second researcher. In total, 12 records were excluded. A total of 6 records were included.

DATA EXTRACTION

We used a standard data extraction method to collect the information of each study: author, year of publication, country, sample size, age interval and gender of the participants, mean follow-up, retention rate, weight loss, and BMI reduction outcomes reported on each study. Weight outcomes evaluated were body weight loss and body mass index reduction after intervention.

QUALITY ASSESSMENT

To assess the quality of the evidence, we used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system, which defines the quality of the evidence as high, moderate, low, or very low. The evidence was evaluated according to the primary outcome (weight loss).

RESULTS

STUDY CHARACTERISTICS

A total of six eligible publications were included, consisting of six RCTs. Table I summarizes the major characteristics of the studies included.

One study had an adolescent population with OW/OB without comorbidities (12), the other five included mixed (13,28-29) and only female populations (30-31) with OW/OB, and one of them included OW/OB with diabetes mellitus in both groups (31). Five of the studies reported statistical power and all studies reported a retention rate higher than 70% at 12 weeks of follow-up.

Different strategies to weight loss achievement were used: five of the studies included a weight loss program with hypocaloric diets, physical activity and/or behavioral programs. Two studies assessed the effect of increasing daily water intake (12,29), two the effect of replacing caloric beverages with water following lunch (30-31), and the remaining two studies evaluated the effect of 500 mL of water preload before all 3 daily meals and before the main meal (13,28).

All studies reported baseline and post-intervention weight, and four of them also reported BMI reduction (12,13,30,31). Other measurements were non-uniformly reported: four studies reported changes in waist circumference, lipid profile and fasting glucose (13,29-31); two of them reported A1C and insulin resistance indicators (30,31), and two reported body fat percentage (12,13).

PARTICIPANTS' CHARACTERISTICS

A total of 609 participants were included in this study. Total size samples ranged from 38 to 303 participants. Gender distribution was reported in all six studies, and there was a greater proportion of women (78.1%) than men (21.9%). Age at baseline ranged from 12 to 75 years. Baseline weight ranged from 83.90 to 93.03 kg, and BMI ranged from 32.0 to 34.2 kg/m^2.

Table I. Study characteristics and weight loss outcomes

Author, year (country)	Follow-up (weeks)	Retention rate (%)	Sample size: sex (age range in years)	Intervention	Weight change from baseline (kg)	p	BMI change from baseline (kg/m²)	p
Wong, 2017 (USA)	24	100	38: M/F (12 to 17)	IG: weight loss diet plus eight cups per day of water vs. CG: weight loss diet	IG: -0.4 CG: -0.6	0.90	IG: -0.6 CG: -0.4	0.71
Madjd, 2016 (Iran)	24	80	81: F (18 to 50)	IG: weight loss diet plus post lunch replacement of DB with water vs. CG: weight loss diet plus DB post-lunch daily	IG: -6.4 CG: -5.25	0.006	IG: -2.5 CG: -2.05	0.006
Peters, 2016 (USA)	52	73	303: M/F (21 to 65)	IG: weight loss behavioral program plus 710 mL of NSS per day vs. CG: weight loss behavioral program plus at least 710 mL of water per day	IG: -8.39 CG: -3.39	< 0.001		
Madjd, 2015 (Iran)	24	71	62: F (18 to 50)	IG: weight loss diet plus post lunch replacement of DB with water vs. CG: weight loss diet plus DB post-lunch daily	IG: -8.0 CG: -7.6	0.015	IG: -3.3 CG: -2.9	0.002
Parreti, 2015 (England)	12	92.8	84: M/F (56.5 mean)	IG: no weight loss diet plus 500 mL water preload 30 min before main daily meal vs. CG: no weight loss diet	IG: -2.4 CG: -1.2	0.028		
Dennis, 2010 (USA)	12	85.4	41: M/F (55 to 75)	IG: weight loss diet plus 500 mL water preload 30 before 3 daily meals vs. CG: weight loss diet	IG: -0.87 CG: -0.6	< 0.001	IG: -2.6 CG: -1.9	Not significant

OW: overweight; OB: obese; DM: diabete mellitus; IG: intervention group; CG: control group; DB: diet beverages; CB: caloric beverages; NSS: non-nutritive sweeteners.

