EFFECT OF MANUAL VERSUS ELECTRICAL ACUPUNCTURE ON ADOLESCENTS OBESITY

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Abstract

Background and Purpose: Obesity in adolescents represents one of the biggest global health problems in developed countries and has a negative impact on their physical and psychological status. Acupuncture is a non-invasive approach that could be used in the medical field. The aim of the study was to compare the effects of manual and electrical acupuncture on obesity control in adolescents. **Methods:** Forty obese adolescents of both genders, whose ages ranged from 15 to 18 years, were assigned randomly into two equal groups; manual acupuncture group (MAG) and electrical acupuncture group (EAG). Both groups received selected physical therapy exercises and diet therapy. In addition, MAG received manual acupuncture and EAG received electrical acupuncture. Body-mass index (BMI), body fat percentage, and waist/hip ratio (WHR) were measured before and after three successive months of intervention. **Results:** There were non-significant differences between both groups in pretreatment in all measuring variables ($p>0.05$). Within-group comparison revealed significant decrease in BMI and body fat percentage ($p<0.05$) and a non-significant decrease in WHR ($p>0.05$). Post-treatment comparison revealed a significant difference between groups in all measured variables in favor of EAG as compared to MAG. **Conclusion:** Both manual and electrical acupuncture could be used in conjunction with diet and physical therapy exercises to reduce obesity, but electrical acupuncture is more effective than manual acupuncture on controlling obesity in adolescents.

Keywords: Manual acupuncture; Electrical acupuncture; Obesity; Adolescents

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1. Introduction

Obesity is a common metabolic disorder that is characterized by an excess of adipose tissue and contributes to numerous chronic diseases. It is the consequence of a long-term imbalance between energy intake and expenditure, which is determined by food intake and physical activities. It is influenced by biological and environmental factors.[1] The prevalence of obesity is increasing amazingly in developed countries, particularly in the last decade, the growth rate of obesity has ascended exponentially.[2]

Obesity in adolescents has a notably higher prevalence and is linked to higher adult morbidity and mortality rates.[3,4]

Numerous of these children suffer from one or more comorbidities, such as fatty liver disease, pre-diabetes, diabetes, polycystic ovary syndrome, obstructive sleep apnea, and psychological problems.[5]

Therefore, a careful program design is important to develop an ideal health care system and verify its effectiveness before adolescents become severely obese.[6]

The use of multicomponent program that incorporate dietary advice and physical activity with behavioral change skills is recommended as an appropriate treatment for all categories of obesity in young people aged < 18 years old.[7]

Acupuncture is one of the oldest medical therapies. It originated in China and was established within the framework of traditional Chinese medicine (TCM). It is one of the most important alternative and complementary therapies for treating numerous diseases. While acupuncture has been practiced

worldwide, the lack of high-quality clinical evidence makes acupuncture a highly controversial therapy.[8]

Acupuncture has various types, including manual acupuncture, electro-acupuncture, auricular acupuncture, electro-acupuncture plus auricular acupuncture. Both manual and electrical acupuncture are commonly used in the medical field to achieve therapeutic benefits.[9]

Manual acupuncture (MA) is the insertion of thin needles through the skin at strategic acupuncture points on the body for a certain period of time,[10] while electroacupuncture (EA) involves the conduction of electrical stimuli via acupuncture needles at certain frequencies.[11] Therefore, the aim of this study was to compare the effects of manual and electrical acupuncture on BMI, body fat percentage, and WHR in obese adolescents.

2. Methods

Study design:

It is a prospective, comparative, pre-post study that was conducted from January to November 2022.

Sample size:

The Steven Samson equation was used to calculate the sample size. Based on the assumption that sample size was calculated for an infinite community population (90,000,000), with a confidence level of 90%, a probability level of 50%, and a margin of error of 0.05%, a sample size of 40 adolescents would be required.

