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The Acute Consumption of an Isovolumic Water or Protein Shake Affects Body Composition as Determined via a Multi-Frequency Bioelectrical Impedance Analysis

Original Research

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Abstract

Introduction: The purpose of this study was to examine the effects of consuming either591.5 mL of water or 591.5 mL of isovolumic protein shake (160 kcal, 3 g fat, 4 g carbohydrate, 30 g protein) on indices of body composition.
Methods: Forty-two recreationally active men (n=13) and women (n=29) (mean±SD – height 168±10 cm, age 22±5 yr, body mass 69.8±11.2 kg) consumed 591.5 mL of water or a protein shake in a randomized, crossover study. Body composition was assessed via multi-frequency bioelectrical impedance (InBody 270) at baseline, immediately post-consumption (0 minutes), 30 minutes post-consumption, and 60 minutes post-consumption.
Results: There were no significant changes in body mass, lean body mass, and fat mass between the water and protein groups over the treatment period. In both water and protein groups, percent body fat was significantly greater ($p<0.0001$) at time points 0, 30, and 60 minutes compared to baseline.
Conclusions: The acute consumption of either water or an isovolumic protein shake resulted in a measurable increase in percent body fat immediately post-consumption as well as 30 and 60 minutes thereafter.

Key Words: BIA, Anthropometrics, Hydration

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Introduction

Bioelectrical Impedance Analysis (BIA) is an inexpensive, non-invasive, and readily adaptable test that estimates body composition and total body water (TBW). BIA is a popular and highly reliable assessment tool with many advantages; it is a quick and easy method for assessing body composition in vivo. The test is easy to administer which eliminates the need to use specially trained, well-experienced technicians. The results of BIA are instantaneous, reliable, and have high validity [1-3]. BIA uses a prediction equation based on the opposition of alternating electrical currents [3-5]. In the human body, the opposition of resistance is the extra-cellular part of non-adipose tissues [2]. The electrical current or resistance rate at a specific frequency is inversely related to total body water and lean body mass [1, 2]. Unlike lean body mass, which has a higher water and electrolyte content, bone mass and adipose tissue are not as conductive, thus, generating more resistance to the electrical flow [2]. Therefore, the difference in the electrical currents traveling through the body is used to determine the amount of lean body bass and fat mass.

The InBody270 is an electric circuit in hand-to-foot BIA that extends from the wrist to the ankle. The InBody270 utilizes different frequencies ranging from 0 to 500 kHz. Using multi-frequency measures the resistance through the arm, trunk and leg allows for the segmental assessment of the gut, trunk, upper and lower body rather than whole body [1, 4, 6]. MF more accurately predicts extra-cellular water compared to a single frequency and better estimated total body water compared to bioelectrical spectroscopy (BIS)[1, 6]. Body impedance is a function of body size, body water, and ionic content. A change in any of these parameters could result in inaccurate measurements. Food and drink consumption, exercise-induced variation in body fluids, and skin temperature are all considered to influence BIA accuracy [7-13].

Although there have been some studies on the influence of food and hydration on the hand-to-hand and foot-to-foot method, there have not been many published studies that consider the effect of immediate fluid consumption on measurements with hand-to-foot BIA. Several studies examining the traditional BIA method have reported significant changes in whole-body impedance, %BF, and total body water after drinking [8-11]. Other studies reported no effects after fluid consumption [14, 15]. Hence, the general recommendation is to perform MFBIA in a fasted state. Due to the rate of digestion, macronutrient distribution of meals is thought to affect impedance levels. Impedance after a high-fat meal compared to a high carbohydrate meal was reported to be higher [11].

However, the author is unaware of any data showing whether protein consumption (through a protein shake) would affect body impedance readings. Thus, there is no research comparing the post-consumption effects of protein and water. Therefore, the present study aimed to assess if water and protein alone can affect hydration levels, potentially skewing the results of biological impedance analysis.

Scientific Methods

Subjects

Forty-two healthy, active adults (13 male, 29 female) aged 19-44 (n = 22) volunteered to participate in this randomized crossover trial. The Nova Southeastern University International Review Board, approved the study protocol. All subjects signed informed consent before the investigation.

