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The Effect of High Intensity and Low Intensity Exercises on Body Fat and Weight Reduction

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ABSTRACT

Previous studies have shown that long duration, Low Intensity (LI) exercise reduces weight and body fat percent, but the effect of short duration, High Intensity (HI) exercise is not clear. The purpose of this study was to compare the effect of LI exercise with HI exercise on Body Weight (BW) and Body Fat (BF) percent. Forty two male and female healthy college students have been randomly assigned to three different groups: LI, HI, none exercising (control) groups. The exercising groups underwent a supervised 14-week, 3 day/wk exercise program (LI group: 25 min of continuous run regardless of the intensity, HI group: 10 sec. max run, 10 sec. rest x 20 times).

The results showed:

a- BW loss and BF % reduction in both exercising groups but not in the control group is ($P<0.01$).

b- None significant difference between both exercising groups.

Conclusion: short duration bouts of a supervised HI exercise program in college aged males and females have similar beneficial effects on body composition and weight, as the effect of longer duration bouts of LI.

Keywords: Low Intensity Exercises, High Intensity Exercises, Body Fat, Body Weight.

1. INTRODUCTION

The incidence of obesity in Jordan and all over the world is currently on rising. Statistics show that 25 percent of U.S. adult females and 20 percent of U.S. adult males are obese (National Heart, Lung and Blood Institute, 2002). Over the last two decades, the number of cases of obesity in the U.S. has increased more than 50 percent (from 14.5 percent of the adult population to 22.5 percent). The main cause of weight gain is an energy intake that constantly exceeds the amount of physical activity. Blair and Nichaman (2002) showed that a decrease in regular physical activity, and not an increase in energy intake, is responsible for the recent increase in obesity prevalence. It is estimated that 40% of women and 25% of men in the U.S.A. are trying to lose weight at any given time (Smith and Natighton, 1993; Technology Assessment Conference, 1992; Treuth et al., 1996; Wilmore et al., 1994).

Although most people lose weight to improve appearance, concerns for health is frequently cited as an important reason to lose weight (Smith and Natighton, 1993). Weight loss is often recommended for overweight individuals for health reasons (National Task Force on the Prevention and Treatment of Obesity, 1994; Perri et al., 1992). Most literatures agree that obesity is a major cause of premature death (Williamson, 1996; Mc Ardle et al., 1986; National Task Force on the prevention and Treatment of Obesity, 1994) and that weight loss can be expected to improve health and longevity (American Dietetic Association, 1997; Mc Ardle et al., 1986; Perri et al., 1992).

Studies dating back to the late 1940's have shown an important association between obesity and metabolic conditions that seems to augment the risk of coronary heart diseases (Chen et al., 1997; Epstein, 1992). In addition to obesity, hypertension, dyslipidemia, hyperinsulinemia and glucose intolerance, sedentary lifestyle has been implicated as an important risk factor for coronary diseases (Gladden and Welch, 1978). The effect of regular physical activities on many conditions of metabolic disorders seems to be related to the loss of

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weight in overweight individuals (Blair, 2002; Despres and Lamarche, 1993; Despres et al., 1991; Manson and Faich, 1996; Poehlman and Danforth).

The research on the development and maintenance of cardiorespiratory fitness recommends performing endurance exercise, 3 to 5 days per week, on an exercise mode that involves the major muscles groups (in a rhythmic nature) for a prolonged time period (ACSM 2000). Even in the presence of little weight loss, exercise training has shown to result in an important improvement in many conditions of metabolic disorder. For these reasons and more, weight loss and the prevention of extra weight gain of the population in general and young individuals in particular is a great challenge for the modern society (Poehlman and Danforth, Williamson et al., 1992).

Increased levels of physical activities and moderate physical exercise have been found to reduce excess weight and improve weight maintenance (Gasser and Brooks, 1975). For the improvement of cardiorespiratory fitness, ACSM (2000) recommends intensities between 55 and 65% to 90% of maximum heart rate. ACSM suggests low fit individuals may experience improvements at exercise intensities of only 40 to 49% HRR or 55 to 64% Maximum Heart Rate (HRmax). (Skinner et al., 2004) suggested that sedentary subjects are already doing enough activity in their daily lives to maintain intensity levels that are generally greater than 50% VO2 reserve, it is not necessary to reduce the prescribed intensity to 40% VO2 reserve, as recommended by the ACSM.

