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Efficacy of Individual Nutrition Counseling on Resting Energy Expenditure, Oxygen Consumption, Fat-Free Mass, and Percentage Fat of Body Weight

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Abstract

There is agreement that optimizing intake of calories, protein, and carbohydrates to fuel muscle will enable athletes to train harder, but translating nutrition knowledge into nutrition behavior is problematic. The efficacy of individual nutrition counseling (INC) on nutrition behavior using objective measurements in competitive athletes has not been investigated. We therefore evaluated the influence of INC on the objective outcomes: oxygen consumption (VO2) at rest, resting energy expenditure (REE) measured by indirect calorimetry, fat-free mass (FFM), and percentage fat of body weight (PF) measured by tetra-polar bioelectrical impedance in varsity cross-country athletes at three time points of pre-during-& post-season.

A block design of 20 male and female competitive cross-country participants, 18 years and older, was randomly divided into experimental and control groups. All participants completed 3-day diet and exercise logs for baseline nutrition information and received a general nutrition team talk, whereas 10 participants received INC based on REE and specifically tailored to each of their food preferences and daily training routines. Special emphasis was placed on timing of meals and snacks and pre- and post-workout fueling choices. Diet logs were analyzed by computer for baseline measures of calories, protein, and carbohydrates. VO2, REE, FFM, and PF were assessed by standard procedures to provide objective outcome measures at three time points.

Female participants who received INC were the most consistent across the time points in maintaining VO2, REE, and FFM, suggesting they were more receptive to INC than the other groups. Subjective feedback further suggested that motivated participants of both genders who received INC were most responsive to change behaviors.

Our results suggest that in this group of competitive cross-country runners, motivational INC helped female athletes to maintain VO2, REE, and FFM. A larger study using various sports and follow-up nutrition intake logs may provide further insight into the efficacy of individual nutrition counseling on athletic training.

Introduction

Scientific literature clearly documents athletes' need to consume adequate calories, protein, carbohydrates, as well as appropriate timing to fuel muscles during training and competition for maximal performance (American Dietetic Association, 2009; Zinn, Jessri, & RashidKhani, 2010). Intake of athletes is generally seen as inadequate, especially as related to total calories and carbohydrates (Wenzel, Valliant, Chang, Bomba, & Lambert, 2012). Barriers to optimal nutrition are lack of knowledge, rigorous schedules, and food availability. The reliance on equations to calculate energy needs, versus indirect calorimetry, may further be seen as an obstacle to assess the true needs of individual athletes.

Athletes lack knowledge despite high interest in nutrition information and this misinformation may lead to poor food intake and declined performances (Cotugna, Vickery, & McBee, 2005). Nutrition education to improve knowledge has been seemingly successful, but mostly did not lead to positive behavior changes (Rash, Malinauskas, Duffrin, Barber-Heidal, & Overton, 2008). However, objective body composition outcome measures have not been used to assess behavioral changes post-intervention, which may have further influenced assessment of behavior change.

Outcome measures to assess improvements in nutrition among athletes traditionally use self-reported surveys, questionnaires, and self-reported dietary intake logs (Rash et al., 2008). This may not be an accurate reflection of true intake and thus behavioral change. The use of objective outcome measures, such as changes in REE, VO2, FFM, and PF would conceivably be of benefit to reduce self-report bias.

Individual nutrition counseling (INC) has been proposed as an effective strategy to assist athletes to improve nutritional efficacy. Individual dietary counseling sessions for female volleyball players were associated with improvements in body composition and nutrition intake (Wenzel et al., 2012). Yet, limitations of this study, as described by the authors, included the use of equations to predict caloric needs, the use of subjective outcome measures for behavioral change, and the lack of INC. Further, the accuracy of using standardized equations to estimate caloric needs of individual athletes is a known confound, whereas across the board the use of indirect calorimetry is seen as the most accurate individualized assessment of caloric needs.

Method

Sample and Procedures

Bradley University's Committee on Use of Human Subjects in Research (CUHSR) approved the study and all participants signed the informed consent document. The study used a randomized block design, randomly assigning ten collegiate cross-country runners of each sex

to either intervention or control. All 20 participants received a general nutrition team talk, whereas 10 participants in the experimental group received INC. Seniors were excluded, as they would have graduated before research was completed.