Participants:

Forty obese adolescents of both sexes participated in this study. They were recruited according to the following inclusion criteria: a) Their ages were between 15 to 18 years; b) Their BMI was equal to or greater than the 95th percentile, according to the Centers for Disease Control (CDC) for boys and girls,[12] c) All adolescents passed their pubertal timing; and d) They were clinically and medically stable. Adolescents were excluded if they had one of the following: a) Impairment of sensation; b) Any neurological or psychological problems; c) Endocrine diseases such as thyroid, pituitary, and sex disorders; d) heart disease such as arrhythmia, heart failure, myocardial infarction, or requiring a pacemaker; and e) allergic, immune, and kidney diseases.[13]

Participants were recruited from schools and pediatric clinics at governmental hospitals located in Damanhur City, El-Buhera, Egypt. They were randomized into two study groups of equal number; manual acupuncture group (MAG) and electrical acupuncture group (EAG) using closed envelopes. Both groups received selected physical therapy exercises and diet therapy. In addition, MAG received manual acupuncture and EAG received electrical acupuncture. Treatment sessions were conducted three times per week for three successive months. All Participants were assessed before and after treatment for body-mass index (BMI), body fat percentage, and waist/hip ratio (WHR).[14]

Materials and Instrumentation:

Digital body weight scale was used to measure weight to the nearest 0.1 kg and a stadiometer was used to measure weight to the nearest 0.1 cm. Soft tape measure double scale body flexible ruler was used to measure waist and hip circumferences.

Skinfold caliper used to assess the skinfold thickness, so that a prediction of the total amount of body fat can be made. This method is based on the hypothesis that the body fat is equally distributed over the body and that the thickness of the skinfold is a measure for subcutaneous fat.[15]

Electrical treadmill and bicycle ergometer were used to apply the selected physical therapy exercises. Needle acupuncture and electro-acupuncture stimulator were used to apply acupuncture.

Procedure:

Ethical Considerations:

The study was approved by the Ethical Committee of the Faculty of Physical Therapy, Cairo University, Egypt (P.T.REC/012/003021). A signed written consent form was obtained from the children's parents or legal guardians before starting the study.

Evaluation:

All participants were assessed for BMI [weight (kg) / height (m2)],[16] fat body percentage (pinch test) by using a skinfold caliper. The sites for measuring fat density were the chest, abdomen, and thigh for males and the triceps, suprailiac, and thigh for females. Then the body fat percentage was calculated for each participant according to the Jackson and Pollock formula[17] as well as WHR by dividing the waist circumference (WC) in centimeters by the hip circumference (HC) in centimeters.[18]

Intervention:

Both MAG and EAG received the same balanced diet and selected physical therapy exercises. Diet therapy was prescribed by dietetic supervision for establishing a specific daily diet schedule. A balanced diet was low in fat (20–25%), high in complex carbohydrates (50–60%), and sufficient in protein (20–30%) to support growth. Calorie intake was calculated using a 24-hour diary recall. The diet was reduced by 500 kcal until it reached 1200–

1600 kcal, according to World Health Organization (WHO) guidelines.[19]

The selected physical therapy exercises included cycling, abdominal exercises (30 minutes) as well as treadmill training for 30 minutes as follows:

1. Cycling where each participant seated with an erect back at a suitable chair height and feet resting on the pedal and cycled continuously at a moderate velocity for 10 minutes.[20]
2. Abdominal exercises first from supine position where each participant contracted his or her abdomen and held it for 30 seconds then relaxed for 30 seconds and repeated it for 5 repetitions. Second from crock lying position, each participant touched his or her knees with fingers with straight arms (holding for 30 seconds, then relaxing for 30 seconds and repeating it for 5 repetitions). Third, from supine lying, each participant raised his or her leg up (straight leg raising) then down slowly without touching the plinth (10 repetitions).[21]
3. Treadmill training where each participant walked on a treadmill with zero degree of inclination at a speed of 1.5 kilometers per hour for 5 minutes (warming up). The speed was increased gradually to reach 3 kilometers per hour with 10 degrees of inclination after 20 minutes. The speed was returned to 1.5 km/h with a zero degree of inclination for another 5 minutes as a cooling down.[22]

Acupuncture was introduced as manual acupuncture for MAG and as electrical acupuncture for EAG as follows:

- Manual acupuncture consists of the rapidly rotating (back-and-forth or in one direction) and/or pistoling (up-and-down motion) of the needle. The needle was applied for 30 minutes.
- Electrical acupuncture was conducted at the same abdominal acupuncture points as MAG for 30 minutes, with using the electro-acupuncture stimulator. The stimulation frequency was set at 2/15 Hz, and the intensity varied from 0.1 mA to a maximum of 2.0 mA until the needle handle began to tremble slightly.[23]