In spite of lack of accurate statistical information, it is clearly noticed that a big percentage of Jordanian people are dieting to lose weight and more people think that they should diet. Because of the misunderstanding of the relationship between dieting and physical activities, many people suffer from eating disorders such as anorexia nervosa and bulimia as they search for thinness. Until now, it is not clear to many people that dieting is only one component of a sound weight management program. For long term success of such a program, physical exercise must be integrated in any effort to reduce weight. It is true that caloric intake reduction alone may result in a decrease in weight, but such weight reduction is most likely the result of a decrease in leads to a greater fat mass reduction and lesser muscle mass both fat mass and muscle mass. Caloric reduction combined with an exercise program reduction (Abe et al., 1997). An excellent evidence for a the role of exercise in weight maintenance and reduction comes from the National Weight Control Registry (Wing, 2001). The registry is a data base for a large number of men and women who have lost an average of 30 kg, and maintained a required minimum weight loss of 13.6 kg for 5 years. Members of this group are highly active and only 9% of registry subjects reported maintaining weight loss without regular physical activity. It is well documented that Resting Metabolic Rate (RMR) decreases with caloric intake reduction, which makes losing weight more difficult. However, RMR increases in response to exercise, which makes losing weight easier. The increase in RMR seems to last for up to 24 hours after an exercise bout (Meyer et al., 1991). This increment of RMR seems to depend upon the intensity of exercise, which plays a key role on the weight controlling efforts. It is important for any individual trying to lose or maintain weight to achieve that goal using the most effective intensity. Thus, different exercise intensities (low vs high) should have different long term effect on weight reduction and lowering body fat mass percentage.

2. THE STUDY PROBLEM AND PREVIOUS INVESTIGATIONS

Some previous studies attempted to clarify the effect of exercise intensity on weight reduction and lowering body fat mass percentage through the study of fuel oxidation (Brooks and Mercier, 1994; Coyle, 1995). It is well documented that at Low Intensity (LI), the energy supplied is primarily from oxidation of plasma free acids. As exercise intensity increases, the additional energy is obtained by utilization of muscle glycogen, blood glucose, and intramuscular triglyceride (Brooks and Mercier, 1994).

During High Intensity (HI) exercise, fat oxidation gradually decreases until 100% carbohydrate occurs at about maximal effort. The shift from fat to carbohydrate utilization gives the muscle the possibility to obtain more energy from each liter of oxygen consumed than from fat. This shift allows for greater energy output during HI exercise when oxygen uptake may be limited. Therefore, it is commonly accepted that LI exercise may be more suitable than HI exercise for increasing fat oxidation and therefore weight loss and body fat mass reduction (Hunter et al., 1992). However, to better understand the long term impact of exercise intensity on weight loss and body fat reduction, various exercise regiments must be examined during long

term training investigations. Previous studies that investigated the effect of exercise intensity on weight loss and body fat mass reduction have examined Energy Expenditure (EE) during exercise, immediately after an acute exercise session (Excess Post-exercise Oxygen Consumption or EPOC) and measuring RMR. One study that examined different exercise intensities found that the highest EPOC (up to three hours after exercise) was in moderate exercise intensity in men and women (Williamson, et al., 1992). However, in another study (Serluda et al., 1994), no differences were noticed between low and moderate exercise for the magnitude or duration of EPOC in women. In addition several other studies have indicated that the energy cost of exercise may be higher during and immediately after HI aerobic exercise (Serluda et al., 1994) or even resistance exercise (Hunter et al., 1988). Moreover, EPOC up to 4 hours after exhaustive (supramaximal 108% VO2max) exercise have been shown to be increased (Bahr et al., 1992).

Another investigation found that near-exhaustive exercise causes thermal adjustment, which may maintain an elevated oxygen consumption, and therefore increased caloric cost, up to 24 hours (Brooks and Mercier, 1994). That may result in a 10% increase in energy cost compared to same exercise performed at lower intensities. This leads to the problem of this study concerning the effect of HI exercise versus LI exercise on weight loss and body fat mass reduction. Fewer researchers have examined the effect of different intensities on total body weight loss and total body fat reduction over a period of time. A long term controlled training program seems to be the ideal way for studying the long term effect of exercise intensity. Little is known about the long term effect of high EPOC and high RMR after a bout of HI exercise on total body weight loss and total body fat reduction. Moreover, the effect of HI versus LI exercise for an extended period of time (e.g. 14 weeks) has not been extensively investigated. In this study the researchers attempt to determine and compare the effect of both HI and LI exercise in young adult college-aged women and men by a long term training experimental study.

