International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Effect of Multi-Muscle Transcutaneous Electric Stimulation on Body Composition of Overweight Females

Nazia Choudhary[1], Vishwajeet Trivedi[2], A.G.K. Sinha[3]

[1]Post graduate Student, [2]P.hD. Research Scholar, [3]Professor,
Department of Physiotherapy; Punjabi University Patiala.

Corresponding Author: Vishwajeet Trivedi

Received: 10/11/2016 *Revised: 03/12/2016* *Accepted: 08/12/2016*

ABSTRACT

Background: Obesity is a chronic disease which has been raised to epidemic proportions in both developed and developing countries across the globe. Obesity occurs as a result of genetic, environmental, metabolic, physiological, behavioral, social and even racial influences. These factors cause energy imbalance which lead to excessive fat deposition. Various methods are used to control the obesity such as anti-obesity drugs, dieting, behavior therapy, physical exercises and fat reduction surgery. Also the multi-muscle stimulator seems to have the potential to cause contraction in major muscles of body simultaneously for causing significant energy expenditure.
Aim and objective: To find out the effect of multi-muscle transcutaneous electric stimulation on body composition, skin fold thickness, muscle girth circumferences and BMI of overweight females.
Method: Out of 40 volunteers, 20 healthy females were recruited according to inclusion and exclusion criteria and divided randomly into two groups: A (experimental) and B (Control) equally. Subjects were positioned comfortably in supine position and deltoid, Quadriceps and Glutei were stimulated bilaterally along with the abdomen by using multi-channel Russian Current stimulator for 30 minutes (10 second on and 30 second off time) at the motor level intensity for group 'A' and at the sensory level intensity for group 'B'. Each subject had received similar 3 sessions of stimulation per week for 4 weeks.
Results: Mean ±SD of Body weight, BMI, circumferences, skin fold thickness, percent fat, BMR, fat weight and lean weight were analyzed during pre- intervention, and at2nd, and 4th weeks, as well as at6th and 8th week for follow up. One way ANOVA and Tukey's Kramer Post Hoc Test were used to analyze the variables in between and within the groups respectively.
Conclusion: Four weeks of multi muscle stimulation Russian currents have no effect on most of the parameters of body composition, except arm circumference and abdomen skin fold.

Key words: Russian Current, obesity, BMI, circumferences, skin fold, body composition.

INTRODUCTION

Obesity is a global problem, affecting people worldwide. Obesity is commonly defined as abnormal or extensive fat accumulation that negatively affects health (Kopelman, 2000). It is a chronic relapsing, stigmatized neurochemical disease associated with multiple factors responsible for its development like social, behavioral, environmental and genetics (Srivastava et al., 2007). These factors cause energy imbalance which lead to excessive fat deposition (Racette et al., 2003) and the risk for many disorder like hypertension, diabetes mellitus and hyperlipidemia, Coronary artery disease, etc. (Kopelman, 2000). Along with effect on physiological system, obesity also alters the

biomechanical alignment and causes several musculoskeletal disorders (Korth and Baldry, 2012). Diet modification, behavior therapy, anti-obesity drugs, physical exercises and fat reduction surgeries are some interventions that can be opt for the management of the obesity. The proportion of overweight people, especially female in the population is increasing as society getting modernized. The obese person seems to be unable or unwilling to perform physical exercise program. Also, there are people who are chronic bedridden due to presence of some physical impairment in them. Increased weight due to their limitation in energy expenditure among such people is an important health issue for the society.

