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RELATIONSHIP BETWEEN RESISTANCE TRAINING AND SELF-REPORTED HABITUAL MACRONUTRIENT AND ENERGY INTAKE

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ABSTRACT

Obesity is reaching epidemic proportions and more effective treatments are required to prevent the expansion of this disease. Treatments should focus on creating a negative energy balance either via increasing energy expenditure or by decreasing energy intake, or preferably both. Therefore, the purpose of this study was to investigate whether resistance training can influence feeding behaviour as determined by self-reported habitual macronutrient and energy intake. The effect of eight weeks of resistance training (n = 13) on self-reported macronutrient and energy intake was compared to a non-exercising control group (n = 13) in inactive males using a computer-based software program. Similar to the non-exercising control group, resistance training resulted in no significant (p > 0.05) changes in the habitual intake of daily intake of total kilocalories, carbohydrates, proteins and fats. In conclusion, eight weeks of resistance training is not an effective mode of training to promote an improvement in macronutrient and energy intake and despite studies demonstrating that exercise itself, in the absence of counseling, may affect feeding behaviour, it may be that resistance training as a mode of training may not be an effective mode of exercise to promote overall physical activity in an attempt to modify the patterns of macronutrient and energy intake. As such, negative energy balance would solely be due to the energy expenditure during this mode of exercise.

Key words: Diet; Exercise; Feeding behaviour; Physical activity.

INTRODUCTION

With the rising incidence of co-morbid diseases stemming from inactive lifestyles and an over-consumption of energy-dense foods (Olivares *et al.*, 2004; Sallis, 1993; Sclicker *et al.*, 1994), physical activity has been promoted as an invaluable tool in long-term weight management due to its ability to promote not only an increased energy expenditure through exercise but also changes in nutrient intake (Ambler *et al.*, 1998; Sallis, 1993; Sclicker *et al.*, 1994; Tremblay & Almeras, 1995). This is due to the fact that physical activity has been shown to alter macronutrient metabolism and/or stores and affect neuro-systems, such as the Leptin hypothalamic signaling pathway, involved in the control of food intake (Tremblay & Almeras, 1995). In this regard, voluntary energy intake can increase in response to an increased exercise volume (Janssen *et al.*, 1989) possibly due to compensation for the increased energy expenditure during exercise. Also, finding an exercise programme that can both reduce macronutrient and energy intake and increase energy expenditure may prove an invaluable tool in the prevention of overweight and obesity.

However, fitness levels and gender may influence the affect that exercise has on feeding behaviour and Ambler *et al*. (1998) found that fitness levels are associated with increased energy intakes in males while females increase their fat intake in response to exercise. Similarly, Titchenal (1988) found that novice marathon runners increase their carbohydrate intakes by 3 to 4% in response to exercise while Janssen *et al*. (1989) found unchanged carbohydrate intakes in champion marathon runners. With regards to gender, previous research has also shown that protein intake increases acutely in males following two hours of vigorous exercise but carbohydrate intake increases acutely when considering both males and females together following two hours of vigorous exercise (Verger *et al.*, 1992; Verger *et al*., 1994). In this regard, it has been suggested that males maintain or decrease their energy intake in response to exercise more so than females (Donnelly & Smith, 2005, Janssen *et al*., 1989). Furthermore, females are more likely to compensate for the increased energy expenditure through exercise by increasing their energy intake (Donnelly & Smith, 2005). Further, the body composition of an individual may influence how exercise affects nutritional behaviour. Titchenal (1988) found that the energy intake of obese individuals remained unchanged following exercise. It has also been pointed out that the mode of exercise may too influence feeding behaviour (Shaw *et al.*, 2008). However, relatively few studies have investigated the effects of resistance training on macronutrient and energy intake (Shaw *et al*., 2008) and as such no definitive conclusions can be drawn to either disregard or prescribe this mode of training to alter macronutrient and energy intake. Therefore, the purpose of this study was to investigate the association between resistance training and self-reported habitual macronutrient and energy intake.

METHODS

A random sample of 30 inactive male subjects (mean age 28 years and seven months) were recruited to take part in the eight-week study (Table 1). The study was approved by the Institutional Review Board at the Rand Afrikaans University (now University of Johannesburg). All subjects gave written informed consent and underwent standardized medical screening. Subjects were included in the study if they were previously inactive, free of pre-existing disease and not on any prescribed diet or supplement which could have altered their macronutrient and energy intake or energy expenditure.

TABLE 1. **SUBJECT DESCRIPTIVE DATA**

	Non-exercising Control Group (NE) (n = 15)	**Resistance Training Group (RT) (n = 13)**
Height (centimeters)	179.02 ± 6.01	178.53 ± 4.35
Body mass (kilograms)	85.17 ± 5.69	77.78 ± 5.48
Percentage body fat (%)	27.94 ± 1.68	26.83 ± 1.52

Values are means ± standard deviation

Pre- and post-training estimated three-day food records were successfully collected from 28 of the initial 30 subjects specifying the type and quantity of food and fluids consumed. Portion sizes were estimated with the aid of measuring cups, glasses, bowls and food items. The dietary records were analyzed for total kilocalories, carbohydrates, proteins and fat intakes using the Dietary Manager® computer-based software programme (Dietary Manager, Program Management, South Africa).