CHANGE IN WEIGHT LOSS

Weight loss outcomes in the intervention groups, based on body weight in kgs, are shown in Table 1. Mean body weight at baseline and at end of follow-up was 89.33 kg and 84.55 kg, respectively. After the interventions all the studies showed a mean weight loss of -4.96 kg, ranging from -0.4 kg to -8.8 kg. The mean percentage weight loss was 5.15%. The most effective intervention among the studies was the replacing of caloric beverages with water, with weight loss ranging between 7.62% and 9.41% at 24 weeks of follow-up with a significant difference between groups (31). Interventions involving an increase in daily water intake were the least effective, with reductions that ranged from 0.46% to 2.98% at 24 (12) and 52 weeks of follow-up (29), respectively; differences between groups were reported only in the 52-week study. Premeal waterload showed a reduction that ranged from 2.6% to 7.8% at 12 weeks of follow-up. Both studies found significant differences between groups (13,28).

The study with the longest follow-up had 52 weeks, and reported a weight loss of 2.98% in the group with higher water intake (29).

GENERAL CHARACTERISTICS OF THE STUDIES INCLUDED

A RCT conducted by Dennis (13) studied the effects of water consumption on body weight. Participants were 55-75-year-old adults and included predominantly white men. The intervention group (IG) had a hypocaloric diet plus 500 mL of bottled water prior to each of the three daily meals, and the control group (CG) had a hypocaloric diet alone. After 12 weeks of follow-up a weight reduction of 7.8% ($p < 0.001$) was found in the IG, which was approximately 2 kg greater in the water group than in the CG. Weekly water intake compliance was 90%. There were differences in food and beverages energy density within groups but not between groups at the end of the study. No differences in mean ad libitum breakfast meal energy intake at the end of follow-up was found. Most male and white participants were included in the IG. The Institute for Public Health and Water Research funded the study.

Parretti et al (28) conducted a RCT to assess the efficacy of water preloading before meals as a weight loss strategy. All races, a nonspecific wide age range, and participants with comorbidities were included. The IG had 500 mL of water within 30 min prior to the main meals each day, without any specific diet, plus a

behavioral program. The CG received behavior counseling only. After 12 weeks of follow-up a change of -2.4 ± 3.4 kg was found in the IG. Twenty-seven percent of the participants lost at least 5% of their body weight; the change in CG was -1.2 ± 2.9 kg; a difference of -1.3 kg was reported between groups ($p = 0.028$). The mean difference in weight change between drinking water three times a day versus no water regimen a day was 3.6 kg (95% CI -7.0 to 0.2). Private funding was reported.

Madjd et al. (30) conducted a RCT to study the effect of replacing diet beverages (DBs) with water during a 24-week weight loss program with a hypocaloric diet, exercise, and behavioral support. Participants were 18-50-year-old women without other comorbidities. Subjects in the IG replaced their usual intake of DB with 250 mL of water after the main meal (lunch), and the CG was instructed to drink 250 mL of DB once a day after lunch, five times a week, and the resting days only water. In both groups no water or DBs were allowed during lunch. At the end of follow-up a weight loss of 8.8 ± 1.9 kg was reported in the IG, and of 7.6 ± 2.1 kg in the CG, with a 13.6% greater weight reduction in the IG ($p = 0.015$) group. A greater improvement in insulin sensitivity and cardiometabolic risk was found in both groups. The authors reported no conflicts of interest.

In 2016, Madjd et al. (31) replicated their previous study in type-2 diabetes female patients. With a larger sample and a retention rate of 80%, they found after 24 weeks of follow-up a reduction of 7.62% in body weight in the IG, compared to 1.16 kg in the CG ($p = 0.006$). A greater improvement in fasting plasma glucose and insulin sensitivity was reported in the IG. There was a greater reduction in energy intake in the IG compared with the CG. The authors reported no conflicts of interest.