Since, many centuries Electrical Muscle Stimulation (EMS) is used as an alternative method of active exercise for improving muscle strength, endurance of muscle (Currier & Mann, 1983), Range of motion (Alon et al., 1994), neuromuscular re-education (Currel-Bazo et al., 1992), pain management (Bauer et al., 1992), reducing oedema (Mohr et al., 1987) and healing of pressure sores has increased in recent years (Thakral et al., 2013). Since obesity is the result of increase in energy intake without any increase in expenditure, researchers are going on to manage the cause of obesity in terms of energy expenditure. For achieving over all significant energy expenditure in overweight people, an electrical stimulation which can induce strong muscle force is required. It is believed that transcutaneous electric stimulation initially breaks the fatty capsule that covers the muscle improves blood supply to the muscles, and then helps it to gain the loss tone to return to its original size. This return to size and tone gives the muscles the strength to crumble the fatty capsule from the inside, through their contractions (Bailey, 1976). The multi-muscle stimulator seems to have the potency to cause contraction in major muscles of body simultaneously for causing significant energy expenditure. Health clinics are using this kind of stimulator of Russian currents for reducing fat in many parts of India and even in foreign countries. The quantity and quality of such claims by the health clinics on multi-muscle stimulator is not examined on the basis of scientific study. In order to examine the effects of electrical stimulation on body composition on body composition the present study is planned.

MATERIALS AND METHODS

Subjects

The study was carried out in the department of Physiotherapy, Punjabi University Patiala. Amongst forty volunteers, four volunteers were dropped out due to their assumption regarding safety of the stimulation on their health status, out of remaining, twenty apparently overweight female volunteers of age 20-40 years with BMI (25.0-29.9) were served as subjects for this study. The mean age of the experimental group participants was 26.1 ± 3.84 years whereas 25.6 ± 3.40 years for control group subjects. Subjects engaged in any type of regular formal exercise were excluded from the study. Subjects were randomly assigned by lottery method to either a control (n=10) or EMS group (n=10). Consent forms were signed by the subjects after summarizing the whole purpose and procedure of the study. Study protocol was approved by the institutional ethical committee of Punjabi university Patiala.

Testing

The pre-and posttests included measurement of Body weight, Body mass index, Girth measurement (Upper Arm circumference, Waist circumference, hip circumference and thigh circumference), Skin fold thickness (Biceps, Triceps, Sub scapular, abdomen, Suprailiac and calf), and Body composition (percent fat, BMR, fat weight, lean weight). Both groups of subjects underwent an identical battery of tests before starting of intervention and at 2^{nd}, and 4^{th} weeks of intervention program as well as after 6^{th} and 8^{th} week for follow up.

Body Weight and Height: Body weight was measured using weighing scale of Equinox Company (Model-EB6171). Maximum limit of measuring weight was 150 kg. Height was measured by using the anthropometric rod in centimeters.

Skin folds and Girths: All skin folds and girths were measured by the same examiner. Skin fold thicknesses (fat folds) were each measured 3 times at the following 6 sites on the body using Harpenden calipers; Biceps, triceps, sub scapular, abdomen, Suprailiac and calf. The mean of the 3 measurements for each site was used in the calculation. Percentage of body fat was estimated from the sum of 3skinfolds (triceps, abdomen, and supra iliac) as described by Pollock et al., 1980. Girth measurements (circumferences) were made at 4 sites using an inch tape measure. Measurement sites included the Upper Arm, Waist, Hip and thigh. All measurements were taken without clothes except Hip circumference due to the culture reason. Absolute girth measurements include both the circumference of the muscle as well as the subcutaneous fat layer.

Body Mass Index: It is defined as ratio of individual's body weight (in kilograms) and height (in meter^2). After measuring height and weight, BMI was calculated.

Body Composition: Body composition analyzer-510 of EM International Company was used. Body composition analysis is done by measuring the bioelectric impedance (determined by amount of adipose tissue present in body) by the machine. To ensure the accurate results subject were instructed; not to consume food in last 3 hours and alcohol in last 24 hours as these can deviate results. Initially sex, age, height and weight of a subject were feed to the machine and then it automatically analyze the percent fat, fat weight, lean weight, basal metabolic rate (BMR) and body mass index of a subject.

Intervention

Experimental group: Multi-channel (8 channels) electrical stimulator of "Johri Digital" company (model no. TR841) was used to deliver Russian current of 2500 Hz of motor level intensity with 10 seconds of stimulation followed by 30 seconds rest. Total four muscles (glutei, deltoid, and quadriceps of both sides and abdomen) were stimulated for 30 minutes using standard clinical protocol. Subject received 3 sessions per week for the period of 4 weeks. Subject was positioned comfortably in supine position in the calm and quiet room with head well supported on pillow and skin was clean well with the spirit to reduce the resistance. Circular Carbon electrode were placed over Deltoid, abdomen, Quadriceps and Glutei bilaterally and secured in place by straps. Muscles undergo stimulation and placements of electrodes are shown in table 1.

