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Comparative Effect of Electrical Muscle Stimulation and Resistance Training on Body Weight and WHR in Overweight People

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Abstract:

Objective: To determine the effects of electro muscle stimulation (EMS) in comparison with resistance training (RT) on decreasing waist to hip ratio (WHR) and on losing body weight in overweight of university students.

Methods: The study comprised of 90 male students who were classified into 3 groups as EMS (n=30), RT (n=30) and Control (n=30). Anthropometric measurements, blood lipids levels were analyzed.

Results: Analyses of WHR and body weight in 3 groups after 16 week exercise reveal that RT was more effective to decrease WHR and body weight.

Conclusion: Overweight and Obesity is the important problem in the new era. Effects of new and advanced exercise protocols and positive effect of decreasing WHR and body weight may help reduce the risk of cardiovascular diseases in the young population.

Key words: WHR, Overweight, Electrical Muscle stimulation,

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Resistance Training

Introduction

Globally, there are more than 1 billion overweight adults, at least 300 million of them, obese. The key causes are increased consumption of energy-dense foods, high in saturated fats and sugars, and reduced physical activity (WHO 2000).

Overweight has several negative consequences such as Blood Pressure (Hypertension), Stroke, Heart disease, Hyperlipidemia, Non-Insulin-dependent Diabetes Mellitus, Osteoarthritis, Mood disorders, Sleep disorders, Eating disorders, Gout, Gall Bladder, some Cancer and most importantly Body Deformity that so many people suffer from, which has physiological consequences by itself (Baray 2003). That is why almost all fat people seek for the way which can help them overcome this problem efficiently.

The purpose of the present study is to broaden the knowledge and understanding on the effect of electro muscle stimulation as a new innovation device and resistance training on losing weight and decrease of WHR in overweight college age males.

Materials and Methods

A group of 90 overweight male between the ages of 19 - 25 years (mean age = 22 ± 3 years), with $1 \leq \text{WHR} \leq 0.9$ were randomly selected from the Islamic Azad University, Borujerd Branch in Iran. Those selected should not have been involved in any recruitment program for at least 6 months prior to the study, nor had any injury in their body. They are enrolled for this study after signing the informed consent form. In order to be eligible for inclusion into the study, subjects were required to be physically suitable for a program of Electrical Muscle

Stimulation (EMS) and program of Resistance Training performed in the Gym's university. So prior to final selection they were checked out by a physician.

During the experimental period, subjects were asked not to change their diet habits and not to take any medicines. They had to avoid consuming caffeine and alcohol one day before the EMS and RT session and not indulge in any physical activity during the experimental period.

STUDY DESIGN: The primary aim of the study was to evaluate the effect of Electro Muscle Stimulation (EMS) and Resistance Training to know which training method is beneficial to lose weight and decrease WHR in overweight students. In order to achieve this goal, Subjects were randomly assigned to one of the following three groups:

- Group EMS (N = 30) - Electro Muscle Stimulation Groups: Subjects received electric muscle stimulation of 6 muscle groups (Rectus Abdominis, Internal and External Oblique, Transvers Abdominal Oblique, Gluteal, Quadriceps, Hamstring) with 60% to 70% maximum tolerated intensity, 1h session (30 min. for waist area and 30 min. for hip area), 3 time per week, for 16 weeks. Electrical muscle stimulation (EMS) was applied using a Selderton EMS machine. The device is manufactured by Bio-Medical Research LTd., Ireland. It has 6 channels and is able to send stimulus to 6 groups of muscles. The device works using a 9V portable battery or AC adaptor. Pad placements are done according to pad placement charts and used by conductive gel for better connection between skin and pads were provided by the manufacturer.