For both groups, the needles were applied appropriately and in hygienic settings. The acupuncture needles used in this study were of a finer gauge than even the finest needles used for intradermal injections.[24] To minimize skin resistance, the acupuncture points were cleaned with alcohol before inserting needles.[25] The locations of acupuncture points for treating obesity were:

1. ST25 (Tianshu): On the upper abdomen, two fingers (width of the middle finger) from the centre of the umbilicus.
2. CV12 (Zhongwan): On the upper abdomen, four fingers superior to the center of the umbilicus, on the anterior median line.
3. CV9 (Shuifen): On the upper abdomen, one finger superior to the center of the umbilicus, on the anterior median line.
4. BL20 (Pishu): In the upper back.
5. BL24 (Qihai): Lumber region, at the same level as the inferior border of the spinous process of the 11th thoracic vertebra (T11), and the 3rd lumbar vertebra (L3), 1.5 finger lateral to the posterior median line.

Statistical analysis:

Results were expressed as the mean and standard deviation for each variable. Between-groups Chi-square test was conducted for comparison of the sex distribution between both study groups. A comparison of ages between groups was performed using an unpaired t-test. An analysis of covariance (ANCOVA) test was used to compare between the two groups. Within-groups comparison was performed using a paired t-test. The Statistical Package for Social Sciences (SPSS) computer program (version 19 for Windows) was used for data analysis. P value ≤ 0.05 was considered significant.

3. Results

Results revealed non-significant differences between the two groups concerning age and gender ($p>0.05$) **Table (1).** There were also non-significant differences between the two groups regarding BMI, body fat percentage, and WHR ($p>0.05$) before intervention. However, after intervention, there were significant differences between the two groups regarding BMI and body fat percentage with no significant difference regarding WHP **Table (2).** Within-group comparing revealed a significant decrease regarding BMI and body fat percentage with no significance difference regarding WHR for MAG as well as for EAG **Table (2).**

Table (1): Comparison of age and gender distribution between the two groups

		MAG	EAG	t-value	p-value
		Mean±SD			
Age (years)		16.66±0.99	16.55±1.04	0.359	0.722^{NS}
		N (%)		X^2	p-value
Gender	**Girls**	12(60%)	12(60%)	0.000	1^{NS}
	Boys	8(40%)	8(40%)		

SD: Standard Deviation, MAG: manual acupuncture group, EAG: electrical acupuncture group, t-value: unpaired test value, X2: Chi squared value, p-value: probability value, N(%): Number(percentage), NS: Non-significant.

Table (2): Comparison of BMI, body fat percentage and WHR between the two groups.

		MAG Mean±SD	EAG Mean±SD	F-value	p-value
BMI	Pre- treatment	35.07±1.7	34.39±1.56	1.73	0.196^{NS}
	Post- treatment	29.95±2.08	28.58±1.58	4.74	0.036^{S}
	% of Improvement	14.60%	17.24%		
	t-value	12.039	12.353		
	p-value	0.001^{S}	0.001^{S}		
Body Fat Percentage	Pre- treatment	1.02±0.01	1.03±0.02	2.390	0.130^{NS}
	Post- treatment	1.01±0.3	1±0.01	7.572	0.009^{S}
	% of Improvement	0.69%	1.56%		
	t-value	3.57	7.58		
	p-value	0.002^{S}	0.001^{S}		
WHR	Pre- treatment	1.057±0.161	1.055±0.138	0.001	0.970^{NS}
	Post- treatment	1.039±0.226	1.039±0.153	0.001	0.990^{NS}
	% of Improvement	1.70%	1.52%		
	t-value	0.535	0.497		
	p-value	0.599^{NS}	0.625^{NS}		

BMI: Body mass index, WHR: Waist/Hip ratio, MAG: Manual acupuncture group, EAG: Electrical acupuncture group, SD: Standard deviation, F value: ANCOVA test, p- value: Probability value, %: Percentage, t- value: paired t-test, NS: Non-significant, S: Significant.