Control group: Similar procedure was adopted for control group also but instead of delivering current up to motor intensity, sham stimulation was delivered to the subjects in the control group. Figure 1 shows the subject receiving electrical stimulation.

RESULTS

Statistical Analyses

The data was analyzed using Microsoft Excel 2007. Mean and Standard Deviation were derived initially for the required variables. The analysis of variance (one way ANOVA) was applied for comparison of different sessions of stimulation. Further within group analysis was done using Tukey's Kramer Post Hoc Test.

The mean ± SD of Weight and BMI at different points of intervention of control group and experimental group are presented in Table 2. The body weight decreases slightly by 0.3 and 2.02 percent in control group and experimental group respectively. Similarly, the BMI also shows some decrement by 0.13 and 0.73 percent in control group and experimental group respectively.

The Mean±SD of arm circumference were analyzed at different intervention points and results shows slight decrement by 0.5 and 2.4 percent in control group and

experimental group respectively. The results are presented in table 3. Post hoc t test showed statistically significant differences ($p \leq 0.05$) amongst the pre-stimulation vs 4th week, pre-stimulation vs 6th week follow up, pre-stimulation vs 8th week follow up, 2nd week vs 6th week follow up and 2nd week vs 8th week follow up in experimental group. The changes in arm circumference at different points of interventions are summarized in table 3.1 and figure 2 respectively.

Skin fold data are summarized in Table 4. There were no significant ($p \geq 0.05$) differences in the biceps, triceps, sub scapular, supra iliac, calf, or thigh skin folds over the course of the study in either group were found. Statistically significant differences were observed only in experimental group abdomen skin fold thickness at pre-stimulation vs 6th week follow up, pre-stimulation vs 8th week follows up, 2nd week vs 6th week follow up, 2nd week vs 8th week follow up, 4th week vs 6th week follow up and 4th week vs 8th week follow up. Data for which is summarized in Table 4.1. Figure 3 shows the change in abdominal skin fold thickness of experimental group at various points of intervention.

Changes in body composition over the course of the study are summarized in Table 5. There were no significant ($p \geq 0.05$) changes in the percentage of body fat, fat weight, lean body weight or BMR from pre- to post testing in either group were found.

Table 1: shows muscles stimulated and placement of electrodes

Muscles Stimulated	Area of electrodes Placement	
Quadriceps	Proximal Electrode	Distal Electrode
	On femoral nerve in femoral triangle	Over motor point
Glutei	Gluteal surface of ilium	Gluteal sulcus
Deltoid	Just below the tip of the acromion process	Just below the deltoid tuberosity
Abdomen	Over the belly of external oblique muscle	Over the belly of external oblique muscle

Table 2: shows the Mean ± SD of weight and BMI in control and experimental group

	Variables	Pre stimulation	2nd week between stimulation	4th week post stimulation	1st follow up at 6th week	2nd follow up at 8th week
Control Group	Weight(kg)	65.96±5.17	65.96±5.17	65.66±5.33	65.48±5.22	65.66±5.27
	BMI	26.40±1.35	26.40±1.35	26.28±1.41	26.19±1.44	26.27±1.42
Experimental Group	Weight	69.82±7.87	69.65±7.98	68.66±8.11	67.7±8.01	67.8±7.98
	BMI	27.93±1.27	27.86±1.34	27.46±1.27	27.08±1.38	27.9±1.39

Table 3: shows the Mean ± SD of different circumferences in control and experimental group

