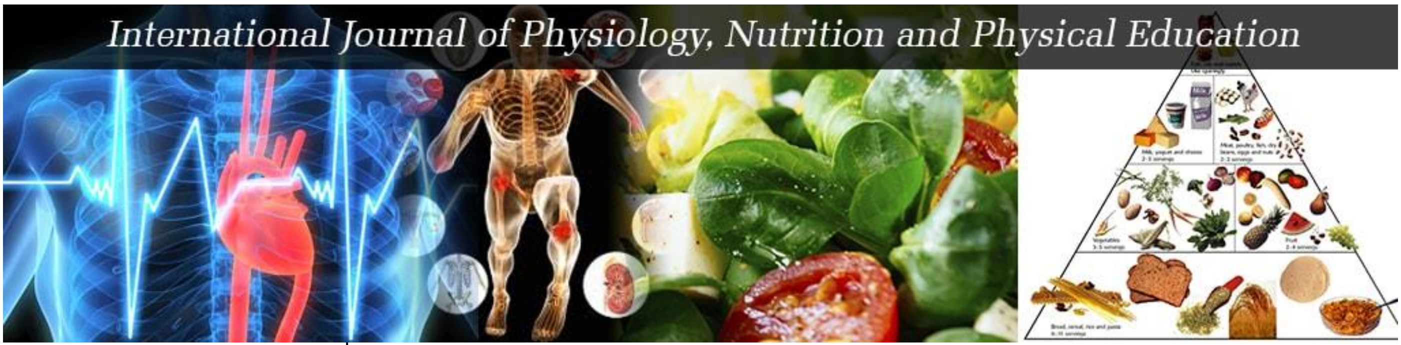

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Efficacy of cardio resistance training and concurrent training on resting metabolic rate and respiratory rate among sedentary males

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Abstract
The aim of the study was to examine the efficacy of cardio, resistance training and concurrent training on resting metabolic rate and respiratory rate among sedentary Males. To achieve the purpose of the study sixty healthy males (N=60) were randomly assigned into exercising group namely, cardio training group (*n*=15), resistance training group (*n*=15), and concurrent (cardio and strength) training group (*n*=15) a non-exercising control group (*n*=15). Resting metabolic rate was measured by using after calculation from fat free mass and respiratory rate was estimated number of breathing per minute of the subject's pre and post-experiment. The results of the study indicated that control group was found to have decreased their Resting metabolic rate, whereas the cardio and resistance training group increased their mean resting metabolic rate and significant reduction in respiratory rate. In conclusion, cardio training and strength training and concurrent training significantly interfere with improvement in resting metabolic rate and reduction in respiratory rate among sedentary males when compared to control one.

Keywords: Resting metabolic rate, respiratory rate, cardio, strength and concurrent training

Introduction

Physical activity is defined as 'bodily movement that is produced by the contraction of skeletal muscle and that substantially increases energy expenditure' (US Department of Health and Human Services 1996) [19]. Exercise is an integral part of increasing energy expenditure when trying to lose or maintain weight loss (Donnelly *et al*., 2004; Jakicic 1999) [6, 13]. An excess energy intake, positive energy balance, compared to energy expenditure results in weight gain, whereas a negative energy balance will result in weight loss. Exercise is one of the components of energy expenditure that is under voluntary control (Donnelly *et al*., 2004) [6]. Energy balance is altered by exercise in variety of ways. This can include the energy expended during exercise, the energy expended post exercise, and any alterations in resting metabolism induced by the exercise over time (Donnelly *et al*., 2004) [6].

Physical activity affects total energy expenditure, which is the sum of the basal metabolic rate (the amount of energy expended while at rest in a neutrally temperate environment and in a state of fasting), the thermic effect of food (otherwise known as dietary-induced thermogenesis) and the energy expended in physical activity (Department of Health 1991) [4].

Resting metabolic rate is the largest part of total daily energy expenditure. Resting metabolic rate accounts for approximately 60-75% of total daily energy expenditure and represents the energy requirements of vital body functions. Seventy five to eighty percent of the variability in resting metabolic rate is predicted by fat-free mass (Ravussin *et al*., 1992; Donahoo 2004; Illner *et al*., 2000; Speakman *et al*, 2003) [16, 5, 12, 18] and when comparing individual organs, it is the skeletal muscle and the liver that significantly contribute to resting energy expenditure (Illner *et al*., 2000) [12].

The thermic effect of food accounts for 10-15% of total daily energy expenditure and represents the energy requirement associated with digestion, absorption, and storage of food. The magnitude of thermic effect of food can be altered by a number of factors (Donahoo *et al*., 2004; Donnelly *et al*., 2004) [5, 6]. For example, thermic effect of food increases with a decrease in ambient temperature, is effected by over and under feeding, weight gain increases thermic effect of food and weight loss decreases thermic effect of food (Donahoo *et al*., 2004) [5].

