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Reverse Osmosis Infrared Filtered Water Consumption Induces Weight Loss

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Abstract

Background: Previous research showed that weight loss in response to weight management program is influenced by total energy intake and water consumption. Whether or not purified water affects weight management is currently unknown.

Methods: An intervention study of 29 middle-aged obese women who reported < 1L/day drinking water at baseline was carried out in Yaounde, Cameroon. Participants were randomly assigned to one of the two groups: (i) hypocaloric diet + physical activity + reverse osmosis infrared filtered water (ROIFW), and (ii) hypocaloric diet + physical activity. Weight, waist circumference and body fat were assessed at baseline, 4, 8, 12, 16, 20, 24, and 28 weeks. General Linear Model procedure of repeated measurements was used to determine whether weight loss as well as changes in waist circumference and body fat differ between the two study groups.

Results: After 12 weeks from baseline, women in both groups lost an average of 7% of their initial body weight. A statistically significant difference in weight loss was observed between the ROIFW (7.9 kg; 95%CI: 6.5-9.3) and control (5.5 kg; 95%CI: 3.7-7.4; *P*=0.03) groups. No significant difference was apparent in both waist circumference and body fat throughout the intervention although women in the ROIFW group experienced higher reduction.

Conclusion: Our results suggest that obese women using ROIFW may augment weight loss when combined with hypocaloric diet and physical activity. More extensive data are warranted to confirm these findings, as well as to address issues of optimal volume and timing of ROIFW consumption.

Keywords: Diet; Weight Management; Water; Obesity; Reverse Osmosis; Infrared

Introduction

Obesity is now considered a public health concern and both westernized and non westernized countries are affected. Despite the great success of bariatric surgery [1], there is agreement that diet, physical activity and behaviour modification constitute the cornerstones of weight management. Epidemiological evidence demonstrated that body weight loss in response to weight management program is influenced not only by the total energy intake and macro- or micronutrient composition of the diet but also by intake of other nutritional determinants, such as omega-3 fatty acids [2], calcium [3] and water [4]. There is a popular belief that water consumption facilitates weight loss. However, few investigations have addressed the effect of increased water consumption on weight management. Among non obese adults water consumed before or with a meal reduces sensations of hunger and increases satiety [5]. In middle-aged and older overweight/obese adults, high water consumption is inversely associated with weight gain [4]. There is suggestion that over 12 months, drinking ≥ 1L water (33.8 fl oz) per day increased weight loss by ~ 2 kg as compared to drinking less water [6]. In general, it is estimated that energy intake among water drinkers is around 9% (194 kcal/d) lower than non-water drinkers [7].

Recently in Yaounde, Cameroon, reverse osmosis (RO) has become the water purification of choice for drinking water in many households. RO is a water treatment process in which water is forced through a semi-permeable membrane that has very small pores. The RO purification process produces clean and safe water with up to 99% free of unwanted substances commonly found in tap water.

Infrared is an invisible form of energy that is accepted by the human body as heat and organic molecules have a tendency to vibrate when they come in contact with infrared energy. The effect of infrared on human bodies include activation of water molecules, improvement of oxygen level, warm and elimination of fat, chemicals and toxins from blood, thus smoothing the flow of blood, reduction of acidic level and improvement of nervous system function [8]. Whether or not purification of drinking water affects weight management is currently unknown. To address this issue, we examined the influence of RO infrared filtered water (ROIFW) in weight loss program among obese Cameroonian women.

Methods

Subjects

Twenty nine obese (body mass index=34.5±3.9 kg.m^{-2}; waist circumference=104±8 cm) women with mean age of 50.2 ± 9.8 years (range = 30 to 65 years) attending the Dietetic Department of Yaounde Military Hospital in Cameroon for weight management were recruited for this pilot study. Study subjects were weight-stable (±2 kg for more than 1 year, determine by self-report), non-smokers, without major chronic disease (i.e., diabetes, coronary heart disease, cancer), reporting <1L/day drinking water at baseline, and not taking medications known to influence body weight or food intake. Participants had no allergies or

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restriction, did not consume alcohol in excess (≤ 5 drinks/week), and had no depression or eating disorders. Subjects were randomly divided into two groups: the ROIFW group and the control group. The diet recommends a hypocaloric diet along with behavioural modifications placing food into four groups (vegetables and fruits, whole grain products and tubers, legumes, fish and white meats) during the ongoing weight loss phase to both groups. Participants were advised to intake at least 2 L/day drinking water. While no indication regarding the type of water was delivered to the control group, ROIFW was given ad libitum to the ROIFW group for cooking and drinking during the study period The program also advises ~ 45 minutes of moderate physical activity on most days of the week. At 28 weeks, data were available for 14 (93%) and 12 (86%) women in ROIFW and control groups, respectively. All subjects provided informed consent before participation in the investigation, but they were not aware of the specific objectives of the study. The study was approved by the Military Health Department Internal Review Committee.