- Group RT (N = 30) – Resistance Training Groups: Subjects were trained at 60% to 70% maximum strength. 6 muscle groups (Rectus Abdominis, Internal and External Oblique, Transvers Abdominal Oblique, Gluteal, Quadriceps Femoris, Hamstring) will exercise with 3 sets of 10 repetition in each muscle group, 1h session, 3 times per week, for 16 weeks. Subjects were provided with the following equipment necessary

for the resistance exercise program: exercise ball (appropriate for height), Nautilus leg press, Nautilus lying leg curl, soft mats for towel crunch and Russian twist, and illustrations of the recommended exercises that were performed. Subjects were prescribed resistance training methods that were performed in each station. In order to determine appropriately, a staff member conducted an exercise class including all prescribed exercises. Subjects were encouraged to do resistance training.

- Group Control (N = 30) – Control Group: In order to enhance compliance, personal follow-up phone calls were made and a motivation session was conducted every Thursday evening over the duration of the study.

| Variable | EMS Groups (n=30) | Resistance Training Groups (n=30) | | Control Groups (n=30) | | Groups | |
|----------|-------------------|-----------------------------------|-----------|-----------------------|-----------|------------|-----------|
| | Units | Pre (Mean) | Std. Dev. | Pre (Mean) | Std. Dev. | Pre (Mean) | Std. Dev. |
| AGE | Years | 22.63 | 1.56 | 23.03 | 1.73 | 22.97 | 1.88 |
| HEIGHT | Cm | 178.53 | 6.67 | 180.43 | 5.07 | 181.47 | 4.97 |
| BW | Kg | 83.22 | 11.24 | 84.30 | 9.86 | 83.22 | 9.16 |
| WHR | None | 0.93 | 0.02 | 0.93 | 0.03 | 0.93 | 0.03 |
| GW | cm | 94.27 | 10.58 | 93.91 | 8.10 | 96.86 | 7.85 |
| GH | cm | 100.85 | 10.41 | 101.03 | 6.25 | 104.22 | 6.76 |

Table 1: Subject Characteristics

Body weight was calculated after finishing each EMS and Resistance Training session and Control Group. Waist circumference was measured with a non-elastic tape at a point midway between the lower border of the rib cage and the iliac crest at the end of normal expiration. Hip circumference was measured at the widest part of the hip at the level of the greater trochanter to the nearest half-centimeter.

An independent statistician was consulted and utilized for all statistical analyses. Standard descriptive statistics for central tendency (mean) and spread (standard deviation) were applied to all variables measured. Differences between pre- and post-test scores within the three experimental groups were

determined by the One-way Analysis of variance. Further, effectiveness of 2 exercise protocol was done through Repeated Measure ANOVA taking pre and post test scores on different parameters, and changes if any between 2 experimental and one control group were verified by considering differential changes from pre to post test session scores.

In all analyses, the 95% level of confidence ($p \leq 0.05$) will apply as the minimum to interpret significant differences among sets of data. All computations were performed using the Statistical Presentation system software (SPSS), Microsoft Windows release 16 (2009).

Results and Discussion

Body Weight

Repeated measure ANOVA revealed a significant decrease of body weight from 85.46 kg to 83.33 kg from pre testing to 16 weeks irrespective of the group which was statistically significant. F value of 103.195 was found to be significant at .000 level. Further, when the decrease in weight verified across 3 different groups-EMS, RT and control, again a significant F value was observed ($F=33.652$; $P=.000$) indicating a differential decrease among groups from pre testing to 16 weeks. From the mean values it is clear that EMS group reduced its body weight by 2.25 kg from pre testing to 16 weeks (from 83.22 kg to 80.97 kg), RT group reduced its weight by 4.21 kg (from 84.30 kg to 80.09 kg) and lastly control group increased its weight by 0.12 kg (From 88.87 kg to 88.94 kg). On the whole, we find that RT group reduced maximum weight, followed by EMS group and control least.