	Variables (cm)	Pre stimulation	2nd week between stimulation	4th week post stimulation	1st follow up at 6th week	2nd follow up at 8th week
Control Group	Arm circumference	31±1.83	31±1.76	30.2±1.98	29.9±1.79	30.5±2.17
	Waist circumference	88.1±7.07	88.1±7.07	87.5±7.02	86.8±7.65	87.2±7.07
	Hip circumference	101.9±5.42	101.9±5.42	101.8±5.43	101.7±5.43	101.7±5.43
	Thigh circumference	56.1±2.72	56.1±2.72	56.1±2.72	56.1±2.72	56.1±2.72
Experimental Group	Arm circumference	30.6±1.83	30.4±1.83	28.9±2.28	29.9±2.02	30.5±1.93
	Waist circumference	88.8±4.39	88.7±4.32	86.2±5.00	84.8±4.89	85.5±5.06
	Hip circumference	104.2±5.20	104.2±5.20	103.1±5.85	101.8±5.76	102±5.79
	Thigh circumference	59.5±3.24	59.5±3.24	59.2±3.38	58.4±3.13	58.3±3.26

Table 3.1: Results of post hoc t test with in experimental group for comparison of arm circumference data

	Pre-stimulation	2nd week	4th week	6th week	8th week
Pre-stimulation					
2nd week	0.2(0.24)				
4th week	1.7(1.83)*	1.5(1.61)			
6th week	2.7(3.12)*	2.5(2.89)*	1(1.03)		
8th week	2.4(2.84)*	2.2(2.60)*	0.7(0.74)	0.3(0.33)	

(*Statistically Significant)

Table 4: shows the Mean ± SD at different sites of skin fold measurements in control and experimental group

	Variables	Pre stimulation	2nd week between stimulation	4th week post stimulation	1st follow up at 6th week	2nd follow up at 8th week
Control Group	Biceps skin fold thickness	13.99±1.14	13.99±1.14	13.86±1.23	13.73±1.28	13.89±1.17
	Triceps skin fold thickness	15.03±0.63	15.03±0.63	14.86±0.66	14.76±0.75	14.89±0.64
	Abdomen skin fold thickness	14.53±0.84	14.49±0.90	14.32±0.99	14.06±0.86	14.23±0.90
	Sub scapular skin fold thickness	12.26±1.19	12.56±1.19	12.56±1.19	12.53±1.18	12.56±1.19
	Supraillac skin fold thickness	13.16±1.53	13.16±1.53	13.03±1.46	13.03±1.42	13.16±1.47
	Calf skin fold thickness	12.96±0.70	12.96±0.70	12.93±0.74	12.86±0.70	12.96±0.66
Experimental Group	Biceps skin fold thickness	14.76±1.09	14.63±1.09	13.86±1.18	13.06±1.46	13.23±1.42
	Triceps skin fold thickness	16.79±1.52	16.63±1.59	15.99±1.61	15.33±01.30	15.36±1.26
	Abdomen skin fold thickness	14.43±1.22	14.29±1.08	13.86±1.11	12.79±1.26	12.86±1.28
	Sub scapular skin fold thickness	14.26±1.49	14.26±1.49	13.89±1.50	13.46±1.55	13.53±1.50
	Supraillac skin fold thickness	14.16±1.46	14.06±1.46	13.66±1.44	12.99±1.56	13.03±1.54
	Calf skin fold thickness	13.49±1.15	13.49±1.15	13.06±1.18	12.53±1.04	12.59±0.97

Table 4.1: Results of post hoc t test with in experimental group for comparison of abdominal skin fold thickness data

	Pre-stimulation	2nd week	4th week	6th week	8th week
Pre-stimulation					
2nd week	0.14(0.26)				
4th week	0.57(1.13)	0.43(0.88)			
6th week	1.64(3.04)*	1.5(2.84)*	0.37(1.99)*		
8th week	1.57(2.89)*	1.43(2.69)*	0.42(1.85)*	0.07(0.11)	

(*Statistically Significant)

Table 5: shows the Mean ± SD of several parameters of body composition in control and experimental group