Water processing equipment

The equipment that produced ROIFW used in the present experimentation was provided by Aura Cameroon Company. Water processing equipment comprised a RO unit along with an infrared cartridge (Pure Pro USA Corporation, IL, USA). During the initial filtration stage, tap water passes through a pre-filter with 5 micron cartridge that removes silt, sediment, sand and clay particles. Water is after forced through and active carbon filter that is supposed to trap minerals and contaminants such as chromium, mercury, copper, chloramines, chlorine and pesticides. Water is then transferred under pressure into the RO module, allowing only clean water to pass through the small pores in the membrane and impurities unable to pass through that membrane are left behind. Finally, treated water is passed through an activated carbon filter of 1 micron to further improve the water's taste and smell before moving through an infrared filter that integrates decontamination, mineralization, activation, biochemical and magnetization.

Anthropometric variables

Procedures were performed at baseline and at each clinic visit under standard protocols. Height was measured only at the first visit with a portable stadiometer and recorded to the closest 0.1 cm. Weight (within 0.1 kg) and body fat (within 0.1%) were measured by using tetrapolar bioelectrical impedance (Tanita Body Composition Analyser TBF-300A, Tanita Corporation, Arlington Heights, IL, USA). Subjects were weighted without shoes and socks while wearing light clothing. Waist circumference was measured with a non-stretchable tape measure to the nearest 0.1 cm. Measurements were conducted by trained nurses and all instruments were calibrated daily.

Other sociodemographic and lifestyle variables

At baseline, each participant completed a lifestyle questionnaire to obtain data on selective demographic characteristics and lifestyle factors, such as age, marital status, occupation and physical activity, smoking habits, weight and weight change history, height, body fat, number of pregnancies, household, and the desired weight the participant would like to reach.

Dietary assessment

The method of dietary assessment in this study consisted of a 24-hour recall and a comprehensive dietary history to assess habitual food intake as well as the total number of meals eating per day. Taken into account the food habits of each participant, the nutritionist prescribed a personalized diet and taught the participants how to estimate portion sizes.

Time points for data collection

Eight clinic visits were scheduled at baseline, 4, 8, 12, 16, 20, 24, and 28 weeks after randomization and appointments were given to study participants. They also received a telephone call a day before each follow-up visit to confirm the date and time of the next appointment. At these clinic visits, participants attended class diets and weight, waist circumference and body fat were measured. For each individual, repeat measurements were conducted using the same instrument. As well, throughout the study period, intensive contact with the nutritionist was provided to participants and they were asked to identify and report any problem and side-effects associated or not with study participation.

Statistical analysis

The analytical plan was based on the intent-to-treat principle. Analyses involved standard statistical techniques, including descriptive analysis and summary statistics to describe the study population. A General Linear Model procedure of repeated measurements was used to determine whether weight loss as well as changes in waist circumference and body fat differ between the intervention and control groups and to compute changes within the 2 study groups from baseline to different clinic visits. The pair wise comparisons were tested and Bonferroni's adjustment was used. All tests of statistical significance are 2-sided, and analyses were undertaken with the Statistical Packages for Social Sciences for WINDOWS (release 17, 2008; SPSS Inc., Chicago).

Results

The characteristic of the study population are summarized in Table 1. Mean age (± SD) was 46.7 ± 10.3 years for the ROIFW group and 47.8 ± 9.9 for the controls, and the age distribution was similar. The average BMI in both the ROIFW and control groups were comparable and in the obesity range. Women in the intervention group were more likely to have a higher number of full-term pregnancies, while there were no appreciable differences between the two study groups with respect to waist circumference, body fat, household, usual number of daily meals and participation in physical activity.

Table 2 summerized the change in body composition with 95%CI (confidence interval) over the course of the study. After 12 weeks from baseline, women in both groups lost an average of 7% of their initial body weight. A statistically significantly difference in weight loss was observed between the ROIFW (7.9kg; 95%CI: 6.5-9.3) and control (5.5kg; 95%CI: 3.7-7.4; *P*=0.036) groups. No significant difference was

Characteristics	ROIFW group (n=15)	Control group (n=14)
Age, years	46.7 ± 10.3 $^{\Psi}$	47.8 ± 9.9
BMI, kg.m-2	35.1 ± 4.8 $^{\Psi}$	38.8 ± 8.7
WC, cm	106.8 ± 11.3 $^{\Psi}$	108.6 ± 11.4
Body fat, %	43.4 ± 4.4 $^{\Psi}$	47.4 ± 11.0
Full-term pregnancies, n	6	4
Household, n	6.7	5.9
Habitual number of daily meals, n	2.5	2.6
Physical activity, %		
Less active	85	90
More active	15	10

Ψ: Mean ± SD.