Study Protocol

Each subject reported to the body composition laboratory on two occasions. Subjects were instructed to adhere to the following guidelines: (a) no excessive physical activity for 12 hours prior to the test (b) no alcohol for 24 hours prior to the test, and (c) no food for 4 hours prior to the test. Additionally, subjects were instructed to arrive adequately hydrated and to void their bladder prior to the baseline measurement. Body composition was measured through Bioelectrical Impedance Analysis (BIA). Total body weight (TBW), lean body mass (LBM), body fat mass (BFM), skeletal muscle mass (SMM), percent body fat (PBF), and dry lean mass (DLM) were all measured with the InBody270. After initial body composition measurements were taken, each subject was asked to consume either 591.5 mL of plain water or either 591.5 mL of protein (1 scoop of protein powder mixed with 591.5 mL of water) served. Body composition was assessed at 0, 30, and 60-minute post-consumption.

Statistical Analysis

A one-way ANOVA was performed to determine if any time points differed from baseline. Furthermore, Dunnett's multiple comparisons test was used to determine which time points differed from baseline.

Results

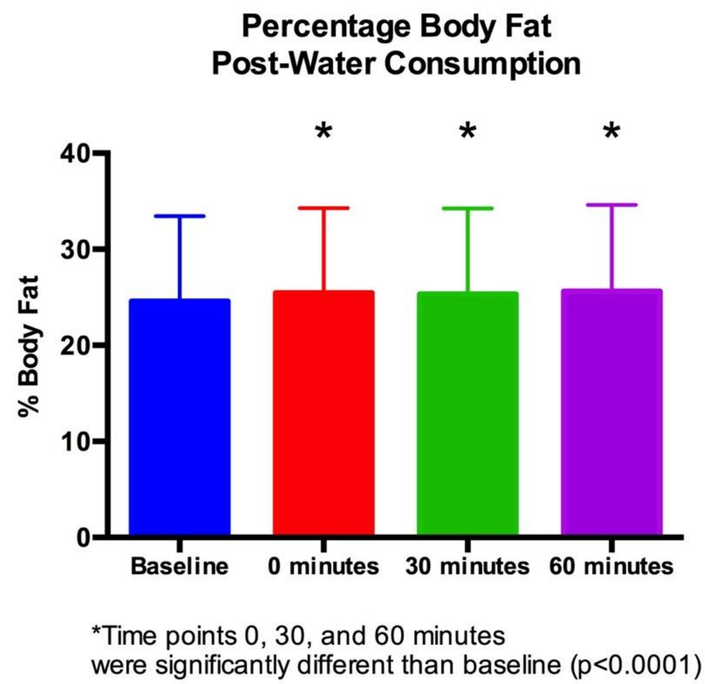
Anthropometric characteristics are described at baseline in Table 1 and Table 2. All data are expressed as the mean +/- SD. No significant changes were reported in body mass, lean body mass, fat mass, and total body water across all time points in both water and protein groups. Significant differences in percent body fat at 0, 30, and 60 min post consumption were reported compared to baseline (Table 1, Figure 1, and Figure 2).

Table 1. Body Composition Post-Consumption of Water

	Baseline	0 min	30 min	60 min
Body Mass (kg)	69.8±11.2	70.4±11.2	70.3±11.2	70.3±11.2
Lean Body Mass (kg)	52.7±11.1	52.5±11.2	52.6±11.2	52.4±11.2
Fat Mass (kg)	17.1±6.6	17.8±6.6	17.7±6.7	17.9±6.8
Total Body Water (Liters)	38.6±8.1	38.4±8.2	38.5±8.2	38.3±8.2
Percent Body Fat	24.6±8.9	25.5±8.8*	25.3±8.9*	25.6±9.0*

Data are presented as the mean±SD. Legend: kg (kilogram); min (minute). *p<0.0001 versus baseline.

Figure 1. Percent Body Fat Post Water Consumption.



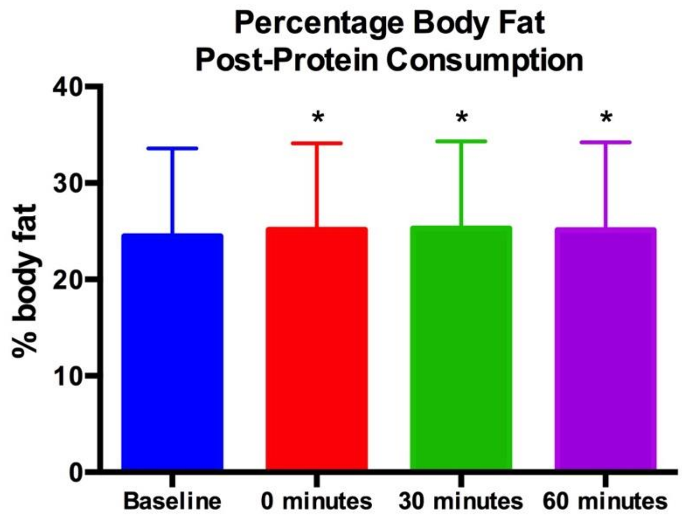
	Baseline	0 minutes	30 minutes	60 minutes
Mean	24.59	25.46	25.31	25.61
Std. Deviation	8.872	8.839	8.946	9.004