3. PURPOSES OF THE STUDY

The purposes of the study are as follows:

1- To determine the effect of high intensity exercise, low intensity exercise and no exercise on body fat percentage and weight of male college students.
2- To determine the effect of high intensity exercise, low intensity exercise and no exercise on body fat percentage and weight of female college students.
3- To compare the effect of high intensity exercise, low intensity exercise and no exercise on body fat percentage and weight of male college students.
4- To compare the effect of high intensity exercise, low intensity exercise and no exercise on body fat percentage and weight of female college students.

4. LIMITATIONS OF THE STUDY

The following limitations were included as a part of the study:

1- The level of motivation of participants was a key element which might influence the results of the study.
2- The willingness of participants for losing fat may have an effect on some participants to avoid certain types of food.
3- Due to the difficulties of measurement, caloric intake was not controlled in this study.

Subjects:

Subjects for this study were 42 college students attending Mu'tah University during the academic year 1999/2000. A sample of 21 male students and 21 female students ranging in age from 19 to 22 years was selected from 140 volunteers. Selecting a volunteer was based on his studying schedule, weight, and health exam. Each subject was assigned randomly to one of the three groups. Subjects were asked not change their dietary habits during the period of the study.

5. DESIGN OF THE STUDY

An experimental pretest-posttest-control group design was used in order to examine the effect of high intensity exercise and low intensity exercise on body fat percentage and weight of male and female college students. The subjects in the control group had no exercise during the training program, and they were tested at the beginning and at the end of the training program for the purposes of comparing their results with two experimental groups. The body fat percentage was measured according to the procedures and equation (table1) mentioned by Jackson and Pollack (Jackson and Pollock, 1978). Weight was measured at the time the body fat percentage was assessed.

Table1. Generalized Regression Equations for Predicting Body Fat Percentage

Regression Equations	R	g/cc	% Fat
Males BD (M-2) = 1.10938000-0.0008267(X_2) + 0.00000016 (X_2)^2- 0.0002574 (X_4)	.91	.008	3.4
Females BD (F-2) = 1.099421- 0.0009929 (X_3) + 0.00000023 (X_3)^2 - 0.0001392 (X_4)	.84	.009	4.0

Key: X_2 = sum of chest, abdomen and thigh skinfolds; X_3 = sum of triceps, suprailium and thigh skinfolds; X_4 = age in years (Jackson and Pollock, 1978).

Pretest Procedures

The male and female students were divided randomly into three groups, each one of them included seven students (table 2).

Table2. The Number of Subjects in Each Group

Group	Male	Female	Total
High intensity group	7	7	14
Low intensity group	7	7	14
Control group	7	7	14

Total number = 42

An analysis of variance, the One Way-ANOVA, was performed to determine if there were significant differences among the three groups for the same gender on the pretest of the concerned variables (table3). The One Way-ANOVA revealed no significant differences among the three groups for both genders at α=0.05.

Training of Assistants

Due to the length of the two training programs, four assistants were trained by the researchers to perform the following responsibilities:

1. To give proper verbal instructions to the participants about the objectives and the nature of two training programs.
2. To record the time of the training units and number of the training units, each participant performed in each week.
3. To guide and supervise participants during the two physical training programs to insure that each subject abide by the right instructions of his/her training program.
4. To check materials and equipments used in the study before starting any physical training units.
5. To report in any emergency situation.

Practice Procedures

To achieve the purposes of this study. The following two training programs were used:

1- The high intensity training program: The high intensity training program which was adapted from Corbin and Lindsey (1994) contained the following steps:

A- Subjects warmed up by performing the following supervised flexibility exercises; 1) arm stretches 2) neck rotation 3) side bender 4) sitting stretches 5) leg hug 6) hamstring stretches 7) hip and thigh stretches 8) lower leg stretches 9) calf stretches (Subjects performed 10 repetitions two times for each exercise). Then Subjects performed slow jogging for three minutes.