	Variables	Pre stimulation	2nd week between stimulation	4th week post stimulation	1st follow up at 6th week	2nd follow up at 8th week
Control Group	Percent fat	24.36±2.28	24.36±2.28	24.16±2.44	23.85±2.53	24.01±2.51
	BMR	1501.3±106.25	1501.3± 106.25	1497.3± 107.91	1496.2.3± 109.79	1498.3± 111.04
	Fat weight	16±2.43	16±2.43	15.86±2.55	15.55±2.63	15.61±2.64
	Lean weight	50.13±3.43	50.06±3.41	49.82.±3.41	49.88±3.59	49.82±3.59
Experimental Group	Percent fat	26.47±2.97	26.19±2.94	25.8±3.03	25.23±2.55	25.33±2.57
	BMR	1546.5±100.95	1543.8± 99.19	1532.6± 99.59	1512.1± 100.89	1513.7± 100.34
	Fat weight	18±4.16	18.27±4.13	17.78±4.20	17.41±3.93	17.45±3.90
	Lean weight	50.84±3.57	50.71±3.47	50.2.±3.52	49.85±3.16	49.89±3.15

Figure 1: shows the subject receiving Electrical Muscle Stimulation

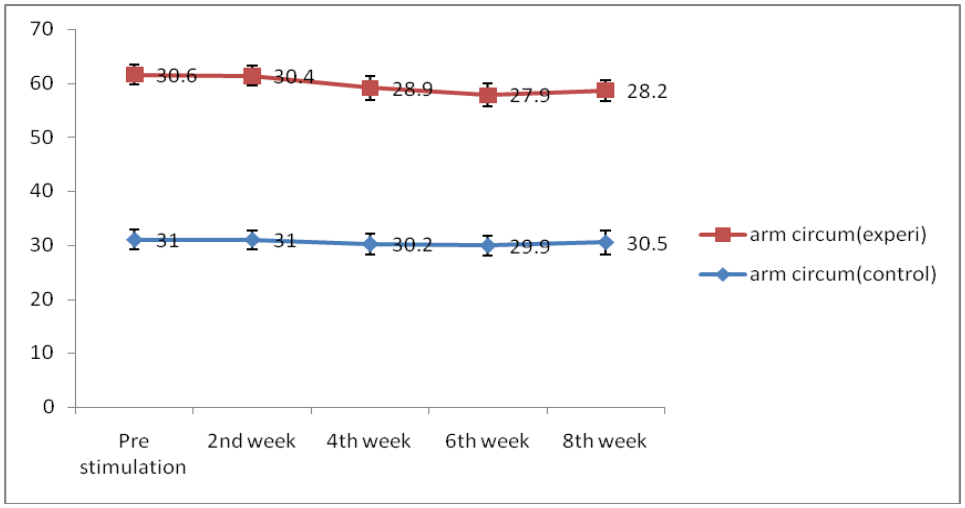

Figure 2: Arm circumference of control and experimental group during intervention and follow-up

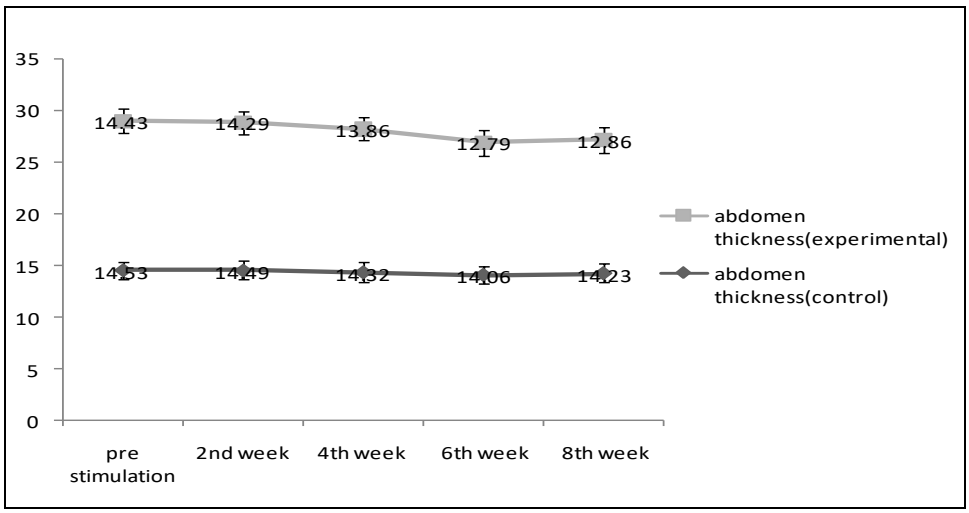

Figure 3: Abdomen thickness of control and experimental group during intervention and follow up