4. Discussion

Obesity is a common kind of metabolic disease. It is characterized by redundant accumulation and abnormal distribution of fat, with transformation of modern lifestyle and diet structure, such as more intakes of refined food and less physical activity. The prevalence of obesity is increasing amazingly in developed countries. Particularly in the last decade, the growth rate of obesity has ascended exponentially.[26] Therefore, The use multicomponent programs that incorporate dietary advice and physical activity, along with behavioral change skills that support an individual to successfully implement and maintain lifestyle changes, are recommended as the most appropriate option for treatment of all categories of obesity in children and young people aged under 18 years old.[27]

There is an increase of the incidence of obesity in children and adolescents, according to Marginean et al.,[28] who stated that the prevalence of this nutritional disorder has reached alarming levels around the world. Byrne et al.,[29] added that obese adolescents remain obese in adulthood and have risk of developing complications such as metabolic syndrome, type 2 diabetes, cardiovascular diseases, fatty liver diseases, psychological disturbances, and premature death. Obese adolescents exhibited poorer performance in their static and dynamic posture tasks.

Acupuncture is a method of treatment mostly used in traditional East Asian medicine (TEAM),[30] but it is gaining worldwide popularity. According to a national survey conducted in 2002, acupuncture rated the third most frequently used complementary and alternative medicine (CAM) therapy in the USA, along with yoga and meditation, with the highest use among women, Asians, persons of higher educational attainment and income, and those living in the western or northeastern USA.[31,32]

The use of acupuncture in the field of obesity is gaining more and more popularity as emerging evidences support its efficacy not only in reducing weight but also in treating medical conditions such as musculoskeletal pain, osteoarthritis, hypertension, diabetes, depression, and even anxiety. All of which are well known complications of unhealthy weight gain.[33]

The age range of the current study was from 15 to 18 years that was selected to exclude the effect of hormones during the puberty period as Sutton et al., (2014)[34] reported that the average age of puberty to be 13.2±2.2 years in men and 11.2±2.0 years of age in women.

Numerous techniques were used to assess obesity, some of which were simple and others were sophisticated.[20] Investigators have emphasized the

accuracy of newer techniques, such as dual-energy x-ray absorptiometry, magnetic resonance imaging, and computed tomography, for measuring body composition; nevertheless, anthropometry is the most widely used method, and it has recently been used to estimate fat distribution. The distinct advantages of anthropometric methods are that they are portable, non-invasive, in-expensive, and useful in field studies, and there is a substantial literature available on the subject. Although precise and sophisticated techniques for measuring body fat distribution are available, they are generally not appropriate except for specific research settings.[35] Simple anthropometric measurements have been used as surrogate measurements of obesity and have more practical value in both clinical practice and for large-scale epidemiological studies.[36]

Body mass index, which relates weight to height, is the most widely used and simple measure of body size and is frequently used to estimate the prevalence of obesity within a population.[37] The use of BMI as a measure for obesity come is in agreement with Spathopoulos et al.,[38] who suggested that BMI is an easily calculated marker and a simple, inexpensive, and noninvasive measurement that is recorded routinely in clinical practice and research settings. While Uzogara[39] reported that the BMI method for assessing obesity had some general weaknesses because total body weight includes both lean and non-lean tissues. In the BMI calculation, non-lean tissue is body fat, while lean tissue is bone, muscle, skin, and organs. Therefore, the pinch test was used in this study to determine body fat percentage. That method was a more accurate way for assessing body fat compared to other anthropometric methods such as BMI.[40] WHR was also measured in the current study as it is the most useful measure of obesity and the best simple anthropometric index in predicting a wide range of risk factors and related health conditions.[36]

The pretreatment results of this study revealed that there were non-significant differences between the two study groups regarding age, gender, and BMI indicating that both groups were homogenous.

The results of this study revealed that within each group comparison, there were significant decrease in both BMI and body fat percentage. These findings revealed that both manual and electrical acupuncture significantly improved obesity control in adolescents. In an agreement with Dung[41] who reported that using acupuncture in obesity may increase the arrival of synapses and improve mindset, which prompts guidelines for food intake. They added that the needle therapy may decrease hunger by endorphin hormone. Ercan et al.,[42] also stated that both manual and electrical acupuncture had beneficial effects on lipid metabolism, weight loss, and significant decreases in total cholesterol. Shiraishi et al.,[43] suggested that both manual and electrical acupuncture are improving the subject's mood by altering serotonin levels that have been observed in treating clinical depression, improving temperament, and obesity. However, the findings of this study disagree with those of Park[44] who stated that acupuncture treatment did not affect anthropometric parameters in obese individuals.

