Original Article

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Effect of 'Water Induced Thermogenesis' on Body Weight, Body Mass Index and Body Composition of Overweight Subjects

Physiology Section

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ABSTRACT

Context: Drinking lots of water is commonly suggested as a part of weight loss regimens. However, only few systematic studies have addressed this notion. In this study, the effect of drinking 1500 ml of water, over and above the daily water intake on body weight, body mass index (BMI) and body composition of overweight subjects was assessed.

Aim: To evaluate the role of drinking excessive water in weight reduction and body fat reduction of overweight subjects.

Settings and Design: This study was conducted on 50 overweight girls for eight weeks, during which they were instructed to drink 500 ml of water, three times a day, half an hour before breakfast, lunch and dinner, which was over and above their daily water intake.

Material and Methods: Body weight was measured in kilograms (kgs). BMI was calculated as weight in kilograms, which was divided by the square of height in metres. Body composition score was calculated as a sum of skin fold thickness in millimetres at three different sites, which was measured by using skin fold calipers. Pre and post-study body weight, body mass index and body composition scores were measured.

Statistical Analysis: SPSS, version 14.0.1 and paired t-test were used to find out the statistical significance of the results.

Results: The mean values of the pre-study and post-study body weight, body mass index and body composition scores were 65.86 kg and 64.42 kg, 26.7002 and 26.1224 and 79.626 mm and 76.578 mm respectively. All the three results were highly significant statistically.

Conclusions: The decrease in body weight, body mass index and body composition scores of overweight subjects at the end of study period establishes the role of water induced thermogenesis in weight reduction of overweight subjects.

Key words: Overweight, Body weight, Body mass index, Body composition

INTRODUCTION

The current obesity epidemic is a major public health concern worldwide, in both developed and developing countries, and in adults and children alike. Obesity confers physical stress on multiple biologic processes and it is associated with an increased risk of developing cardiovascular disease, type 2 diabetes mellitus, osteoarthritis, and certain forms of cancer, among other serious diseases [1].

Recent studies have shown that water drinking provided a sympathetic stimulus which increased the metabolic rate, i.e, thermogenesis, which in turn augmented the daily energy expenditure [2]. Hence, this study was designed to check whether this water induced thermogenesis translated into actual weight loss.

SUBJECT AND METHODS

This study was conducted at a tertiary care hospital in Mumbai, India. The approval for conduction of the said study was taken from the local ethics committee.

The study design: Fifty girl subjects were included in the study. The duration of the study was eight weeks. Written informed consents were obtained from the subjects. The purpose of the study and the rationale behind it were explained to them.

Inclusion criteria: Overweight girls (BMI 25-29.9 kg/m^2) who were of the age group of 18-23 years were included in the study.

Exclusion Criteria: It was made sure that none of the subjects had any major illnesses and eating disorders and that they were not on any medications.

Parameters of the study: Pre-study body weight, body mass index (BMI) and body composition scores were measured and they were compared with the post-study values.

Body mass index (BMI) is the cornerstone of the current classification system for obesity and its advantages have been widely exploited across disciplines, which range from an international surveillance to an individual patient assessment [3].

BMI = Weight (kg) / (Height (m) x Height (m))

The normal range is 18.5-24.9 kg/m^2, overweight is 25-29.9 kg/m^2, and obesity is >/= 30 kg/m^2 [4].

Body composition scores were computed by measuring skin fold thickness in millimetres by using skin fold calipers at three different sites – triceps, abdomen and thigh. Skin fold thickness is used as a valid anthropometric indicator of regional body fatness. Because of its low cost and non-invasive nature, it is one of the most widely used anthropometric methods for assessment of body fat. Skin fold thickness measurements were performed by lifting a fold of skin and subcutaneous fat away from the underlying muscle and bone. Each skinfold thickness was measured in duplicate by using a Harpenden skinfold caliper. When difference between the first and the second measurements exceeded 6 mm, a third measurement was taken [5]. The 'sum of skin- folds' reflected absolute or percentage changes in fatness before and after physical conditioning or diet regimens. Hence, the sum of the individual skin fold thicknesses at three different sites were taken as a composite score.