Physical activity is a key component of energy balance (Donnelly et. al., 2004) [6]. The physiological effects of physical activity are wide ranging, and affect various body systems. As a modifiable component of energy expenditure, physical activity can affect energy balance. However, the total effects of physical activity on total energy expenditure go beyond the physical activity-induced energy expenditure. Increases in resting metabolic rate and non-exercise activity thermogenesis are also seen. Furthermore, physical activity can modify body composition favorably by decreasing fat mass and increasing lean mass.

It is well known that endurance training improves the aerobic capacity and changes occur both in the cardiorespiratory system (Ekblom *et al*., 1968) [7] and within the muscle machinery itself with profound metabolic (Gollnick *et al*., 1972) [9] and morphological adaptations (Hoppeler *et al*., 1973) [11]. Resistance training may be an important component of a successful weight loss program by maximizing fat loss while stimulating increases in lean body mass and muscular strength (Kraemer *et al*. 2002) [14]. The increase in metabolic rate post exercise following resistance training may have a significant effect on weight loss. Resistance training does not produce the same caloric expenditure during exercise that aerobic exercise does (Braun *et al*., 2005) [2]. The incorporating strength and endurance training sessions in the one training regime irrespective of whether the training is performed on the same day or separate days is known as concurrent training (Hickson, 1980) [10]. The literature advises health professionals to prescribe strength and endurance exercises in the one training regime in order to improve and sustain health-related fitness (Garber *et al*., 2011) [8]. Therefore, the present study was aimed to assess the efficacy of cardio, resistance training and concurrent training on resting metabolic rate (RMR) and respiratory rate in healthy adults.

Methods

To achieve the purpose of the study sixty active men who volunteered to participate in this study were selected and their age ranged between 30 to 35 years. Subjects were randomly assigned into cardio training group (n = 15), a resistance training group (n=15), a concurrent cardio and resistance training group (n=15), and a non-exercising control group (n=15). Prior to participation in the investigation, all volunteers gave written informed consent and physical examinations. All subjects underwent a similar test before and after the 12-week intervention period. Each subject’s Lean body mass (LBM) were calculated from the equations (Moore *et al*., 1963) [15], where M is body mass in kg and A is age in years, assuming all subjects to be normal. Male LBM = (79.5 - 0.24 M - 0.15 A) x M ÷ 73.2.The methods of estimating Resting Metabolic Rate from Fat-free mass (Cunningham, 1980) [3], RMR (cal./day) = 500 + 22 (LBM in kg).

Statistics

Data were analyzed using analysis of covariance (ANCOVA) and the adjusted post-test means were tested for significance. If the ‘F’ ratio was significant, Scheffe’s post-hoc test was employed to find out the paired mean difference. The level of confidence was fixed at 0.05 level of significance

Training programme

Cardio exercise training: Cardio exercise was performed on treadmills, rowers, steppers and cycle ergometers. After a 5 minute warming up exercise participants were instructed to perform cardio training before resistance training. Cardio exercise intensity was adjusted based on maximum heart rate (220 - age =MHR). For the first two weeks the target intensity was 50-60% of maximum heart rate (MHR). The intensity progressively increased to moderate level 60-85% MHR. 25 minute was given for the first two weeks and increased to 30 minute from the third week onwards.

Resistance exercise training

Resistance exercise training was performed after cardio exercise. Subjects were guided to perform sensible resistance exercise with major body muscles seven different exercises (Upper body: biceps curl, bench press; Core body: sit-ups or curl-up; Lower body: squat, leg press, leg extension, leg curl) were conducted. During the first week, the exercises were performed with 50% of one repetition maximum (1RM) in 2 sets with 10 repetitions and a recovery period of 1-2 min. The intensity of the workout increased to 85% of 1RM in 3 sets with 6 repetitions during the 8th week. At the end of the first 4 weeks, the 1RM was measured and the training programme for the second 4 weeks was devised based on the new 1RM.

Concurrent training

In the present investigation made use of sessions that utilized both cardio and resistance training in equal durations. Therefore, each subject in the concurrent group used resistance training equating to two sets of 15 repetitions at a workload of 50% 1-RM, or in the case of crunches, the maximum number of repetitions performed in one minute during the baseline testing. As with the Resistance training group, every week each subject’s estimated 1-RM was re-evaluated and his exercise programme adjusted accordingly. The Concurrent group subjects were also required to exercise using a combination of treadmills, rowers, steppers and cycle ergometers at an intensity of 50% to 60% of their individual age-predicted heart rate maximum. This intensity was readjusted every week by a 5% increase in heart rate. While subjects in the exercise groups were not permitted to engage in any form of exercise other than their prescribed intervention programmes. The Non-exercising group subjects were not allowed to take part in any structured exercise and had to continue with their inactive lifestyles.