The possible mechanism for the actions of acupuncture in obesity control is based on both animal and clinical studies. The mechanisms of action for acupuncture in obesity are mainly focused on the central nervous system (CNS) and peripheral adipose tissue. The CNS plays an important role in receiving different signals and maintaining energy homeostasis. The integration of these signals by peripheral nerves modulates the central neuropeptides through regulation of food intake and energy homeostasis.[45]

The expression of appetite is chemically encoded in the hypothalamus. The hypothalamus is not only a brain area that modulates food intake and energy homeostasis through hormonal and neural signals but also has a significant role in the efficacy of acupuncture on obesity. The hypothalamus transfers neuronal signals via hypothalamic nuclei and related neuropeptides, integrating them with the brain stem and peripheral signals. This process regulates food intake and energy balance to achieve the goal of weight control.[15,46]

The significant reduction of BMI and fat percentages in MAG may be due to the combined effects of the intervention program, which included manual acupuncture, diet, and exercises. This comes in agreement with Kim et al.,[47] who demonstrated that manual acupuncture combined with lifestyle modification was more effective than lifestyle modification alone in reducing BMI of obese women.

The significant reduction of BMI and fat percentages in EAG may be also due to the combined effects of the intervention program, which included electrical acupuncture, diet, and exercises. Lima et al.,[48] investigated the effect of electrical acupuncture in obese adolescents. They found that the electrical acupuncture significantly reduced waist and hip circumference as well as body fat percentage compared to the placebo. Li and Fang[49] also evaluated the efficacy of the electrical acupuncture on abdominal fat deposition and revealed significant changes in weight, waist circumference, WHR, BMI and body fat percent. Lima et al.,[48] reported that electrical acupuncture reduced abdominal waist circumference, supra-iliac and body fat percentage in adolescents. They concluded that electrical acupuncture was effective in reducing subcutaneous abdominal fat and improving body composition. It is considered a

treatment option for abdominal fat accumulation in obesity.

Luo and Liu[50] stated that electrical acupuncture promotes fat metabolism via sympathetic nervous system activation, thus decreasing appetite. The current study findings were convenient to an animal study for Wang et al.,[51] who evaluated the effect of electrical acupuncture on obese rats. They found that electrical acupuncture produced significant reductions in both food intake and body weight when compared to a control group that received a diet alone.

In post-treatment comparison between the two study groups, the results revealed better improvement in EAG compared to MAG. These results are in agreement with Kaniusas et al.,[52] who stated that electrical acupuncture stimulates the vagal nerve, whose effect on increasing tone of the smooth muscle of the stomach leads to suppressing appetite. Electrical acupuncture controls stress and depression via endorphin and dopamine production. In addition to these effects, it is thought that the increases in plasma levels of beta endorphin naturally occurring after acupuncture application can decrease body weight. Gao et al.,[9] also stated that electrical acupuncture was more effective than another type of acupuncture in reducing body weight.

Concerning the results of the current study regarding WHR in both MAG and EAG, there were non-significant improvements after treatment programs. These findings disagree with the results of Liu et al.,[53] who reported that acupuncture reduced WHR.

The result of this study cannot confirm the long-term effects of acupuncture on obesity control in adolescents. Therefore, further studies should consider the follow-up effect of 6–12 months after the end of the treatment program. Children and adolescents should understand the importance of prevention and early treatment of obesity to prevent its complications. Further studies should be conducted on a large sample size and different age groups as well as sex groups to determine sexual differences.

5. Conclusion

This prospective study demonstrated significant beneficial influences of three months of acupuncture in conjunction with diet and exercises to reduce body weight and fat percentage in obese adolescents. In otherwise electrical acupuncture is more effective than manual acupuncture on obesity control in adolescents.

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Authors' contributions

Eman Ibrahim Elhadidy, Sahar Abd Al-Aziz Khairy and Samia A. Abdel Rahman: Supervision.

Conflict of Interest

There are no conflicts of interest

6. References

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