| Group | PRE | | 4 WEEKS | | 8 WEEKS | | 12 WEEKS | | 16 WEEKS | |
|---------|-------|-------|---------|-------|---------|-------|----------|-------|----------|-------|
| | Mean | S.D | Mean | S.D | Mean | S.D | Mean | S.D | Mean | S.D |
| EMS | 83.22 | 11.24 | 83.03 | 11.11 | 82.13 | 11.04 | 81.36 | 10.54 | 80.97 | 10.45 |
| RT | 84.30 | 9.86 | 83.86 | 9.76 | 81.88 | 9.79 | 81.20 | 9.71 | 80.09 | 9.60 |
| Control | 88.87 | 9.16 | 89.01 | 9.11 | 89.01 | 9.02 | 88.99 | 9.02 | 88.94 | 9.05 |

| | | | | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Total | 85.46 | 10.31 | 85.30 | 10.27 | 84.34 | 10.41 | 83.85 | 10.33 | 83.33 | 10.41 |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|

Table 2- Mean weight scores of EMS, RES and Control groups from pre testing to 16 weeks

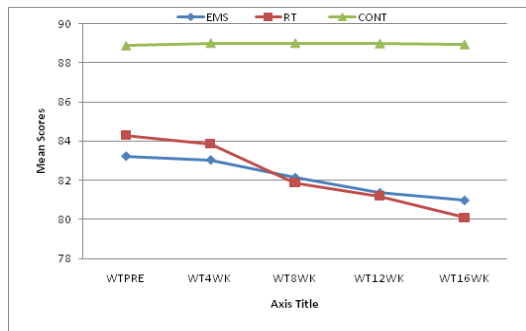


Figure 1- Mean weight scores of EMS, RES and Control groups from pre testing to 16 weeks

Waist to Hip Ratio

Repeated measure ANOVA revealed a significant decrease of WHR from 0.93 to 0.92 from pre testing to 16 weeks irrespective of the group which was statistically significant. F value of 59.788 was found to be significant at .000 level. Further, when the decrease in WHR verified across 3 different groups-EMS, RT and control, again a significant F value was observed (F=23.917; P=.000) indicating a differential decrease among groups from pre testing to 16 weeks in their WHR scores. From the mean values it is clear that EMS and control groups maintained the same WHR from pre testing to 16 weeks where WHR values of 0.93 maintained from the pre test to 16 weeks. Only in the case of RT group we find a reduction of 0.2 scores (0.93 to 0.91). On the whole we find that RT group reduced its WHR maximum, EMS and control group did not show any change in WHR from pre test to 16 weeks.

In between subject effects a non-significant difference was observed between groups in their WHR scores where F value of 1.318 was found to be non-significant (P=.273).

| Group | PRE | | 4 WEEKS | | 8 WEEKS | | 12 WEEKS | | 16 WEEKS | |
|---------|------|------|---------|------|---------|------|----------|------|----------|------|
| | Mean | S.D | Mean | S.D | Mean | S.D | Mean | S.D | Mean | S.D |
| EMS | 0.93 | 0.02 | 0.93 | 0.02 | 0.93 | 0.02 | 0.93 | 0.02 | 0.93 | 0.02 |
| RT | 0.93 | 0.03 | 0.93 | 0.03 | 0.92 | 0.03 | 0.92 | 0.03 | 0.91 | 0.02 |
| Control | 0.93 | 0.03 | 0.93 | 0.03 | 0.93 | 0.03 | 0.93 | 0.02 | 0.93 | 0.02 |
| Total | 0.93 | 0.03 | 0.93 | 0.03 | 0.93 | 0.03 | 0.93 | 0.02 | 0.92 | 0.02 |

Table 3- Mean WHR scores of EMS. RT and Control groups from pre testing to 16 weeks



Figure 2- Mean WHR scores of EMS. RT and Control groups from pre testing to 16 weeks

Waist Circumference

Repeated measure ANOVA revealed a significant decrease of waist circumference from 95.02 cm to 93.06 cm from pre testing to 16 weeks irrespective of the group which was statistically significant. F value of 146.416 was found to be significant at .000 level. Further, when the decrease in waist circumference was verified across 3 different groups-EMS, RT and control, again a significant F value was observed (F=57.082; P=.000) indicating a differential decrease among groups from pre testing to 16 weeks. From the mean values it is clear that EMS group reduced its waist circumference by 1.89 cm from pre testing to 16 weeks (from 94.27 cm to 92.38 cm), RT group reduced its waist circumference by 4.1 cm (from 93.91 cm to 89.79 cm) and lastly control group slightly increased its waist circumference by 0.16 cm (From 96.86 cm to 97.02 cm). On the whole we find that RT group reduced its waist circumference

maximum, followed by EMS group and control least from pre testing to end of the 16 weeks.