Study Procedure: Before the start of the study, body weights and heights of all the 50 girl subjects were measured and they were tabulated.

BMI was calculated as Weight (kg) / (Height (m) x Height (m). Body composition scores were computed by taking sum of the individual skin fold thicknesses at three different sites as a composite score.

After taking the pre-study readings, the subjects were instructed to increase their water intake by 1.5 litres, over and above their usual daily water intake. This increment in water intake was made by drinking 500 ml of water, half an hour before breakfast, lunch and dinner. The increments in water intake of the subjects before breakfast and before lunch were directly supervised and the increment which had to be made before dinner was instructed to them. At the end of eight weeks, the parameters of the study were re-assessed. The compliance to the instructions which were given to the subjects was good, on an average.

STATISTICAL ANALYSIS

The statistical analysis of the data of the present study was done by a professional statistician. SPSS, version 14.0.1 was used. Since the study was interventional in nature, paired t-test was used to find out the statistical significance of the results. A p - value of less than 0.05 indicated that the result were significant statistically and a p - value which was less than 0.01 indicated that the results were highly significant, statistically.

RESULTS

1) Body weight: The mean value for the pre-study body weight was 65.86 kg and that for post-study body weight was 64.42 kg. The p- value was less than 0.01 and hence, the result for body weight was highly significant statistically [Table/Fig-1].

2) Body mass index (BMI): The mean value for the pre-study body mass index was 26.7002 kg/m^2 and that for post-study body mass index was 26.1224 kg/m^2. The p-value was less than 0.01 and hence, the result for body mass index was also highly significant statistically [Table/Fig-2].

3) Body composition score: The mean value for the pre-study body composition score was 79.626 mm and that for the post-study body composition score was 76.578 mm. The p-value was less than 0.01 and hence, the result for body composition score was also highly significant statistically [Table/Fig-3].

DISCUSSION

This study which was done on evaluation of the role of thermogenic effect of excessive water intake in weight reduction was conducted in view of the inadequacy of the studies which had addressed this issue. As no studies had been done previously, we considered the results of the present study and the hypothesis for the same. This study was conducted on 50 girls for a duration of eight weeks. The results of the study were analyzed statistically by using the paired t-test, with A p-value of less than 0.05 indicating significant results and a p-value of less than 0.01 indicating highly significant results.

The mean values for the pre-study and post-study body weight, body mass index and body composition scores were 65.86 kg and 64.42 kg, 26.7002 kg/m^2 and 26.1224 kg/m^2 and 79.626 mm and 76.578 mm respectively. All the three results were highly significant statistically.

In 2003, a study was conducted to test the hypothesis that 'the sympathetic stimulus which was provided by water drinking could increase the metabolic rate' (Thermogenesis), which was published in 'The Journal of Clinical Endocrinology and Metabolism'. The novel finding of this study was that drinking 500 ml of water increased metabolic rate by 30% in both men and women. The increase in metabolic rate was observed within 10 minutes after completion and it reached a maximum, 30-40 minutes after water drinking. The effect was sustained for more than an hour. Based on these measurements, it was estimated that increasing water ingestion by 1.5 litres, over and above the normal water intake, would augment daily energy expenditure by approximately 200 KJ. Over one year, energy expenditure would increase by 73,000 KJ (17,400 Kcal), which is the energy content of 2.4 kg adipose tissue [2]. Hence, this study was designed to check whether this water induced thermogenesis translated into actual weight loss.

A similar study was done in 2011 on overweight children to check the effect of water drinking on the Resting Energy Expenditure (REE). This study demonstrated an increase of up to 25% in REE, following the drinking of 10 ml kg$^{(-1)}$ of cold water in overweight children, which lasted for over 40 min [6].