B- Each Subject ran at his/her maximum speed (100%, subjectively) for 10 seconds approximately (64 to 91 meters).

c- According to the purposes of the study for this group, the heart rate of the subjects should be raised near maximal (95%-100%).

D- Each Subject rested for 10 seconds by walking slowly.

E- Steps two and three were alternately repeated until 20 runs had been completed.

F- Walking slowly for two minutes as a cooling down procedures.

2- The low intensity training program: The low intensity training program contained the following steps:

A- Subjects warmed up by performing the following supervised flexibility exercises: 1) arm stretches 2) neck rotation 3) side bender 4) sitting stretches 5) leg hug 6) hamstring stretches 7) hip and thigh stretches 8) lower leg stretches 9) calf stretches (Subjects performed 10 repetitions two times for each exercise). Then Subjects performed slow jogging for three minutes.

B- Each Subject ran for 25 minutes without stopping.

C- The intensity of the physical training program for this

group ranged from 70%-85% of the maximal heart rate for each subject. The heart rate was measured manually immediately post-exercise during the pilot work for each subject. During the orientation period, the subjects were trained to the pre-specified aerobic intensity. During each exercise session the exercise intensity was monitored at the end of each training period.

D- Walk slowly for two minutes as a cooling down procedures.

3- The control group: The control groups' members did not perform any exercises during the study, they received no instructions regarding their diet or life style changes, and they were tested at the beginning and at the end of the study.

4- Each Subject in the two experimental groups exercised four times a week.

5- The length of each training program was 14 weeks.

Table3. One-Way ANOVA for Male Students on the Pretests

Test	Source	Sum of Squares	df	Mean Square	F	Sig.
Male Students						
Pretest(Fat)	Between Groups	3.069E-03	2	1.534E-03	.66	.526
	Within Groups	4.151E-02	18	2.306E-03		
	Total	4.458E-02	20			
Pretest (Weight)	Between Groups	67.714	2	33.857	.51	.609
	Within Groups	1194.857	18	66.381		
	Total	1262.571	20			
Female Students						
Pretest (Fat)	Between Groups	5.974E-03	2	2.987E-03	3.6	.052
	Within Groups	1.478E-02	18	8.210E-04		
	Total	2.075E-02	20			
Pretest (Weight)	Between Groups	1.238	2	.619	.03	.966
	Within Groups	317.714	18	17.651		
	Total	318.952	20			

Posttest Procedures

At the end of the study, the researchers measured the body fat percentage and weight for each subject in the three groups.

Statistical Analysis

T-test, mean and standard deviation were used to investigate the effect of high intensity exercise and low intensity exercise on body fat percentage and weight. The one-way-ANOVA was used to test the differences among the high intensity training group low intensity training group and no exercise group (independent variables) on body fat percentage and weight (dependent variables) at α=0.05. A Scheffe post hoc test was performed when significant differences were detected.

6. RESULTS OF THE STUDY

Means, standard deviation, range, minimum and maximum of male students for the three groups were determined (table 4). In the high intensity group, the mean ± SD in the pretest (fat) were 0.24±0.041, while in the posttest (fat) the mean ± SD were 0.16±0.034. In the pretest (weight), the mean ± SD were 86±11.5 kg while in the posttest, the mean ± SD were 82±11.66 kg. However, in the low intensity group , the mean ± SD in the pretest (fat) were 0.26±0.053, while in the posttest (fat) the mean ± SD were 0.22±0.041. In the pretest (weight), the mean ± SD were 90.28±6.9.5 kg while in the posttest, the mean ± SD were 86.57±6.37kg. In the control group, the mean ± SD in the pretest (fat) were 0.26±0.047, while in the posttest (fat) the mean ± SD were 0.27±0.049. In the pretest (weight), the mean ± SD were 87.28±4.3 kg while in the posttest, the mean ± SD were 87±4.03 kg.

