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Original Research Article

Effect of Whey Protein Intake on Female Body Composition and Resting Metabolic Rate

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Abstract

The aim of the current study was to examine the effect of whey protein supplement on anthropometric measurements as well as on resting metabolic rate. Forty-one Saudi female students between 18-24 years old recruited for this case controlled study. Twenty-eight students were given 24 grams of whey protein supplement daily for 21 days. These subjects were divided into three groups based on their body mass index. Group one with normal weight, group two with overweight, group three with obesity. The remaining subjects who had normal weights served as controls. Anthropometric measurements, blood analysis, resting metabolic rate were measured in all subjects at baseline and at the end of the study. Twenty-four hours recall was conducted four-five times during the study to determine macronutrients intake for all subjects. Fat body mass decreased significantly (P= < 0.024) in group one. Resting metabolic rate increased significantly in group one and three subjects (P= < 0.001). Group two and three were not regularly eating breakfast by 42.9% and 50%, respectively. Dietary whey protein supplementation even during a three-week intervention showed significant increase in resting metabolic rate among females' subjects with normal weight as well as subjects with obesity.

Keywords: Body composition, Females, Metabolic Rate, Obesity, Whey protein

INTRODUCTION

World Health Organization (WHO) estimate that 2.8 million people die annually because of obesity. In all WHO regions, women were more likely to have obesity than men (WHO, 2017). Saudi Arabia is one of the highest prevalence of obesity and overweight (DeNicola et al., 2015). Nevertheless, body fat accumulation is associated with several health risks such as atherosclerosis, heart diseases, cancer, type 2 diabetes and osteoarthritis (Must and McKeown, 2012). The recommended dietary allowances (RDA) for a normal person for protein intake should constitute between 10-35% of the total daily energy requirement (Pesta and Samuel, 2014; Antonio et al., 2014). A diet with more than 0.8 grams per kilogram body weight is considered a high protein diet (USDA, 2015). High protein intake is a potential successful tool for weight loss (Halton and Hu, 2004; Lorenzen et al., 2012; Tang et al., 2013). In addition, subjects who consumed a high protein diet lost less lean body mass than subjects who consumed normal amount of protein (Tang et al., 2013). The addition of high protein breakfast prevented an increase in body fat and weight (Leidy et al., 2015). When the effect of different protein types (whey, casein and soy) on energy metabolism was studied, it was found that whey, casein, and soy protein meals were better than carbohydrates in their thermogenic effect (Halton and Hu, 2004; Acheson et al., 2011). Amongst the proteins, whey was found to have the highest thermogenic effect and cumulative fat oxidation (Mikkelsen et al., 2000; Acheson et al., 2011; Tsani et al., 2012). The aim of the current

study was to examine the effect of a whey protein supplement on anthropometric measures as well as on resting metabolic rate (RMR).

MATERIALS AND METHODS

Subjects

Healthy Saudi female students recruited from Imam Abdulrahman Bin Faisal University for this case controlled study. The inclusion criteria were: age (18-24 years), non-smokers, non-pregnant, and non-lactating. The exclusion criteria were: whey protein allergy, metabolic disease, diabetes, hypothyroidism or being rigorously athletic.

Food habit questionnaire

A questionnaire was designed to collect data related to food habits, nutritional intake, and food consumption pattern. This utilized 24-hour recall four-five times during the study to determine macronutrients intake.

Experimental design

Forty-one subjects were divided to 4 groups; A control group with normal body mass index (BMI), (BMI range 18.5-24.9) (n=13). The experimental groups were as follows: group one with normal weight (BMI range 18.5-24.9) (n=15), group two with overweight (BMI range 25-29.9) and group three with obesity (BMI range 30-34.9) (n=7). The study was conducted over a period of 21 days. Experimental groups received whey protein powder (24 grams daily). They were instructed to take the supplement mixed with water only, at 8:00 am. Reminder messages were sent via social media platforms daily. The following measurements were made at baseline and at the end of the study period. Body weight and height were measured with calibrated electronic scale and a stand meter. The BMI was derived from these measurements. Total body fat (TBF) and lean body mass (LBM) were measured using the Tanita device. Blood analysis for albumin, total protein, and creatinine were performed at the same hospital laboratory using UNICELL DXC 600 made by Beckman Coulter International SA**,** Switzerland. Cardio Pulmonary Exercise Testing (CPET) measured RMR, oxygen consumption (VO2) and carbon dioxide production (VCO2) after a period of 12 hours fast in the Exercise Physiology Laboratory at the Physical Therapy Department of Imam Abdulrahman Bin Faisal University in Dammam.