All subjects underwent a standardized anthropometric evaluation which included the assessment of body mass which was measured to the nearest 0.1 kilogram on a calibrated medical scale (Mettler DT Digitol, Mettler-Toledo AG, Ch-8606 GreiFensee, Switzerland) wearing light running shorts and without shoes. Percentage body fat was also assessed using the seven-skinfold method of Jackson and Pollock (1978).

The subjects were randomized by standard random number technique into two groups that received no dietary intervention or advice. The non-exercising control group (NE) (n = 15) was instructed not to participate in any exercise and remain inactive and the resistance training group (RT) (n = 13) participated in an eight-week structured and supervised exercise training program which consisted of progressive resistance training exercises three times weekly. Each session was started by performing a five minute warm-up and concluded with stretching and a five minute cool-down. Each session required that each RT subject complete three sets of 15 repetitions per exercise. Each workout of the RT group was designed according to National Strength and Conditioning Association (NSCA) guidelines (Baechle *et al.*, 2000a; Earle & Baechle, 2000). The resistance exercises included shoulder shrugs; lateral shoulder raises; seated chest presses; latissimus dorsi pulls; seated rows; bicep curls; triceps extensions; crunches and leg press. For crunches, each subject had to perform three sets of 60% of the maximum number of repetitions that he performed during testing.

Levene's test was used to determine if the NE and RT groups were heterogeneous or homogenous at the start of the eight-week period. The macronutrient and energy intake records were analyzed using a mixed factorial analysis of variance and $p \leq 0.05$ was selected as being indicative of statistical significance. Values are expressed as means ± standard deviation (SD). To calculate test-retest reliability the control group's self-reported macronutrient and energy intake was used by establishing the intraclass correlation coefficient (ICC).

RESULTS

The NE and RT groups were found to be homogenous at the start of the experimental period in terms of total kilocalories, carbohydrate, protein and fat intakes (Figures 1-4). Total kilocalories for the NE group remained relatively unchanged over the eight-week period (2543.85 ± 831.59 kilocalories (kcal) to 2406.38 ± 616.12 kcal ($p = 0.324$)). Even though the RT group decreased their total kilocalories from 2685 ± 975.49 kcal to 2238.13 ± 819.71 kcal, it was found not to be significant ($p = 0.242$). Both the NE and RT groups demonstrated no significant differences in their carbohydrate intake from the pre- to post-training (NE: 300.14 ± 120.13 grams (g) to 268.63 ± 116.50 g ($p = 0.134$); RT: 293.66 ± 107.53 g to 242.14 ± 47.65 g ($p = 0.246$)). The NE group increased their protein intake from 105.71 ± 42.93 g to 111.36 ± 36.68 g, while the RT group decreased their protein intake from 121.70 ± 42.93 g to

103.75 ± 34.26 g. However, neither of the changes in the NE or RT were significant (p = 0.512; p = 0.137, respectively). Similarly, the differences observed in the fat intake of the NE group (107.61 ± 43.43 g to 103.06 ± 27.30 g) and the RT group (104.39 ± 44.18 g to 103.21 ± 36.71 g) were found not to be significant (p = 0.589; p = 0.945, respectively).

The body mass of both the NE and RT group remained unchanged from the pre- to post-training (NE: 85.17 ± 22.05 kilograms (kg) to 85.76 ± 21.62 kg (p = 0.063); RT: 77.78 ± 19.75 kg to 78.23 ± 19.57 kg (p = 0.240)). The percentage body fat of the NE group decreased slightly from 27.94 ± 6.52 % to 27.55 ± 6.19 %, but was found not to be significant (p = 0.548), while the RT group decreased significantly from 26.83 ± 5.47 % to 23.33 ± 6.25 % (p = 0.000).