Means, standard deviation, range, minimum and maximum of female students for the three groups were determined (table5). In the high intensity group, the mean

± SD in the pretest (fat) were 0.27±0.018, while in the posttest (fat) the mean ± SD were 0.19±0.009. In the pretest (weight), the mean ± SD were 67±.89 kg while in the posttest, the mean ± SD were 64.4±1.27 kg. However, in the low intensity group , the mean ± SD in the pretest (fat) were 0.30±0.03, while in the posttest (fat) the mean ± SD were 0.25±0.02. In the pretest (weight), the mean ± SD were 67.28±5.9.5 kg while in the posttest, the mean ± SD were 63.57±5.2kg. In the control group, the mean ± SD in the pretest (fat) were 0.31±0.03, while in the posttest (fat) the mean ± SD were 0.31±0.03. In the pretest (weight), the mean ± SD were 67.71±4.1 kg while in the posttest, the mean ± SD were 67.5±4.19 kg.

Table 4. Descriptive Statistics of Male Students for the Three Groups

Test	N	Range	Minimum	Maximum	Mean	Std. Deviation
High intensity group						
Pretest (Fat)	7	.118	.198	.316	.24114	4.1747E-02
Posttest (Fat)	7	.083	.126	.209	.16643	3.4746E-02
Pretest (Weight)	7	36.00	68.00	104.00	86.000	11.5036
Posttest (Weight)	7	37.00	63.00	100.00	82.000	11.6619
Low intensity group						
Pretest (Fat)	7	.157	.174	.331	.26671	5.3627E-02
Posttest (Fat)	7	.101	.165	.266	.22029	4.1844E-02
Pretest (Weight)	7	20.00	80.00	100.00	90.285	6.9454
Posttest (Weight)	7	19.00	77.00	96.00	86.571	6.3733
Control group						
Pretest (Fat)	7	.114	.217	.331	.26686	4.7960E-02
Posttest (Fat)	7	.125	.206	.331	.27143	4.9916E-02
Pretest (Weight)	7	10.00	84.00	94.00	87.285	4.3095
Posttest (Weight)	7	11.00	83.00	94.00	87.428	4.0356

Table 5. Descriptive Statistics of Female Students for the Three Groups

Test	N	Range	Minimum	Maximum	Mean	Std. Deviation
High intensity group						
Pretest (Fat)	7	.62	.247	.309	.27843	1.8347E-02
Posttest (Fat)	7	.23	.183	.206	.19471	9.3935E-03
Pretest (Weight)	7	2.00	67.00	69.00	67.857	.8997
Posttest (Weight)	7	4.00	62.00	66.00	64.428	1.2724
Low intensity group						
Pretest (Fat)	7	.109	.237	.346	.30043	3.3960E-02
Posttest (Fat)	7	.74	.227	.301	.25671	2.3949E-02
Pretest (Weight)	7	18.00	55.00	73.00	67.285	5.9080
Posttest (Weight)	7	16.00	53.00	69.00	63.571	5.2236
Control group						
Pretest (Fat)	7	.80	.266	.346	.31971	3.1197E-02
Posttest (Fat)	7	.86	.266	.352	.31743	3.3316E-02
Pretest (Weight)	7	13.00	62.00	75.00	67.714	4.1519
Posttest (Weight)	7	12.00	62.00	74.00	67.571	4.1975

Table 6. T-Test for Male Students in the Three Groups

variables	Pretest Mean	SD	Posttest Mean	SD	Mean difference	t	Sig
High intensity group							
Body fat percentage	0.241	0.042	0.166	0.034	0.075	9.03	0.00
Weight	86.00	11.50	82.00	11.66	4.00	12.9	0.00
Low intensity group							
Body fat percentage	0.266	0.053	0.220	0.041	0.041	6.13	0.00
weight	90.28	6.94	86.57	6..37	3.71	8.83	0.00
Control group							
Body fat percentage	0.266	0.047	0.271	0.049	-0.004	-0.40	0.69
weight	87.28	4. 30	87.42	4.03	-0.142	-0.31	0.76

The T-test for male students (table 6) revealed that the results of the body fat percentage and weight in the posttest were significantly lower than in the pretest in the high intensity group and low intensity group. However, there were no significant differences between the posttest and pretest in the control group. In the high intensity group, body fat percentage in the posttest (mean=0.16±0.03) while it was in the pretest (mean=0.24±0.04), weight in the posttest (mean=82±11.66kg) while it was in the pretest (mean=86±11.5kg). In the low intensity group, body fat percentage in the posttest (mean=0.22±0.04) while it was in the pretest (mean=0.26±0.05), weight in the posttest (mean=86.5±6.37kg) while it was in the pretest (mean=90.28±6.9kg). However, In the control group, body fat percentage in the posttest (mean=0.27±0.04) while it was in the pretest (mean=0.26±0.04), weight in the posttest (mean=87±4.03kg) while it was in the pretest (mean=87±4.30kg).