In between subject effects, a non-significant difference was observed between 3 groups, where F value of 2.730 was found to be statistically non-significant (P=.071).

| Group | PRE | | 4 WEEKS | | 8 WEEKS | | 12 WEEKS | | 16 WEEKS | |
|---------|-------|-------|---------|-------|---------|-------|----------|-------|----------|-------|
| | Mean | S.D | Mean | S.D | Mean | S.D | Mean | S.D | Mean | S.D |
| EMS | 94.27 | 10.58 | 94.03 | 10.48 | 93.30 | 10.37 | 92.78 | 10.25 | 92.38 | 10.28 |
| RT | 93.91 | 8.10 | 93.47 | 7.88 | 91.69 | 7.13 | 90.97 | 6.94 | 89.79 | 6.67 |
| Control | 96.86 | 7.85 | 96.99 | 7.97 | 97.03 | 7.69 | 97.05 | 7.73 | 97.02 | 7.74 |
| Total | 95.02 | 8.93 | 94.83 | 8.89 | 94.01 | 8.72 | 93.60 | 8.72 | 93.06 | 8.81 |

Table 4- Mean waist circumference scores of EMS. RT and Control groups from pre testing to 16 weeks

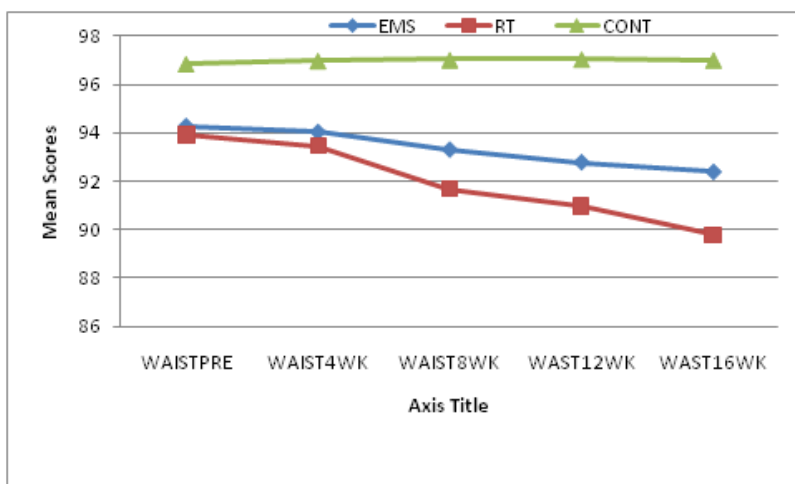


Figure 3- Mean waist circumference scores of EMS. RT and Control groups from pre testing to 16 weeks

Hip Girth

In the case of hip girth scores, again repeated measure ANOVA revealed a significant decrease of from 102.03 cm to 100.83 cm from pre testing to 16 weeks irrespective of the group which was statistically significant. F value of 167.923 was found to be significant at .000 level. Further, when the decrease in hip girth was verified across 3 different groups-EMS, RT and

control, again a significant F value was observed ($F=61.628$; $P=.000$) indicating a differential decrease among groups from pre testing to 16 weeks. From the mean values it is clear that EMS group reduced its hip girth by 1.14 cm from pre testing to 16 weeks (from 100.85 cm to 99.71), RT group reduced its hip girth by 2.5 cm (from 101.83 cm to 98.53 cm) and lastly control group increased its hip girth by 0.03 cm (from 104.22 to 104.25). On the whole we find that RT group reduced its hip girth as the maximum, followed by EMS group and control least.