Table 1: Baseline characteristics of the study population.

	Study groups	Weight loss (kg)	Waist circumference reduction (cm)	Body fat reduction (%)
Change after 12 weeks from baseline	ROIFW group	7.9 (6.5-9.3)*	8.1 (5.8-10.5)	3.7 (0.1-7.4)
	Control group	5.5 (3.7-7.4)	5.8 (2.1-9.4)	1.4 (-0.2-3.1)
Change after 16 weeks from baseline	ROIFW group	8.4 (6.7-10.1)	9.3 (6.4-12.1)	3.3 (0.2-6.4)
	Control group	6.4 (4.7-8.1)	6.7 (3.2-10.1)	2.9 (0.3-5.5)
Change after 28 weeks from baseline	ROIFW group	9.9 (8.1-11.8)	11.4 (8.0-14.7)	3.2 (0.4-6.0)
	Control group	7.8 (5.0-10.7)	8.2 (4.2-12.3)	3.4 (1.0-5.9)

[1] Values with 95%CI.
* $P < 0.05$

Table 2. Body composition change over the course of the study.[1]

apparent in waist circumference although women in the ROIFW group experienced a higher reduction in waist circumference (8.1 cm; 95%CI: 5.8 -10.5) compared to women in the control group (5.8; 95%CI: 2.1-9.4). As well, a non-significant decrease in total body fat was found in the ROIFW group (3.7%; 95%CI: 0.1-7.4) compared to control group 1.4; 95%CI:-0.2-3.1).

After 16 weeks from baseline, the estimated marginal mean difference in weight was 7.8 kg (95%CI: 5.2-10.6). At the end of the study, the mean difference was 8.8 kg (95%CI: 5.8-11.7), which was statistically significantly different as compared to that after 12 weeks from baseline: 6.1 kg (95%CI: 3.2-9.0; P=0.001). No significant difference in the reduction in other anthropometric measurements was observed between the two groups.

There was no noticeable difference in weight between the ROIRFW and control groups at any clinic visit. However, a linear trend in weight loss was apparent (F=59.86; P<0.0001) over time for the two study groups. There was also a quadratic component (F=24.09; P<0.0001), reflecting the fact that the decline in weight levelled off toward the end of the study period (Figure 1).

Discussion

In this investigation we found that in association with a hypocaloric diet and physical activity, ROIFW has an important weight-reduction benefit. Compared to women who only followed a hypocaloric diet and engaged in physical activities, those who used ROIFW for drinking and food preparation experienced an additional body weight loss of 2.4 kg after 12 weeks. No significant waist circumference-and body fat-reduction were seen with the consumption of ROIFW in this weight-loss program. The ROIFW includes 4 degrees of purification and its nice taste elicits to increase water intake that induce optimal hydration. Our finding is in agreement with prior reports. Dennis et al. [9] found that when combined with a hypocaloric diet, consuming 500 ml (~16 fl oz) of water prior to each of the three main daily meals leads to ~2 kg greater weight loss over 12 weeks as compared to a hypocaloric diet alone among middle-aged and older adults. The authors attributed that difference to a 44% greater rate of weight loss among water group participants compared to nonwater participants over the 12-week period. In a secondary analysis of a trial comparing several weight loss diets, Stookey et al. [6] found that increasing self-reported daily water consumption by ≥1L in overweight women is associated with increased weight loss of ~2 kg over a 12-month diet intervention compared with women who consumed <1L water daily.

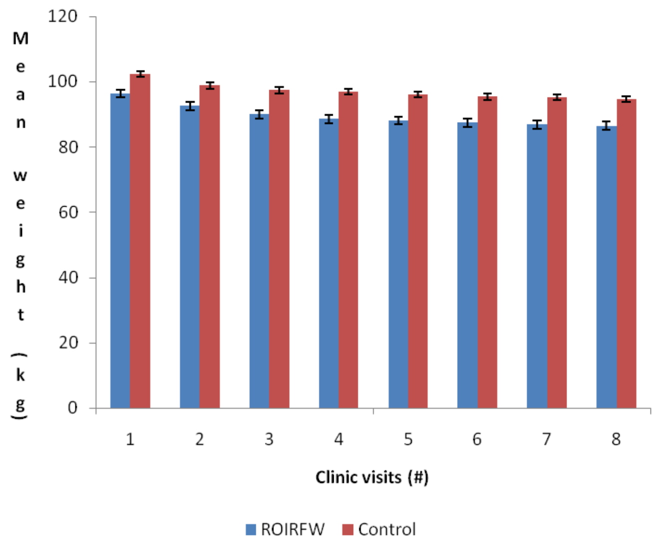

Figure 1: Weight loss among ROIRFW and control group participants at the 8 clinic visits over 28-week intervention.