The T-test for female students (table 7) revealed that the results of the body fat percentage and weight in the posttest were significantly better than in the pretest in the high intensity group and low intensity group. However, there were no significant differences between the posttest and pretest in the control group. In the high intensity group, body fat percentage in the posttest (mean=0.19±0.009) while it was in the pretest (mean=0.27±0.018), weight in the posttest (mean=64.4±1.27kg) while it was in the pretest (mean=67.85±0.89). In the low intensity group, body fat percentage in the posttest (mean=0.25±0.02) while it was in the pretest (mean=0.30±0.03), weight in the posttest (mean=63.57±5.22 kg) while it was in the pretest (mean=67.28±5.9kg). However, In the control group, body fat percentage in the posttest (mean=0.31±0.03) while it was in the pretest (mean=0.31±0.03), weight in the posttest (mean=67.5±4.19kg) while it was in the pretest (mean=67.7±4.15kg).

The analysis of variance for male students on the posttest revealed significant differences among the three groups in the body fat percentage test at α=0.05 (table 8). However, there were no significant differences among the three groups in the weight test.

A Scheffe Post Hoc test was performed to determine were the significant differences are (table 9). (Table 9) shows that the significant differences were found between the high intensity group (mean=0.16) and the control group (mean=0.27).

The analysis of variance for female students on the posttest revealed significant differences among the three groups in the body fat percentage test at α=0.05 (table10). However, there were no significant differences among the three groups in the weight test.

A Scheffe Post Hoc test was performed to determine were are the significant differences (table11). (Table 11) shows that the significant differences existed between the high intensity group (mean=0.19) from one side and the low intensity group (mean=0.25) and the control group (mean=0.31). Moreover, there were significant differences between the low intensity group (mean=0.25) and the control group (mean=0.31).

Table7. T-Test for Female Students in the Three Groups

variables	Pretest Mean	SD	Posttest Mean	SD	Mean difference	t	Sig
High intensity group							
Body fat percentage	0.278	0.018	0.194	0.009	0.083	8.61	0.00
Weight	67.85	0.899	64.42	1.27	3.42	6.49	0.00
Low intensity group							
Body fat percentage	0.300	0.033	0.256	0.023	0.043	6.72	0.00
weight	67.28	5.90	63.57	5.22	3.714	10.3	0.00
Control group							
Body fat percentage	0.319	0.031	0.317	0.033	0.002	0.79	0.45
weight	67.7	4.15	67.57	4.19	0.143	0.42	0.68

Table 8. One-Way ANOVA for Male Students on the Posttests

Test	Source	Sum of Squares	df	Mean Square	F	Sig.
Posttest (Fat)	Between Groups	3.860E-02	2	1.930E-02	10.623	.001
	Within Groups	3.270E-02	18	1.817E-03		
	Total	7.129E-02	20			
Posttest (Weight)	Between Groups	119.238	2	59.619	.927	.414
	Within Groups	1157.429	18	64.302		
	Total	1276.667	20			

Table 9. Scheffe Post Hoc for the Thee Groups (Males)

Group	N	Subset for alpha = .01	
		1	2
High intensity Group	7	.16643	
Low intensity Group	7	.22029	.22029
Control group	7		.27143
Sig.		.088	.108

Table 10. One-Way ANOVA for Female Students on the Posttests

Test	Source	Sum of Squares	df	Mean Square	F	Sig.
Posttest (Fat)	Between Groups	5.271E-02	2	2.635E-02	44.623	.000
	Within Groups	1.063E-02	18	5.906E-04		
	Total	6.334E-02	20			
Posttest (Weight)	Between Groups	62.095	2	31.048	2.002	.164
	Within Groups	279.143	18	15.508		
	Total	341.238	20			

Table 11. Scheffe Post Hoc for the Three Groups (Females)

Group	N	Subset for alpha = .05		
		1	2	3
High intensity group	7	.19471		
Low intensity group	7		.25671	
Control group	7			.31743
Sig.		1.000	1.000	1.000

7. DISCUSSION

The present study was undertaken to determine the effect of HI and LI exercise in the absence of dietary restriction on changes in body composition. The study included three groups: HI, LI and none-exercising groups and examined the precise effect of exercise on fat percentage reduction and total body weight loss in male and female college students.