A team talk was provided for all participants that emphasized the importance of calories, protein, and carbohydrates to athletic performance. Questions regarding the appropriate timing of intake for training and competitions were answered. Detailed information regarding nutritional intake, fueling by macronutrients, and timing of daily food intake were discussed. Participants provided 3-day nutrition logs for individual baseline assessment of calories, protein, and carbohydrate intake. From February to August 2012, participants partook in three measurement days at the beginning, middle, and end of season to obtain physical measurements. The experimental group additionally set up appointments after each measurement day for INC.

INC sessions lasted approximately 20 to 30 minutes and individualized content for each participant included caloric intake based on the athlete's indirect calorimetry measurements, the appropriate percentage of carbohydrates, lifestyle and training schedules, as well as timing and choices for pre- and post-workouts snacks. Participants in the experimental group were encouraged to approach the counselor at any time with questions or concerns.

Measures

Each participant's VO2, REE, FFM, and PF were measured on three occasions during the athletic season: pre-season, during season, and post-season. All measurements were conducted by trained assistants following standard procedures and manufacturers' guidelines.

Height was measured by a wall-mounted stadiometer (Tanita*) and rounded to the nearest 0.5 cm. Weight was measured by platform bioelectric impedance analyzer (Tanita*). These measures were used as variables for the following measurements. VO2 and REE were measured at rest by indirect calorimeter (KorrMed*). Participants at rest breathed through a mouthpiece in a quiet surrounding to provide objective assessment of REE and aerobic capacity. FFM and PF were measured by tetrapolar bioelectrical impedance analyzer (RJL*) on a non-conducting surface. Protocol prior to this measure included no exercise or sauna within 8 hours, no alcohol consumption within 12 hours, no vigorous exercise with perspiration, and no lotion on skin. Shoes, socks, jewelry, and metal were removed. An activity factor of 4, very active, was used consistently across participants when entering subject information into instrument. These measurements provided objective outcomes for body compositional changes, muscle strength, and fat mass.

The principal investigator (PI) used the tenets of motivational interviewing when administering one-on-one nutrition counseling for the experimental group.

Counseling was based on the pre-season or baseline assessment of nutritional intake for calories, protein, and carbohydrate, training schedules and personal preferences and lifestyle reported in the 3-day diet logs. Nutrition counseling focused on individualization of needs and

timing of fueling to meet the participant's specific preferences and training schedules. The control group was promised individual counseling after completion of the study.

Descriptive statistics were used (SPSS-IBM 19.0) to detect behavior changes across the three time points as reflected by changes in the objective outcome measures of VO2, REE, FFM, and PF (experimental versus control) by sex.

Results

VO2 seasonal trends showed a decline in oxygen consumption at rest for males in the experimental and control groups. However, the female experimental group remained the same from Time 1 to Time 3 (Figure 1). Seasonal trends in REE showed a decrease in calories at rest in male experimental and female control groups, and an increase in the male control group. Similarly, REE for the female experimental group remained the same (Figure 2). Seasonal trends in FFM showed decreased levels for control groups and the male experimental group, but remained the same for the female experimental group (Figure 3). Lastly, PF increased in all groups (Figure 4).