Peters et al. (29) conducted a RCT to evaluate the effects of sweetened beverages with non-nutritive sweeteners (NNS) versus water (WG) in subjects enrolled in a one-year behavioral weight loss program. The sample consisted on 303 participants aged 21 to 65 years. The NNS group consumed 710 mL of NSS per day and the WG had 710 mL of water per day during the 52-week follow-up period. Both the NNS and water treatments were reported as non-equivalent: the NNS group had greater weight loss, -6.2 ± 7.65 kg ($p < 0.001$) when compared to the WG, with a reduction of 3.39 ± 6.33 kg. Forty-four percent of the participants in the NNS group archived a 5% weight reduction, compared to 25.5% in the WG. This study had the longest follow-up period and the largest sample. The authors reported private funding for the study.

Wong et al. (12) conducted a RCT in an adolescent population from 12 to 17 years of age. As an inclusion criterion the participants had to usually drink ≤ 4 cups of water per day. In addition to a standardized nutrition and behavioral intervention, the IG was encouraged to increase water intake to 8 cups per day, referred to as 8×8 (eight 8-oz glasses [1.92 L] of water per day), and the CG received no specific advice on drinking water but did receive the same nutritional and behavioral intervention. After 24 weeks of follow-up water intake was greater in the IG compared with the CG (1.6 cups per day, 95% CI, -0.2 to -3.0, $p = 0.03$), but the IG did not achieve the 8-cup-per-day goal. In addition, a significant reduction in BMI z score within groups, but not between groups, was found. Private funding was declared.

QUALITY OF THE EVIDENCE

The quality of the evidence was evaluated based on study design, study quality, consistency, directness, precision, and publication bias. All the studies reported they had calculated statistical power, retention rates were high, and no imbalance between intervention and control groups was found. Four studies reported their randomization procedures (12,28,30,31) and allocation concealment method (12,28,30,31), and followed an intention-to-treat principle [12,28,29,31]. While all the interventions tested the effect of water intake on weight reduction, the strategies used were different: two tested increase in water intake (12,29), two replacement of caloric beverages (30,31), and two premeal water load (13,28); and all the studies but one (28) included a weight loss diet. The length of the studies ranged from 12 to 52 weeks, and for weight loss longer-term weight assessments are needed. In five out of six studies the IG lost more weight than the control group. Four out of six studies had either industry funding or conflicts of interest with royalties out of a book promoting water intake. The quality of the evidence for the primary outcome of body weight loss was low to moderate.

DISCUSSION

In this systematic review we found that the overall reduction of the initial weight after a water consumption intervention in overweight and obese adults and adolescents was 5.15%, which ranged from 0.46% to 9.41%. However, the quality of the evidence for the effectiveness of water consumption interventions for weight loss ranged from low to moderate. Intervention strategies included increased water intake, replacement of caloric beverages, and premeal water load. Caloric beverage replacement was the most effective approach to weight loss achievement.

These results are consistent with a previous systematic review published in 2013, which included observational studies, non-randomized trials, and RCTs with short-term follow-up periods. Our review limited the studies to RCTs with a retention rate higher than 70% and a follow-up of at least 12 weeks. When compared to other RCTs assessing diet, physical activity, and pharmacological interventions, water consumption strategies show a quantitavely similar effect on weight reduction. However, the period of follow-up prevents long-term (more than a year) predictions regarding weight loss. Additionally, heterogeneous samples and low to moderate quality of the evidence are the main limitations of these results.

Public health programs and RCTs focusing on reducing energy intake from food usually give little value to fluid consumption, but the findings of this review indicate that the strength of the evidence for the effect of water intake, water replacement, or water load is low to moderate.

Among the strengths of this study are that all the studies included were well designed, randomized, controlled trials, had a follow-up of at least 12 weeks, and at least a 70% retention rate.

As for weaknesses, the studies included were heterogeneous, thus a meta-analysis could not be conducted, and the quality of the evidence for weight loss ranged from low to moderate. Other

adiposity indicators were not uniformly reported, and only one study with one year of follow-up was conducted.

CONCLUSIONS

Water consumption interventions in overweight and obese adults and adolescents resulted in a reduction of 5.15% of initial body weight. In this systematic review only six studies were included and the quality of the evidence for the effectiveness of weight loss ranged from low to moderate. Further high-quality studies with long-term follow-up are warranted to assess weight loss during more than one year.

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