The findings of the present study show that body fat mass percentage and body weight were significantly reduced in both groups but not in the non-exercising group. In addition, the findings of this study do not show any significant differences between the effect of HI exercise and LI exercise. Such finding is extremely important in considering the time consumed to perform each exercise. It should be emphasized that the HI group spent approximately seven minutes each exercise session ((10 sec. Exercise + 10 sec. Rest) x 20 runs) but the LI group spent 25 minutes each session. The LI exercise findings are not surprising because overweight occurs when energy intake chronically exceeds energy expenditure (Poehlman and Danforth, Williamson, 1996). The long duration of LI exercise increases energy expenditure and thus it promotes the negative energy balance which reduces weight. However, in many cases, the amount and duration of LI exercise needed to change the caloric balance is too great to be of practical use in modern society. Thus, more focus was directed toward the effect of HI exercise in general and on BMR in particular. The amount of energy expenditure associated with exercise at various exercise intensities is directly related to the effect of exercise on metabolic rate during the onset of exercise. Yoshioka (2001) has shown that metabolic adaptations in skeletal muscle in response to high-intensity intermittent-training appeared to favor lipid oxidation more than low exercise intensity. Even acute resistance exercise has shown to effect BMR up to 72 hours. The present study indicated that the metabolic rate subsequent to the onset of HI exercise may depend upon the intensity of the exercise. In this study, the HI exercise may have produced a higher post- exercise energy expenditure and for a longer period of time. Such an increase in BMR has lasted up to 24 hours in previous investigation (Meyer et al., 1991) or up to 21 hours (Waxman and Stunkard, 1980). In agreement with these results, previous studies showed a significant increase in EPOC for a relatively long duration after supramaximal exercise (Meyer et al., 1991). It is also possible that HI exercise causes higher level of thermal adjustments and for longer duration which may increase caloric consumption and promote beneficial changes in body composition. Such results have been indicated for near-exhaustive exercise (Meyer et al., 1991). It is also important to notice that sympathetic nervous system activation may have been responsible for the increase in BMR following HI exercise. It is possible that the results of the HI exercise relate to a suggested increase in fat oxidation following the exercise onset. Teurth et al. (1996) found that even though Respiratory Equation was lower in LI exercise during the exercise session, similar amounts of lipid were oxidized for LI and HI exercise following the exercise. This indicates the importance of lipid oxidation following HI exercise. A possible physiological reason may be related to the different fuels used during and post exercise. Lipid oxidation may have been higher during the LI exercise. Yet, more lipids may have been used as a fuel after HI exercise to replace the greater amounts of glycogen depleted with HI exercise. Consistent with these results, investigations that compared exercise economy during walking, bicycle and strength exercises found that as intensity increases, exercise economy decreases (Dill, 1965; Epstein et al., 1985; Gladden and Welch, 1978; Gotchachka, 1994; Hunter and Schnitzler, 1992; Hunter et al., 1988). Physiological reasons for this decrease in economy include an increased dependency on inefficient fast-twitch muscle fiber (Epstein et al., 1985; Gladden and

Welch, 1978) and or an increase in metabolism not directly related to measured work output (for example: statically contracting stabilization muscles).

The result of this study is in agreement with previous investigations which conclude that exercise offset the consistently reported reduction in BMR, which is associated with caloric intake reduction during dieting periods (Hill, 1992). In addition to the effect of BMR of HI exercise, Wilmore (Hill, 1992) showed a possible anorexegenic effect (appetite suppression) of HI exercise on male rats. This may further support the results concerning BW and %FM obtained from the HI exercise in this study.