In between subject effects a non-significant difference was observed between groups in their hip girth scores where F value of 2.886 was found to be non-significant ($P=.061$).

| Group | PRE | | 4 WEEKS | | 8 WEEKS | | 12 WEEKS | | 16 WEEKS | |
|---------|--------|-------|---------|-------|---------|-------|----------|-------|----------|-------|
| | Mean | S.D | Mean | S.D | Mean | S.D | Mean | S.D | Mean | S.D |
| EMS | 100.85 | 10.41 | 100.70 | 10.36 | 100.13 | 10.31 | 99.87 | 10.34 | 99.71 | 10.33 |
| RT | 101.03 | 6.25 | 100.76 | 6.21 | 99.36 | 5.86 | 99.18 | 5.90 | 98.53 | 5.73 |
| Control | 104.22 | 6.76 | 104.24 | 6.80 | 104.26 | 6.71 | 104.26 | 6.72 | 104.25 | 6.73 |
| Total | 102.03 | 8.08 | 101.90 | 8.09 | 101.25 | 8.07 | 101.10 | 8.12 | 100.83 | 8.15 |

Table 5- Mean Hip girth scores of EMS. RT and Control groups from pre testing to 16 weeks

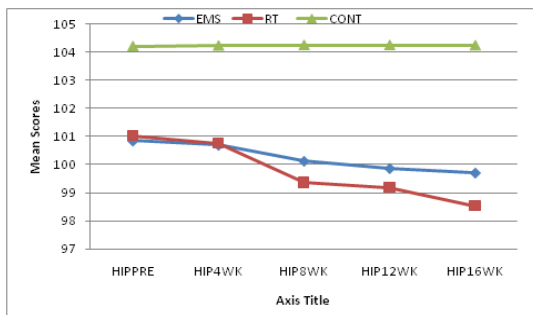


Figure 4- Mean Hip girth scores of EMS. RT and Control groups from pre testing to 16 weeks

Conclusion

The resistance training was more effective in reducing Body weight comparison to EMS group, followed by control groups.

Since 16 week from pre to post test in 2 experimental groups clearly shown differential reduction in weight in EMS and RT groups. The reduction in the weight was found to be highly significant as revealed by tests performed though repeated measure ANOVA. Further, we find a decrease of 4.21 kg from pre to post test situation in the RT group and 2.25 kg in EMS group. More weight reduction in RT group indicates that Resistance Training was more effective than electro muscle stimulation.

The results of the present study are compatible with studies done by some researchers. John P. Porcari et al. (2005) found that EMS training has not effect on body weight. Mentz N. (2005), observed that body weight positively decreases with EMS training and diet. Donnelly et al (2005) and Laura Ann Fonzi (2008) indicated that it is possible to decrease weight during resistance training among over weight individuals. Nelson (2011) explains doing resistance exercise with more muscle means a faster metabolism and faster losing weight.

Dong-il Seo et al (2011) had shown in his research that the training group had significant decreases in body weight followed by resistance training. Gettman and Pollock (1981) summarized the effects of five weight training and six circuit weight training on losing weight. In another study by R.Rahimi (2006) twenty overweight men (age: 27 ± 0.5 years; body weight: 84 ± 1.43 kg), were recruited to participate in a 12-week weight training program. The test showed statistically significant decreases in body weight (HI = 21.58%, P = 0.001; MI = 13.82%, P = 0.01). Ryan et al. (1995) demonstrated overweight women on a weight loss plan of caloric restriction and resistance exercise can positively alter their body weight and body composition.

Body weight is the most accurate method of measuring the change in body composition. Factors like water retention, increase in lean body mass, and many more, can produce fluctuations in body mass (Plowman & Smith, 1997). The

negative caloric balance created through EMS and RT groups significantly contributed to a reduction in body weight. The RT group tended to be the more successful intervention program because of the negative caloric balance.