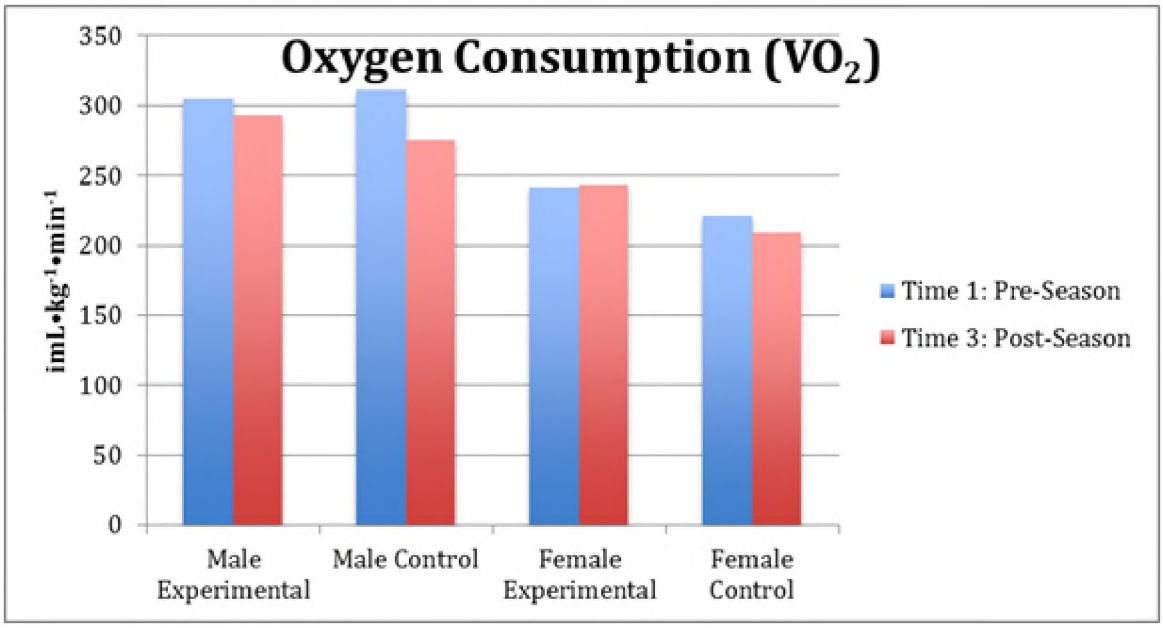

Figure 1. Oxygen consumption during rest at pre- and post-season. (*N*=20)

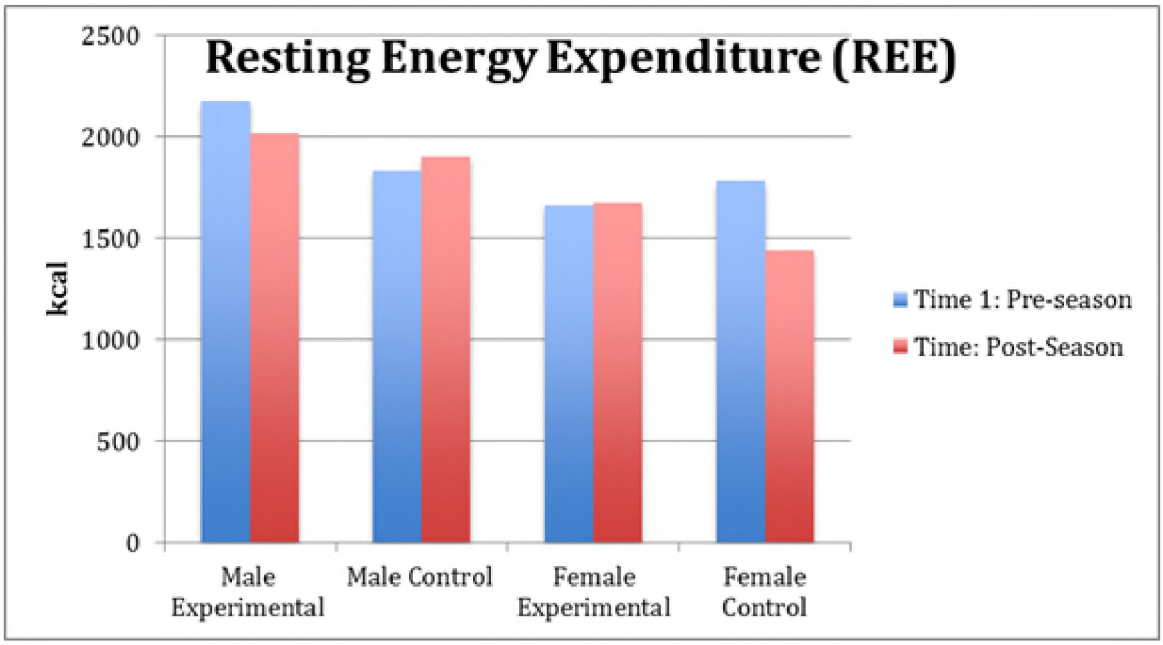

Figure 2. Resting energy expenditure during rest at pre- and post-season. (*N*=20)