In addition to its direct effect on BMR, HI exercise may have further effect on augmenting muscle mass percentage. Several previous studies that have investigated the effect of exercise and physical activity on weight and body composition failed to show benefits of HI exercise programs (Fletcher et al., 1992; Fogelhom et al., 1998; National Institutes of Health, 1997). These studies relied only on investigating body weight changes without measuring body composition. The possible increase in muscle mass that is associated to HI exercise may have an effect on body composition and not on body weight. Such conflicting results in previous studies may have been related to the lack of control group. Even some recent studies (Dill, 1965) lacked an appropriate control group which have been avoided in the present study. The control group in the present study has been of great value to show that significant changes both body composition and body weight resulted in the HI exercise group in spite of the short duration of the exercise session.

Further explanation of the results of this study may be related to the improvement of physical fitness in both exercising groups. There appeared to be a great improvement in physical fitness in both exercising groups as it was noticed by the trained supervisors. The subjects in both groups showed a great enthusiasm and adherence to exercise with the help of the supervisors which may have a carry over effects. In other words, both exercising groups may have been more active outside the structured exercise program. The carry over effect may have influenced not only the physical side but also the psychological well being. For a long time, it has been noticed that psychological slates have a great effect on one's physical health (Haus et al., 1994). Future studies may focus on the effect of exercise intensity on different psychological parameters such as anxiety, depression and emotional distress. The complex interaction between exercise intensity and various psychological parameters may have a great influence on controlling body weight and losing fat mass. In this study neither the exercise intensity (continuous monitoring of heart rate) nor the energy consumption (food intake) of the subjects were controlled, such limitations may introduce a source of error regarding the great weight lose in the HI compared to the number of Kcal expended and may be avoided. In addition, future studies may focus on the combination of HI exercise and caloric reduction because such a combination has shown greater benefits on body composition in moderate intensity (Haus et al., 1994).

8. RECOMMENDATIONS

Based on the results of the present investigation, the following recommendation may be considered:

1- High intensity exercise may be recommended for young healthy individuals for weight control and body fat reduction.
2- Future research may focus more on explaining these results by investigating the interaction of high intensity with different variables such as psychological ones.
3- Future research may focus on studying the effect of high intensity and low intensity exercises on male and female subjects from different ages.
4- The present investigation did not control for caloric intake. Thus future research studies may control for that or even combine caloric intake reduction with high intensity.
5- The present investigation did not control continuously for the heart rate during the low intensity training sessions. Future investigations may accurately and continuously measure the exercise intensity during the whole session of exercise.

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أثر التدريبات مرتفعة الشدة والتدريبات منخفضة الشدة على خفض نسبة الدهن والوزن

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ملخـص

تهدف هذه الدراسة إلى تحديد اثر التدريبات المنخفضة الشدة والتدريبات مرتفعة الشدة على نسبة الدهون والوزن لكل من الذكور والإناث ومقارنتهما، وأجريت على عينة من واحد وعشرين طالباً وإحدى وعشرين طالبة تراوحت أعمارهم من (19-21) عاما من طلاب جامعة مؤتة تم توزيعهم على ثلاث مجموعات: المجموعة الأولى مارست التدريبات مرتفعة الشدة، والثانية مارست التدريبات منخفضة الشدة وأما المجموعة الثالثة (الضابطة) فلم تمارس أي نوع من التدريبات طيلة فترة الدراسة التي امتدت إلى 14 أسبوعا.

أظهرت نتائج هذه الدراسة أن التدريبات المنخفضة الشدة والتدريبات المرتفعة الشدة أدت وبصورة دالة إلى انخفاض في قيمة كل من نسبة الدهن و الوزن عند كل من الذكور والإناث. وعند المقارنة بين اثر كل من التدريبات المرتفعة والمنخفضة على الوزن ونسبة الدهن وجد أن الفرق كان دالا عند الذكور بين المجموعة التي مارست التدريبات المرتفعة الشدة والمجموعة الضابطة في نسبة الدهن فقط، أما فيما يخص الإناث فقد كان الفرق دالا في نسبة الدهن بين المجموعتين التجريبيتين والمجموعة الضابطة، وكذلك بين المجموعة التي مارست التدريبات المرتفعة والمجموعة التي مارست التدريبات المنخفضة ولصالح المجموعة الأولى.

الكلمات الدالة: التدريبات المرتفعة الشدة، التدريبات المنخفضة الشدة، نسبة الدهن، الوزن.

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