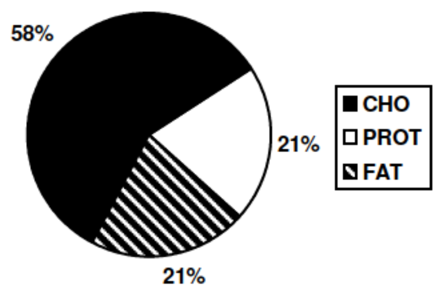

Figure 1 Pre-training Macronutrient Intake of NE

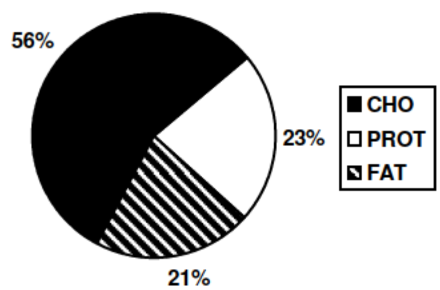

Figure 2 Post-training Macronutrient Intake of NE

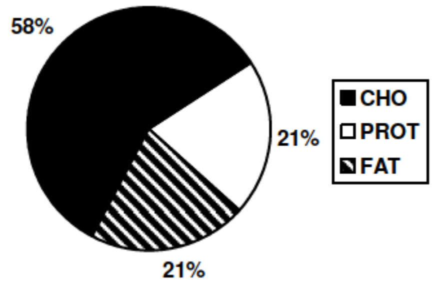

Figure 3 Pre-training Macronutrient Intake of RT

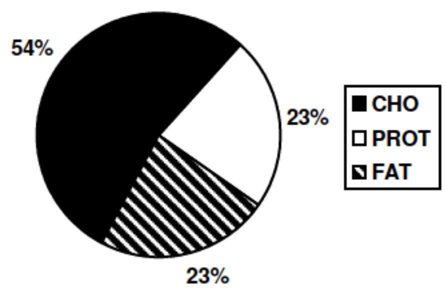

Figure 4 Post-training Macronutrient Intake of RT

DISCUSSION

The results of the present study revealed that RT is an ineffective mode of training at altering macronutrient and energy intake in inactive males over an eight-week period. This finding is in contrast to the efforts to promote physical activity in an attempt to modify the patterns of nutrient intake. This is supported by Shaw *et al.* (2008) who pointed out that the mode of exercise may too affect nutritional behaviour. This is since Shaw *et al.* (2008) found that 16 weeks of aerobic training and 16 weeks of resistance training did not affect feeding behaviour, but that a combination of aerobic and resistance training reduced the intake of total kilocalories, carbohydrates, proteins and fats in previously inactive males. The finding that a single exercise modality may not affect feeding behaviour is supported by Costill *et al.* (1988) who found that 10 days of swimming did change carbohydrate intake. According to Shaw *et al.* (2008), a combination of aerobic and resistance training may more effectively influence feeding behaviour due to the composition of the fuel mix oxidized during this mode of exercise having a direct effect on a specific neurosystem influencing feeding behaviour.

The data of this study also indicated that the subjects in the study consumed more carbohydrates and protein than the recommended daily allowance (RDA) of 50% and 20% respectively, but less fat than the RDA of 30% (Baechle *et al.*, 2000b). This might be due to these subjects perhaps already being aware of taking a prudent diet with lower fat intake in favor of carbohydrates (Janssen *et al.*, 1989). The ineffectiveness of resistance training to alter macronutrient and energy intake may be related to the already reduced daily intake of kilocalories of the subjects and it appears that this sample would benefit from increasing their kilocalorie intake especially in light of their exercising status (from a post-test value of 2406.38 ± 616.12 to a minimum of 3151.29 kcal for the NE and from a post-test value of 2238.13 ± 819.71 to a minimum of 2877.86 kcal for the RT) as based on age and gender norms (Manchester City Council, 2008). It is also evident that the further decrease in kilocalories seen following resistance training was derived primarily from a decrease in carbohydrate, perhaps indicating a decreased reliance on carbohydrate or glycogen stores. Although not significant, this change in carbohydrate intake may physiologically reflect this mode of exercise utilizing carbohydrates as its primary fuel source and thus slightly inhibiting short-term eating via increased levels of carbohydrates being broken down and released into the blood stream (Glucostatic theory) leading to an decreased preference for carbohydrates.

The results of self-reported macronutrient and energy intakes might be questionable since people tend to either underreport macronutrient and energy intake or report the intake that may more closely resemble perceived norms than actual intake (Hoidrup *et al.*, 2002; Schoeller, 1990). However, since the subjects in the present study were well trained on how to keep nutrient records and the records reviewed from each subject and the lack of change in self-reported macronutrient and energy intake in the non-exercising control group suggests that the subjects were consistent in their macronutrient and energy intake recording, regardless of the tendency for people to underreport macronutrient and energy intake. This was substantiated by the test-retest reliability using the control group's macronutrient and energy intake which indicated that the intraclass correlation coefficient was not significant ($p \leq 0.05$) for total kilocalories (ICC = 0.736), carbohydrate intake (ICC = 0.608), protein intake (ICC = 0.610) and fat intake (ICC = 0.597). As such, under intraclass correlation coefficient average measures, the scores of the macronutrient and energy intake measures (re-test) are highly reliable.

The results of the study suggest that when physical activity is promoted to reduce macronutrient and energy intake, more specific and appropriate training regimes should be specified. In addition, the effect of exercise should be assessed in combination with healthy changes in eating behaviour and appropriate counseling from a dietician. This is because, not all forms of exercise will bring about changes in macronutrient and energy intake in all people. The findings of the present study suggest that resistance training alone does not induce macronutrient and energy intake changes and this may be related to this mode of training not creating sufficient energy deficits and appropriate changes in metabolism. As such, the negative caloric balance from this mode of exercise would solely be due to the energy expenditure during this mode of exercise and not as a result of macronutrient and energy intake changes.

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