The potential reasons for this finding may include caloric intake differences or a ROIFW effect on energy expenditure and- or fat oxidation that are suggested to promote weight loss. Previous studies have addressed the role of drinking water in caloric intake reduction. Laboratory-based test meal trials demonstrated that water consumed with a meal reduces rating of hunger and increases rating of satiety [5,10]. Epidemiological studies suggest that energy intake is significantly lower (~9%, or 194 kcal/d) in water drinkers compared with nonwater drinkers [7]. Davy et al. [4] demonstrated that both normal weight and overweight/obese middle-aged and older adults ingest less energy at an ad libitum meal when given a water preload (500 ml, ~16 fl oz) 30 min prior to the meal compared with a no-preload meal condition. Mucklebauer et al. [11] instituted both educational and environmental interventions to increase water intake in 17 German schools. Teachers presented four empirically developed lessons about the body's water needs and the water cycle. Special filtered drinking fountains were installed, water bottles were distributed, and teachers were encouraged to organize filling of water bottles each morning. After one year, interventions in schools led to higher water intakes (1.1 glass/day, $P < 0.001$) and lower adjusted risk of overweight (OR= 0.69; 95% CI: 0.48–0.98).

On the other hand, a number of studies measuring changes in energy expenditure after water drinking in humans have been carried out. Brundin and Wahren [12] reported that consuming 375 ml of water was related to 2% increase in energy expenditure over two hours. Boschmann et al. [13] found that drinking half a liter of water at room temperature increased resting energy expenditure by 30% after an hour. Komatsu et al. [14] also reported a 2.7% increase over 2 hrs in energy expenditure after drinking 300 ml of water. Brown et al. [15] found that drinking distilled water that had been cooled to 3°C increased resting energy expenditure by 5% over 90 min.

However, other studies [16,17] have found that water drinking does not increase metabolic rate although these investigations were of short duration (<45 min). Others driving mechanisms supporting these relationships have been suggested. They include reduction in serum osmolality from drinking water, improvement in cell efficiency and increase in fat metabolism [18,19]. As well, infrared filter activates water molecules, improves oxygen level, warms and eliminates fat and other waste and reduces the acidic level [8]. The body has a reaction to the ROIRFW and raises the heart rate and metabolic rate in response. Because thermogenesis is partly regulated by sympathetic nervous system, it has been hypothesized that the sympathetic activation after high water drinking might stimulate thermogenesis [13]. Indeed, if the thermogenic property is correct, it can help explain why ROIFW increases weight loss in obese women. Unfortunately, the existing research investigating these theories is presently very limited and speculative. Finally, it is possible that daily self-monitoring of ROIFW consumption contributed to a greater weight loss in the intervention group because of a greater adherence to diet and physical activity, as others have demonstrated some benefits of self-monitoring behaviours, such as regulation program based on daily self-weighing, associated with weight management [20]. Ours is the first study to assess the water purification in weight management. Its strengths included the population that has been scarcely studied, the >7% weight reduction in both groups and the relatively low participant withdrawal rate (less than 10%), suggesting an adequate lifestyle intervention [21]. The limitations of this study were similar to those often seen in weight-loss trials, including the question of statistical power and the failure to find differences in waist circumference or body fat. However, we enrolled healthy obese women without significant metabolic abnormalities, which likely masked potential fat-reduction benefit of ROIFW. When commenting on the results of the present study, some aspect must be taken in consideration. From 12 weeks to the end point, although the ROIFW group experience higher reduction in weight, waist circumference and body fat compared to the control group, the differences were not statistically significant. This could be explained partly because of low statistical power, and the likelihood that overtime, a number of women in the control group started using ROIFW, which was becoming more common in town. It is also possible that at the beginning of the trial, consumers of ROIFW were more motivated to diet, more restrained eaters or less depressed than those in the control group. Finally, because all participants in this trial were obese and received the same amount of dietary information and counselling, the potential for bias was likely to have been similar in both groups.

We conclude that obese middle-aged women using ROIFW may increase weight loss when combined with hypocaloric diet and exercise as compared to program including only hypocaloric diet and exercise. This strategy may help in increasing fullness, thermogenesis and self-regulation. More extensive data are warranted to confirm these findings, as well as to address issues of optimal volume and timing of ROIFW consumption.

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