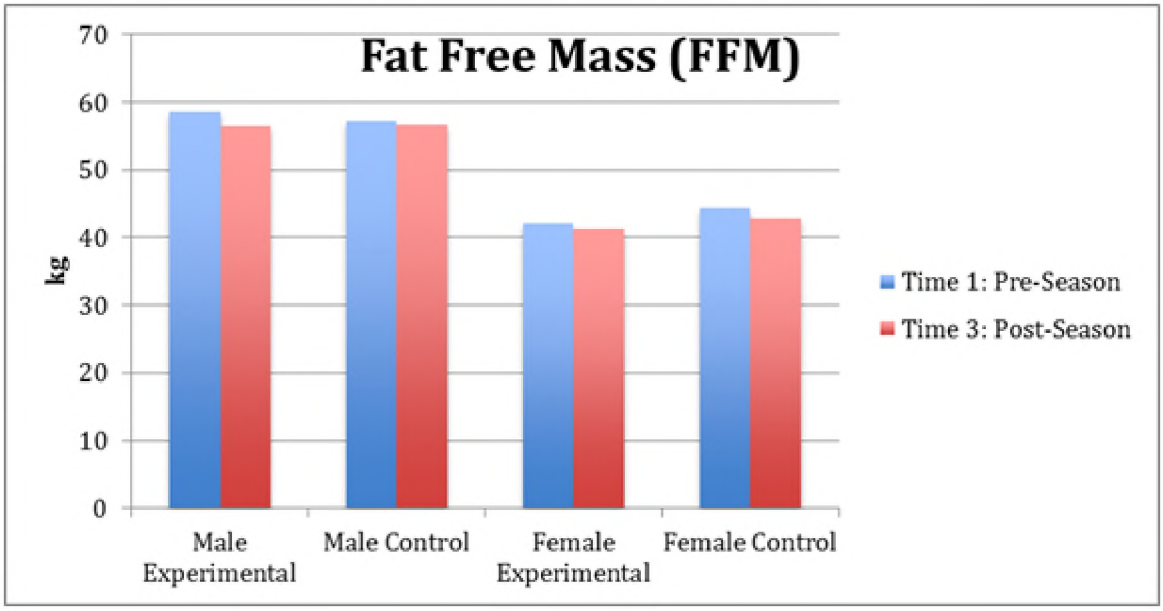

Figure 3. Fat-free mass of body weight at pre- and post-season. (*N*=20)

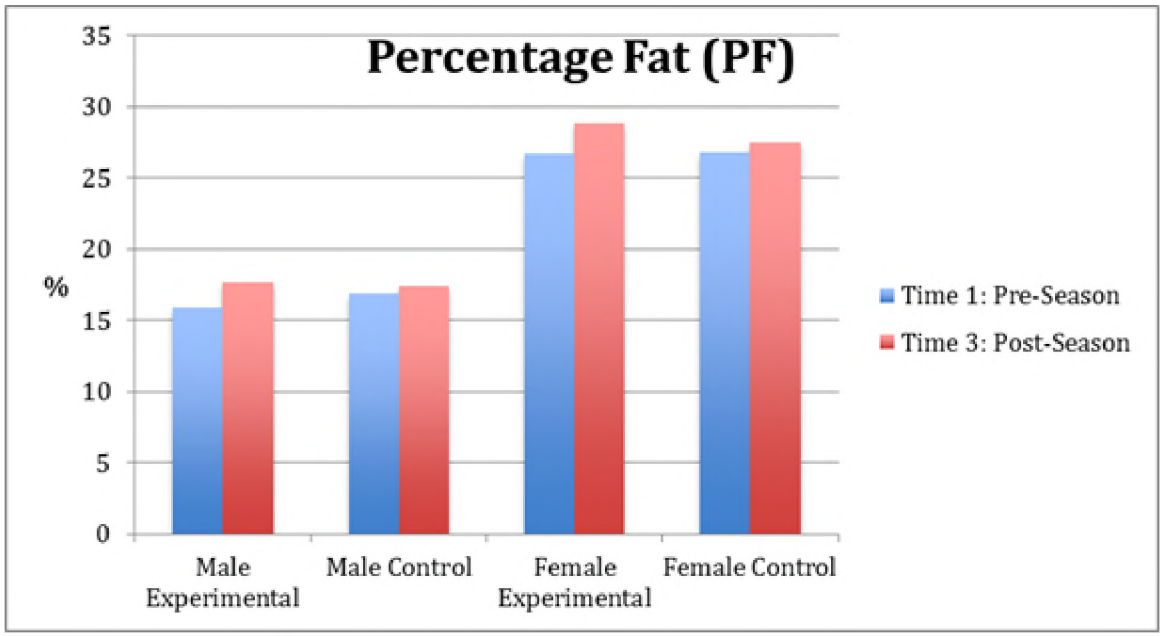

Figure 4. Percentage fat of body weight at pre- and post-season. (*N*=20)