DISCUSSION

In present study the analysis of data revealed no change in most of the parameters of the body composition. Only the parameter of arm circumference and abdominal skin fold showed significant but minute reduction after 4 weeks of stimulation.

Present findings are found to be in agreement with the results of Procrari *et al.*, 2002; Maggioniet *al*, 2012; and Giangregoria *et al*., 2012 who reported that electrical muscle stimulation had no or poor effect on body composition parameters.

In the present study we have used bioelectric impedance analysis as well as skin fold and arm circumference for the assessment of various components of body composition instead of using the scientific tools for measurement of body composition (Dual energy X-ray absorptiometry, Magnetic resonance imaging, Ultrasound and isotope dilation). Changes in body composition might have been more clearly measured by these equipment's.

The exercise or electrical stimulation that have reported for reduction in body fat have used the duration of 12 weeks or more. Tian *et al*., 2003; Sharma *et* al., 2011; Kaur *et al*., 2012; Kemmeler *et al*., 2010; and Kemmler *et al*., 2013 concluded the positive effect of electrical muscle stimulation on body composition over 12 weeks of stimulation. We have stimulated for the period of 4 weeks, which might be the possible factor of our results.

There were several limitations which might have influenced the result of non-significant alteration in the body composition. One of the major limitations of

present study is interruption in the continuity of stimulation protocol due to menstrual cycles. According to the research program each subject had to receive electrical stimulation on alternate days for the period of four weeks. However, this four weeks stimulation could not be applied continuously. During the menstrual days the subjects were not willing to undergo stimulation session and the investigator had to discontinue the stimulation. On an average one week interruption was present in all the subjects; this may be the reason for non-significant result.

Overall the program was well tolerated by the subjects and no adverse effect was observed. This indicates that 30 minute multi-muscle electrical stimulation is safe for the mankind.

Future Scope

It is recommended to investigate to evaluate the effect of electrical muscle stimulation with the protocol of longer duration. It shall be imperative to see whether a program of 12 weeks produces reduction in body fat.

CONCLUSION

In conclusion it can be said that four weeks of multi muscle stimulation Russian currents have no effect on most of the parameters of body composition, except arm circumference and abdomen skin fold. However, the modality is safe to use.

Conflict of Interests

No conflicts of interest, financial or otherwise, are declared by the author(s).

ACKNOWLEDGEMENT

We would like to pay our sincere thanks to the subjects who provide their valuable time and support for the completion of this research study.