Results

Table 1: Analysis of covariance on basal metabolic rate of experimental and control groups

Test	Ex. Gr 1	Ex. Gr 2	Ex. Gr 3	Con. Gr	SV	SS	DF	MS	F
Pre Test	1594.20	1602.93	1643.93	1613.20	B	21156.06	3	7052.022	1.10
					W	359354.66	56	6417.048	
Post Test	1699.27	1713.13	1751.07	1610.47	B	159407.65	3	53135.883	8.36*
					W	355781..33	56	6353.238	
Adjusted	1717.33	1723.05	1722.74	1610.81	B	137000.30	3	45666.768	58.27*
					W	43104.94	55	783.726	
Mean Gain	-105.07	-110.20	-107.13	-2.73					

*Significant at 0.05 level of confidence for 2 and 56 (DF) = 2.70, 2 and 55 (DF) = 2.72

Table 2: Scheffe's test for the differences between the adjusted post-test paired means of experimental and control groups

Con. Gr	Ex. Gr 1	Ex. Gr 2	Ex. Gr 3	MD	CI
1610.81	1717.33	-	-	106.52*	29.20
1610.81	-	1723.05	-	112.24*	29.20
1610.81	-	-	1722.74	111.93*	29.20
-	1717.33	1723.05	-	5.72	29.20
-	1717.33	-	1722.74	5.41	29.20
-	-	1723.05	1722.74	0.31	29.20

*Significant

Table 3: Analysis of covariance on respiratory rate of experimental and control groups

Test	Ex. Gr 1	Ex. Gr 2	Ex. Gr 3	Con. Gr	SV	SS	DF	MS	F
Pre Test	15.41	16.13	16.28	16.04	B	6.641	3	2.214	1.39
					W	89.359	56	1.596	
Post Test	13.37	14.24	14.11	15.97	B	54.583	3	18.194	16.15*
					W	63.104	56	1.127	
Adjusted	13.78	14.12	13.88	15.92	B	45.420	3	15.140	54.10*
					W	15.393	55	0.280	
Mean Gain	2.03	1.89	2.17	-0.07					

*Significant at 0.05 level of confidence for 2 and 56 (DF) = 2.70, 2 and 55 (DF) = 2.72

Table 4: Scheffe's test for the differences between the adjusted post-test paired means of experimental and control groups

Con. Gr	Ex. Gr 1	Ex. Gr 2	Ex. Gr 3	MD	CI
15.92	13.78	-	-	2.14*	0.55
15.92	-	14.12	-	1.80*	0.55
15.92	-	-	13.88	2.04*	0.55
-	13.78	14.12	-	0.34	0.55
-	13.78	-	13.88	0.10	0.55
-	-	14.12	13.88	0.25	0.55

*Significant

The results of the study showed that the cardio, resistance and concurrent training produced significant improvement on basal metabolic rate and significant reduction in respiratory rate. However, there were no significant differences between the cardio, resistance and concurrent training groups on basal metabolic rate and respiratory rate.

Discussion

The results of the current study show that a period of cardio, resistance and concurrent training results in a favorable improvement in basal metabolic rate and reduction in respiratory rate that have previously been thought of as mutually exclusive in terms of concurrent, cardio or resistance training performed in isolation. Consequently, for previously untrained, apparently healthy young men aiming to improve health status, concurrent training may be more effective than cardio and resistance training alone for simultaneously improving both the physical and physiological parameters. Endurance training may slightly lower respiratory rate and tidal volume and slightly decrease ventilation at light exercise loads. Regular physical training increases tidal volume both at rest and during submaximal and maximal exercise. In contrast, after prolonged exercise, respiratory rate is reduced both at rest and during submaximal exercise and increased maximal exercise when compared with matched controls (Åstrand and Rodahl 1977) [1]. Resistance training positively alters the body composition and preserves lean body tissues. Although the body weight may not change, lean body mass (Muscle and bone) increases and body fat decreases. Given that muscle tissue is more metabolically active (Burns more calories) than fat tissue, the increase in muscle size and lean body mass helps to maintain resting metabolic rate when you are on a weight loss diet. Exercise science and nutrition professionals recommend using resistance training combined with aerobic exercise to maximize the loss of body fat and to maintain lean body tissues (Heyward, and Gibson, 2014) [20]. The results of the study emphasize the importance of Regular physical activity and healthy eating habits in young people as well as adult. In addition, energy restriction induces an adaptive reduction of energy expenditure through a lowering of tissue metabolism and a reduction of body movement. An exercise-induced increase in activity expenditure is a function of the training status.

Conclusion

The results of this study suggested that there is a need to increase regular physical training by combining cardio and resistance exercises so that the body improves both resting metabolic rate and respiratory rate simultaneously. Further studies need to be done how the combination of combined exercise training influence resting metabolic rate and respiratory rate on sedentary individuals.

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