Eighteen participants completed diet logs. Baseline data were assessed for intake of total calories, protein, and carbohydrates (Table 1). Participants' baseline energy intake varied between the control and experimental group despite random assignment. Male experimental carbohydrate intake was 45.00 ± 3.53 percent compared to male control carbohydrate intake, 54.67 ± 2.51 percent. Female experimental carbohydrate intake was 50.00 ± 3.53 percent compared to female control carbohydrate intake, 56.00 ± 6.56 percent. Thus, the PI was able to best tailor INC to the individual needs of participants in the experimental group, because only they received INC. For example, during INC, goals were set to increase percentage of carbohydrate intake between 55-65 percent of total calories which could then be observed individually during the next counseling session from 24-hour recall or completed logs (determined by participant). Thus it appears that INC achieved nutrition intakes more closely aligned to participants' actual needs compared to group recommendations in the control group's team talk.

Table 1. *Baseline dietary intake for calories, protein, and carbohydrates*

Sex	Group		Calories (kcal)	Protein (%)	Carbohydrate
Male	Control	Mean	3135.31	16.67	54.67
		SD	1261.41	3.06	2.51
	Experimental	Mean	4325.37	19.40	45.00
		SD	346.50	2.97	3.53
Female	Control	Mean	2344.88	18.00	56.00
		SD	136.37	2.24	6.56

	Experimental	Mean	2380.87	19.60	50.00
		SD	439.13	3.51	3.53
Total	Control	Mean	2641.29	17.50	55.50
		SD	795.36	2.45	5.18
	Experimental	Mean	3461.14	19.5	47.50
		SD	1087.50	2.06	4.25

Note. *N*=18. Completed by participants and analyzed using *Diet Analysis Plus* (Pearson).

Discussion

In our study, we investigated the efficacy of INC with four objective outcome measures: REE, VO2, FFM, and PF, assessed at three stages during the college cross-country season. We used indirect calorimetry to assess caloric needs and objective outcome measures to assess behavioral change and compared intervention with control.

Participating cross-country runners showed trends as expected between the pre- and post-season: a decrease in VO2, REE, FFM, and an increase in PF. However, the female experimental group who received INC remained nearly the same for measurements of VO2, REE, and FFM. While PF increased across all groups, the females receiving nutritional counseling maintained FFM while other groups showed an inverse relationship between FFM and PF -- with decreased FFM and increased PF. This positive outcome is noteworthy, as it indicates that INC may provide the motivation for maintaining FFM.

Other studies investigating the efficacy of nutrition intervention have used nutrition education in a group setting to achieve increases in nutrition knowledge pre-and-post intervention, and/or used self-reported questionnaires and self-reported intake to assess nutritional change (Abood, Black, & Birnbaum, 2004). Whereas, in our study we used INC to tailor individual advice regarding calories, protein and carbohydrate needs based on indirect calorimetry and to the timing of their training sessions and lifestyle preferences. Further, we used objective measurements as outcome measures.

Subjective feedback from participants confirmed that the greatest motivator to nutritional change was the ability to personalize their intake by adjusting nutrition advice to their specific schedules and lifestyle, as well as personal goal setting. As a group, the male participants who received INC did not maintain their mean FFM, as did the female participants. However, some individuals within the male group did, and their subjective feedback was similar to that of the females. Possible reasons for these findings may include the individual attention as well as an individual's motivation.

This study is not without limitations. The sample was small and non-diverse, which restricted statistical power. Furthermore, we were unable to obtain repeat assessment of dietary intake

beyond the baseline, because of problems with the software. Thus we could not report changes in intake logs. However, our use of objective outcome measures did minimize this limitation.

Based on our study with varsity cross-country runners, individual nutrition counseling holds promise. Through tailoring nutrition to individual needs and preferences and providing motivation for change, positive outcomes in nutrition and athletic performance may be enhanced. Future studies should incorporate larger and more diverse samples, utilize social media to report self-report dietary intakes, and possibly compare findings across sports. These will provide valuable input in the field of nutrition and sports performance.

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