REFERENCES

- Alon, G. (1994) High voltage Stimulation. Effects of electrode size on basic excitatory responses and on selected stimulus parameters. *J Orthop Sports PhysTher*, 65:890-005.
- Bailey, H.R. (1976) Local tissue reduction. *Med. J. Australia*, 1:7.
- Bauer, R., Waldrop, T., Iwamoto, G. and Holzwarth, M. (1992) Properties of ventromedullary neurons that respond to muscular contractions. *Brain res. Bull*, 28:167-178.
- Chute, C., Willet, W.C., Colditz, G.A., Stampfer, M.J., Baron, J.A. and Rosner, B. (1991) A prospective study of body mass, height, and smoking on the risk of colorectal cancer in women. *Cancer Cause Control*, 2:117-124.
- Currel-Bazo, H., Petrofsky. J., Brown, S. and Smith, J. (1992) Electrostimulation of the bladder and bladder biofeedback: a case study. *J Neur Orthop Surg*, 13:47-50.
- Currier, D.P. and Mann, R. (1983) Muscular strength development by electrical stimulation in healthy Individual. *Phys Ther*, 63:915-921.
- Giangregorio, L., Craven, C., Richards, K., Kapadia, N., Hitiz, S.L., Masani, K. and Popovic, M.R. (2012) A randomized trial of functional electrical stimulation for walking in incomplete spinal cord injury: Effects on body composition. *The Journal of Spinal Cord Medicine*, 35(5):351-360.
- Kaur, P., Lehri, A. and Verma, S.K. (2012) Effect of electrical stimulation on abdomen skin fold after four weeks program. *Ind. J. SportsSc*, 21:41-47
- Kemmeler, W. and Stengel, S. (2013) Whole body EMS as a means to impact muscle mass and abdominal fat in lean, sedentary and older female adult: sub analysis of the test-3 trial. *Clinical Interventions in Aging*,8:1353-1364
- Kemmeler, W., Rebecca, S., Mayhew, J.L. and Stengel, S.V. (2010) Effect of Whole body Electro-myosytimulation on Resting metabolic rate, body composition and maximum strength in postmenopausal women: The training and Electro stimulation trial. *Journal of Strength and conditioning research*, 24(7):1880-1887.
- Kopelman, P.G. (2000) Obesity as a medical problem. *Nature*, 404:635-643.
- Kortt, M. and Baldry, J. (2012) the association between musculoskeltal

disorders and obesity. *Aust Health Rev*, 25:207-214.

- Maggioni, M.A., Ce E., Giordano, G., Berotli , S., Battezati, A., Veicasteinas, A. and Merati, G. (2012) Effects on body composition of different short term rehabilitation programs in long stay hospitalized elderly women. *Aging clinical & Experiment research*, 24:619-626
- Mc Ardle, W.D., Katch, F.I. and Katch, V.L. (2006) Exercise physiology-Energy, Nutrition and Human performance. Willams. 5th edition.531-631
- Mohr, T.M., Akres, T.K. and Landry, R.G. (1987) Effect of high voltage stimulation on edema reduction in the rat hind-limb. *Phy Ther*, 67:1703-1707.
- Pollock, M.L., Schmidt, D.H. and Jackson, A.S. (1980) Measurement of cardiorespiratory fitness and body composition in the clinical setting. *Compr. Ther.* 6(9):12–27
- Procari, J.P., Mclean, P.K., Foster, C., Kernozek, T. and Swenson, C. (2002) Effect of Electrical muscle stimulation on body composition, Muscle strength and physical Apperance. *Journal of Strength and conditioning Research*, 16(2):165-172.
- Racette, S.B., Deusinger, S.S. and Deusinger, R.H. (2003) Obesity: Overview of prevalence, Etiology and treatment. *PHYS THER*, 83:276-288.
- Sharma, P.A. and Verma, S.K. (2011) Effect of electrical stimulation on reducing fat from the body. *Journal of Exercise Science and Physiotherapy*, 7:24-48.
- Srivastava, N., Lakhan, R. and Mittal, B. (2007) Pathophysiology and genetics of obesity. *Indian Journal of Experimental Biology*, 45: 929-936
- Stampfer, M.J., Sacks, F.M., Salvini, S., Willett, W.C. and Hennekens, C.H. (1991) A Prospective Study of Cholesterol, Apolipoproteins, and the Risk of Myocardial Infarction. *N Engl J Med*, 325:373-381
- Thakral, G., Lafontaine, J., Najafi, B., Talal, T.K., Kim, P. and Lavery, L.A. (2013) Electrical stimulation to accelerate wound healing. *Diabet Foot Ankle*, 4:22081
- Tian, D., Li, X., Shi, Y. and Han.J (2003) The effect of Transcutaneous electric nerve stimulation on obesity. *Journal of Peking University*. 35(3): 277-279.
- World Health Organization (2000). Obesity, Preventing and managing the global epidemic. Report of a WHO consultation, WHO technical Reports Series 894; Geneva, Switzerland.

How to cite this article: Choudhary N, Trivedi V, Sinha AGK. Effect of multi-muscle transcutaneous electric stimulation on body composition of overweight females. Int J Health Sci Res. 2017; 7(1):138-145.

****