Jensen et al. (2004) reported weight loss of 4.3 ± 5.5 kg in response to a 12 week weight loss programs. Other studies of similar duration have reported slightly greater weight loss. For example, Geliebter et al. (1997) reported a weight loss of 7.8 ± 3.8 kg during an 8 week diet and strength training program. In addition, Kraemer et al (1997) reported a weight loss of 7.0 kg in a diet + aerobic training + strength training group during a 12 week intervention. Again, these reductions in percent body fat are similar in magnitude to what others have reported in response to weight loss programs of similar duration. Ballor et al (1988) reported -3.9% body fat reductions during an 8 week diet and resistance exercise intervention. Similarly, Kraemer et al (1997) reported a -4.3% reduction in body fat during a 12 week study that included diet and exercise. Other studies of resistance exercise combined with a reduction in energy intake have also shown no significant effect of resistance exercise on change in body weight during a similar duration intervention (Ballor 1988; Kraemer 1997). Additionally, Wadden et al (1997) also reported no significant effect of resistance training on body weight change over a longer duration study of 48 weeks.

The resistance training was more effective in reducing WHR comparison to EMS group, followed by control groups.

We find a significant reduction in WHR in EMS and RT groups from pre to post test. Further, the reduction in the WHR was found to be highly significant in RT group than EMS group, we find a decrease of -0.002 from pre to post test in the RT group and decrease 0.010 in EMS group. Findings indicate that both EMS and RT exercise reduce WHR, but observing it reveals that RT is more effective in reducing the WHR. Results of the study definitely reveal that Resistance exercise was highly effective for reducing WHR (Waist to Hip Ratio) than

EMS exercise.

The results of the study are in agreement with studies done by John P. Porcari et al. (2005). He found that an 8 week Electro Muscle Stimulation training did not change the waist circumference. Result is similar to Mentz N. (2005), where the researcher observed that WHR was positively related to EMS training. The significant reduction ($p \leq 0.05$) found in group EST (2.53%) indicated that a combination of diet, electrical muscle stimulation and a thermogenic agent had the greatest effect on WHR.

Few studies have examined whether exercise-induced weight-loss is associated with concomitant reduction in abdominal subcutaneous and/or visceral fat. Using waist circumference as a surrogate measure of abdominal obesity, it is reported that minor reductions (2 cm) in waist circumference and WHR are observed in response to exercise-induced weight-loss in the order of 2 to 3 kg (Ross et al. 2000).

Not many studies have examined the influence of electro muscle stimulation on weight-loss and especially abdominal fat loss. In this study it is reasonable to conclude that electro muscle stimulation and resistance training led to a decrease in waist-to-hip ratio but resistance training had more positive effects on certain health aspects.

WHR is strongly associated with visceral fat (Ashwell et al. 1985; Seidell et al. 1987) and appears to be an acceptable index of intra-abdominal fat (Jakicic 1993). Certain predictions about health-related comorbidities can be made by using WHR (Van Itallie 1985). Although an abdominal fat distribution was proposed as a health hazard for coronary heart disease in the 1940's for the first time, it took a long time before it was confirmed (Després et al. 1995). Confirmation only came when various studies showed that a simple anthropometric measurement such as the waist-to-hip ratio (WHR) correlated with insulin resistance, hyperinsulinaemia, dyslipidaemia, hypertension and CHD (Després et al. 1990; Gillum 1987;

Lapidus et al. 1984). A study on coronary angiography showed that the pattern of body fat distribution not only correlated with metabolic and hormonal cardiovascular risk factors, but that those with major coronary stenosis, in fact had a significantly higher WHR than a healthy control group (Hauner et al. 1994). These observations suggest that strategies designed to reduce overweight would be enhanced if abdominal fat, in particular visceral fat, was substantially reduced. It is well established that diet-induced weight-loss is associated with a significant reduction in abdominal subcutaneous and visceral fat and that reduction in visceral fat is related to a corresponding reduction in metabolic risk factors.

In this study it is reasonable to conclude that electrical muscle stimulation and resistance training led to a decrease in waist-to-hip ratio and could have positive effects on certain health aspects.

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