Ethical consideration

1-Ethics approval

The institutional review board (IRB) committee at University of Imam Abdulrahman bin Faisal (University of Dammam previously) approved the study. The IRB number: IRB-UGS- 2015-03-217 dated 7th December 2015. (Appendix A)

2-Consent for publication

All participants in the study were provided with an information sheet that clearly stated that the result from the study should be published in a scientific journal. All participants signed a written consent agreeing to take part in the above study. (Appendix B)

Statistical analysis

Significant differences (p-value) by (ANOVA) and least significant difference (LSD) for verifying differences between groups, and paired sample t-test for verifying differences between values before and after dietary intervention was done using Statistical Package for the Social Science program (SPSS version 23). A p value =/< 0.05 is considered significant.

RESULTS

All subjects had complete baseline data. Five subjects did not complete the study for the following reasons: One subject developed vomiting and diarrhea following supplement ingestion, two could not come for the final visit due to lack of suitable transport at the required time, one did not tolerate the taste of the supplement while the fifth decided not to come for the final visit. Table 1 describes the anthropometric measurements before and after dietary intervention. There was no significant difference in body weight, BMI or LBM at the end of the study compared to baseline. However, FBM decreased significantly (p=0.024) only in subjects in group one. Table 2 illustrates the RMR of the studied groups before and after dietary intervention. There was a significant increase in RMR amongst subjects in group one (p=< 0.000) and three (p= < 0.001) at the end of the study in comparison to baseline. There was a significant increase in VCO2 production when compared to baseline in group one subjects (p=< 0.000) and group three (p=< 0.038). For VO2 consumption, group one, two and three showed an increase in comparison to baseline with p= < 0.002, p=< 0.042, and p=< 0.001, respectively. Table 3 illustrates the least significant difference between the

Table 1. Mean±SD of anthropometric measurements among female students before and after dietary intervention

		Control group	Experimental groups			ANOVA	
			Group one ¶	Group two ††	Group three ‡‡	P value	Sig. §§
Height (cm)		159.67±8.93	160.76±7.21	160.66±7.60	156.35±2.80	0.615	0.610
Weight (kg)	Baseline	55.75±9.17	56.01±7.75	68.70±5.84	77.76±2.08	16.213	0.000
	End of study	56.06±9.27	55.47±7.90	68.45±5.71	77.23±1.76		
	t-test	0.220	0.062	0.303	0.239		
BMI† (kg/m^2)	Baseline	21.93±2.07	21.41±1.53	26.61±1.08	31.84±1.22	46.607	0.000
	End of study	21.83±2.00	21.20±1.86	26.51±1.17	31.62±1.49		
	t-test	0.720	0.362	0.292	0.262		
LBM‡ (kg)	Baseline	39.50±3.67	39.04±5.39	42.87±2.62	44.40±7.09	7.664	0.000
	End of study	39.50±3.89	40.38±2.89	43.06 ±2.48	45.75 ± 1.3		
	t-test	0.984	0.406	0.324	0.666		
FBM§ (%)	Baseline	24.26±6.75	24.16±6.36	34.28±2.14	40.15±4.71	11.968	0.000
	End of study	24.15±6.73	23.34 ±6.45	33.60 ±2.16	39.24±3.76		
	t-test	0.797	0.024	0.115	0.323		

†Body Mass Index ‡Lean Body Mass; § Fat Body Mass; ¶ Subjects with Normal Weight; ††Subjects with Overweight; ‡‡ Subjects with Obesity; §§ Level of significance for ANOVA test P value.