Table 2. Body Composition Post-Consumption of Protein

	Baseline	0 min	30 min	60 min
Body Mass (kg)	69.3±11.1	69.9±11.1	69.9±11.1	69.8±11.1
Lean Body Mass (kg)	52.4±11.0	52.4±11.0	52.3±11.0	52.4±11.0
Fat Mass (kg)	16.9±6.8	17.5±6.7	17.6±6.8	17.5±6.8
Total Body Water (Liters)	38.4±8.0	38.3±8.0	38.0±8.4	38.3±8.0
Percent Body Fat	24.5±9.1	25.2±9.0*	25.3±9.1*	25.1±9.1*

Data are presented as the mean□ SD. Legend: kg (kilogram); min (minute). *p<0.0001 versus baseline.

Figure 2. Percent body fat post protein consumption.



Time 0, 30 and 60 minutes were significantly greater than Baseline (p< 0.0001)

	Baseline	0 minutes	30 minutes	60 minutes
Mean	24.49	25.16	25.27	25.12
Std. Deviation	9.103	8.952	9.058	9.084

Discussion

Contact-electrode BIA analyzers have become an increasingly common method of assessing body composition in clinical and academic settings. Subjects were instructed to refrain from fluid consumption four hours prior to the test to increase measurement accuracy [5, 16]. This study indicated that fluid consumption in the form of water or a protein-containing beverage results in an artificial elevation of body fat percentage. These findings are similar to other studies. Androutsos et al. [11], conducted a study comparing changes in body fat percentage following the consumption of food, water, or electrolyte beverage. Changes in impedance at all time points (30, 60, 90, and 120 min) in all groups were observed. Percent body fat significantly increased at all time points following food and electrolyte consumption but only increased immediately after (o min) after drinking water. Contrary to these findings, Dixon et al. [17], did not report any differences after the consumption of water or carbohydrate-electrolyte drink. After consuming 591 ml of either beverage, a slight change in body fat percentage and body mass at 20, 40, and 60 min post compared to baseline. No changes were reported in total body water. This study suggests the increase in body mass resulting from the consumption of food or drink influences BIA results rather than changes in impedance. Ugras et al. [18], conducted a study observing acute changes following water consumption. Subjects consumed 500 ml of water, and BIA was performed 15 minutes post-consumption. This protocol was performed a total of four times. Significant changes in fat mass and percent body fat were reported at all time points compared to baseline. Unlike our study, significant changes in fat-free mass and total body water were reported at all time points compared to baseline. BIA predicts body composition using equations that consider age, gender, and body mass. In the present study, significant changes in percent body fat were observed, with no significant changes in fat-free mass. Elevations in measured body fat percentage is most likely due to increased body mass associated with fluid consumption. Although the changes in body fat percentage were significant in the present study and the aforementioned studies, changes were minimal, suggesting acute fluid consumption does not result in clinically relevant changes. It has been suggested that consumption of liquids, even in large amounts (>2L), may not be detected via MFBIA in the first hour [2]. In the present study, subjects consumed far less than 2L and were only assessed for up to 60 min post consumption, which may account for no observed TBW.

Subject activity level is a possible limitation of this study. It is unknown whether similar findings would occur in inactive populations. A second limitation of this study is that post-consumption readings only extended for 60 minutes. This may not be enough time for liquid consumed to move through the gastrointestinal tract and be absorbed into the bloodstream.

Conclusions

In summary, the acute consumption of both water and a protein-containing beverage induced a measurable increase in percent body fat immediately post-consumption as well as 30 and 60 minutes post-consumption. Although significant, these changes were small and within the margin of error. Nevertheless, one must be cautious in assessing body composition via bioelectrical impedance due to the fact that percent body fat can be significantly affected by the acute consumption of fluid.

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Not applicable

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