Parameter	Paired samples statistics						Paired samples test			
Body weight (kgs)	Pre-study body weight			Post-study body weight			Paired differences		t- value	p-value
	Mean	SD	SEM	Mean	SD	SEM	Mean	SD	10.254	0.000 *
	65.86	3.614	0.511	64.42	3.704	0.524	1.44	0.993		

[Table/Fig-1]: Pre and post–study body weight
* (p<0.01) (highly significant statistically)

Parameter	Paired samples statistics						Paired samples test			
Body Mass Index	Pre- study body mass index			Post- study body mass index			Paired differences		t- value	p-value
	Mean	SD	SEM	Mean	SD	SEM	Mean	SD	10.208	0.000 *
	26.7002	0.9423	0.1332	26.1224	1.0632	0.1503	0.5778	0.4002		

[Table/Fig-2]: Pre and post–study body mass index (BMI)
* (p<0.01) (highly significant statistically)

Parameter	Paired samples statistics						Paired samples test			
Individual scores : (in mm)	Pre- study weight			Post- study weight			Paired differences		t- value	p-value
	Mean	SD	SEM	Mean	SD	SEM	Mean	SD		
a) Triceps	26.490	3.685	0.521	25.316	3.780	0.534	1.174	0.6945	11.953	0.000*
b)Abdomen	26.632	3.634	0.514	25.780	3.563	0.504	0852	0.979	6.151	0.000*
c) Thigh	26.504	3.616	0.511	25.482	3.698	0.523	1.022	0.541	13.347	0.000*
Total Score (in mm)	79.626	10.385	1.468	76.578	10.477	1.481	3.048	1.687	12.774	0.000*

[Table/Fig-3]: Pre and post–study body composition score
* (p<0.01) (highly significant statistically)

The proposed hypothesis for explaining the role of water drinking in weight loss is as follows:

i) Recent studies have suggested that water drinking elicited acute changes in human physiology. Water drinking profoundly increases blood pressure in patients with autonomic failure. Also, water drinking was shown to increase energy expenditure. The acute changes in cardiovascular regulation and in energy expenditure with water drinking appear to be mediated through activation of the sympathetic nervous system. The acute water pressor response has been exploited in the treatment of patients with impaired orthostatic tolerances [7-10].

Thus, water drinking provides a sympathetic stimulus, which increases the metabolic rate, i.e, thermogenesis, which in turn augments the daily energy expenditure.

The mechanism that elicits a sympathetic activation with water drinking remains unclear. Perhaps, the sympathetic activation with water drinking involves osmo-receptive or osmolality of water being the primary stimulus [11,12].

A study was done in 2005, in Germany, which was published in the journal, 'Neurology', in which the possible mechanism for the sympathetically mediated pressor response to water drinking was studied. It was reasoned that gastro intestinal distension, hypo-osmotic solution, or both contributed to the water induced pressor response [13].

ii) Water is essential to metabolise stored fat into energy, so much so, that the body's metabolism can be slowed down by relatively mild levels of dehydration. Slower the metabolism, slower is the weight loss. To evaluate this aspect, body composition score was taken as one of the parameters of the study, by measuring the skin fold thickness at specific sites. The sum of all the individual scores was taken as a composite score.

iii) Water is a natural appetite suppressant. To evaluate this aspect, appetite score can be taken as one of the parameters in studies, which can be calculated by using the Visual Analogue Scale (VAS). Using the Visual Analogue Scale for appetite can be considered for further research, to check the effect of water induced thermogenesis on appetite suppression.

CONCLUSIONS

Obesity is one of the greatest threats to the health of people. Even a modest weight loss can significantly reduce the morbidity and mortality which are associated with it. In the present study, an attempt was made to check the effect of water drinking in overweight subjects, in terms of weight loss. The decrease in body weight, body mass index and body composition scores of overweight subjects at the end of study period established the role of water induced thermogenesis in weight reduction of overweight subjects. Thus, water drinking induced thermogenesis is an important and unrecognized component of daily energy expenditure. If this is confirmed in other studies, this cost free intervention may be a useful adjunctive treatment in overweight and obese individuals for attaining an increase in energy expenditure.

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