Table 2. Mean±SD of resting metabolic rate among female students before and after

		Control group	Experimental groups			ANOVA	
			Group one ¶	Group two ††	Group three ‡‡	P value	Sig.§§
RMR† kcal/day	Baseline	1684.84±58.96	1638.54±43.19	1675.66±42.73	1655.83±50.53	1.170	0.338
	End of study	1692.69±58.45	1706.72±49.23	1760.33±111.43	1690.00±49.85		
	t-test	0.213	0.000	0.166	0.001		
VCO2‡ ml/min	Baseline	195.84±19.77	187.90±11.22	183.00±8.54	138.50±35.38	11.911	0.000
	End of study	192.07±18.92	204.72±10.48	187.33±10.40	142.83±37.31		
	t-test	0.080	0.000	0.096	0.038		
VO2§ ml/min	Baseline	237.38±11.58	239.36±9.38	234.66±7.09	239.16±7.65	1.503	0.235
	End of study	236.15±17.78	247.36±12.41	240.33±5.03	246.16±6.67		
	t-test	0.602	0.002	0.042	0.001		

† Resting Metabolic Rate; ‡VCO2**:** Carbon Dioxide Production; § VO2**:** Oxygen Consumption; ¶ Subjects with Normal Weight; ††Subjects with Overweight; ‡‡ Subjects with Obesity; §§ Level of significance for ANOVA test P value.

Table 3. LSD of resting metabolic rate among female students before and after dietary intervention.

		RMR¶ kcal/day	VCO2†† ml/min	VO2‡‡ ml/min
Control group	Group one†	-14.034	-12.650	-11.209
	Group two‡	-67.641	4.743	-4.179
	Group three§	2.692	49.243***	-10.012

† Subjects with Normal Weight; ‡ Subjects with Overweight; § Subjects with Obesity; ¶ Resting Metabolic Rate; ††Carbon Dioxide Production; ‡‡ Oxygen Consumption;*** p=< 0.001.

control group and the experimental groups and shows that the subjects in group three had significantly more VCO2 production in comparison to the control group (p=< 0.001). Laboratory testing showed no significant change in serum total protein, albumin or creatinine for any of the subjects during the course of the study. The questionnaire revealed that 53.3% of subjects in group one and 28.6% of group three ate three meals per day.

Sixty-one % of the control group also had three meals per day. 33.3% of subjects in group two skipped dinner. 42.9% of the subjects at group three skipped dinner while 28.6% skipped lunch. In addition, it showed that group two and three subjects were not regularly eating breakfast by 42.9% and 50%, respectively. The highest percentage of breakfast consumption was amongst the control and group one at 69.2% and 66.7% respectively. The result from 24-hour recall analysis indicated that there were no significant difference in energy, fat and carbohydrate consumption among the studied groups.

DISCUSSION

The current study showed no difference in body weight, BMI and LBM probably due to the short study period (Halton and Hu, 2004; Frestedt et al., 2008; Tang et al., 2013). We also observed that subjects with overweight were more likely to skip breakfast. This suggests a possible relationship between meal timing and body weight. These findings are consistent with prior observation that people who consume a large daily meal at breakfast are more likely to lose body weight and waist fat than those who consume a large dinner (Jakubowicz et al., 2013). Our study confirmed that FBM was significantly decreased in group one (normal weight) subjects who were supplemented with a high protein diet. This is similar to previous observation (Halton and Hu, 2004; Frestedt et al., 2008; Arciero et al., 2013). Group one (normal weight) and group three (subjects with obesity) showed a significant increase in the RMR after whey protein supplementation. An increase in RMR over a period of time can lead to a reduction in body weight. Similar results were obtained from previous observations (Mikkelsen et al., 2000; Acheson et al., 2011; Tsani et al., 2012).The potential mechanism for this in the experimental groups (one, two, and three) could be the increased oxygen consumption observed clearly in this study. This is also consistent with prior observation that replacing carbohydrates by an equivalent amount of calories from animal or plant protein resulted in greater energy expenditure. A high protein diet enhances satiety and fullness and reduces hunger thus leading to reduction in food intake and weight (Brennan et al., 2012). We propose that the public require more education on the safety and benefit of increased protein intake as well as the benefit of not missing breakfast as a strategy to tackle the obesity and overweight epidemic in many communities.

CONCLUSION

Overweight and obesity are more likely not to eat breakfast. Dietary whey protein supplementation even during a three-week intervention showed significant increase in resting metabolic rate amongst female subjects with normal weight and subjects with obesity. It also induced a decrease in fat body mass in normal weight subjects.

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