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Compare the effects of electromagnetic therapy and exercises on estrogen hormone

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ABSTRACT

Menopause is the passing phase from fertility to infertility for women. 40 Sprague dawley female rats in different phases of menstruation were randomly selected from Shiraz University of Medical Sciences Laboratory, they were anesthetized and their ovaries were removed. After 12 weeks of rest to reach menopause they were divided to 4 equal groups: control group (C), electromagnetic pulse therapy group (M), exercise group (E), and electromagnetic therapy – exercise group (ME), and continued their exercise program for 10 weeks. Exercise program which was executed for 3 times a week, on flatted treadmill. And subjects from group M were put inside the English made BTL magnet device model 5000, with 51 MT/10 intensity and 30 Hz frequency, 3 days in a week for 30 minutes. Also the subjects in group ME performed the programs from exercise and electromagnetic pulse group simultaneously. After 10 weeks of experimenting, all rats bleeding. The results showed that the average number of electromagnetic – exercise, electromagnetic, and exercise groups are significantly better that control group and this difference is meaningfully considered 95% approved ($p<0.05$). Moreover, the results show that there is a meaningful difference between electromagnetic – exercise group and exercise group ($P= 0.042$, $SD= 0.756$, $M= 2.27$) and these differences are 95% approved in a meaningful level ($p<0.05$). But other differences have no meaning. we can use electromagnetic therapy – exercise method, electromagnetic therapy method, and exercise method to increase estrogen and heal osteoporosis.

Keywords: electromagnet therapy, exercise, estrogen and ovariectomy.

INTRODUCTION

Half the earth's population is consisted of women, and based on the published statistics, almost 90 percent of them reach the age of 65, which means they spend an average of one third of their life in menopause(1).Menopause is the passing phase from fertility to infertility for women (2)which is caused by the permanent halt in ovary performance, a gradual process that happens to a lot of women between the ages of 47 to 55 and based on the studies performed in Iran, between 46 to 51, and it means a stop being put to menstruation cycles for a consecutive period of 12 months, without considering physiological and pathological factors (3, 4).

Menopause is the stage of time in which the ovulation process ends and menstruation doesn't happen anymore. Based on the studies done in Iran, the average age of menopause is around 50. But, some women might enter menopause sooner or later than that time.

In this process women will mostly face multiple physical changes including dry skin, wrinkles on the skin, thinning and falling of hair, loosening and sagging of breasts, vaginal dryness and flushing, and because of the osseous density reduction, danger of osteoporosis is increased. Although, signs and symptoms of menopause depend on physical conditions, and physical activities can have a tremendous effect on reduction of symptoms and complications of menopause. One of the most important features of menopause is the decline in estrogen production. After the slump in ovaries and the estrogen reduction in menopause, multiple symptoms threaten postmenopausal women's health including menstruation pattern disorder, vasomotor instability, genital atrophy, and in the long run, major symptoms caused by estrogen deprivation (heart diseases and osteoporosis)(5). Also, the lack of estrogen has a vital role in the development of osteoporosis after hitting menopause. Estrogen in women is produced by the adrenal glands and ovaries and helps with the growth and development of feminine sexual organs and aspects, increases total fat reserve and helps regulate menstruation.

Estrogen also increases osseous growth and makes so that bones reach their maximum length 2 to 4 years after puberty(6). Estrogen can sedate menopausal vaginal symptoms such as dryness, itchiness, and irritation, and also help the density of bone marrow.

The exact performance mechanism of estrogen on body skeleton is still not fully comprehended, from what can be seen we know that the changes induced into the bones by estrogen is the exact opposite of what happens after menopause. Of course there are estrogen receivers on osteoblasts and osteoclasts, and other osteoclast vives and it is often reported that estrogen is a cause for cell proliferation and the synthesis of cytokines and eventually that estrogen revisits the effects of homeostasis that affect calcium after menopause.

However, to give definite comments, further research is required (7). Various studies have shown that low levels of estrogen observed in postmenopausal women, is accompanied by low levels of osseous density (8). Also, the results obtained by Swaim *et al*. shows that estrogen is beneficial to prevention of osteoporosis and the fractions related to it (9). Overall, the reduction of the hormone that produces Corpus luteum leads to estrogen reduction and estrogen reduction leads to amenorrhea, which is accompanied by reduced density of osseous minerals and in turn, leads to osteoporosis(10).

In other words, with getting older, comes the increased erosion of bone tissue. One of the reasons of this erosion is the reduction in estrogen production, especially in women reaching the age of menopause. Therefore, regarding the importance of what has been said about the role estrogen plays in menopause period and postmenopausal women's health, it is expected that the two methods of electrotherapy and exercising will have significant effects on estrogen changes of postmenopausal women.

The result of the study done by Mc. Tirnan*et al*. shows that the estrogen level in blood serum changes after 12 months of aerobic exercise (11). But regarding the way estrogen affects bone tissue, it is possible that exercising would decrease significant estrogen reduction according to lack of movements in menopause period and therefore prevent bone mass loss. Performing an appropriate exercise program can decrease many of the problems caused by estrogen deficiency. Considering the fact that the aging process is accompanied by changes in different arts of the body including the bone structure, cardiovascular, and endocrines, therefore studying the role exercising and estrogen play especially on the Skeletal system can be presented to society as a strategy(6).

Zerath*et al*. showed that six weeks of endurance training would lead to an increase in parathyroid, calcium, phosphate, alkaline phosphatase, albumin levels, and a decrease in osteocalcin in older men(12). Research results show that it seems that regular and long-term physical activities especially those which work with body weight, can be effective in increasing estrogen levels as the most important factor in the prevention of osteoporosis, preserving bone minerals (calcium and blood phosphorus), and changes in hormones that affect these minerals (calcitonin and PTH) (13).

Meanwhile, magnetic therapy is consisted of the use of magnetic fields. Doctors claim that it would be beneficial if certain parts of body are exposed to magneto static fields, and hemoglobin protein of blood while carrying oxygen

has weak magnetic effects and magnetic can be effective in increasing blood flow. Electromagnetic therapy pulses form osteoclast cells by gradually decreasing the production of local factor and can prevent ovariectomy based osteoporosis(14). Additionally, this field will help increase recovery rate of the connective tissue, and causes structure and discipline on extracellular matrix (15). Gupta *et al*. examined the effects of electromagnetic therapy pulses on not healed Tibia of 45 subjects. The results showed that electromagnetic pulses can be used as a non-aggressive method to mend not healed fractured long bones(16).

Also, Walking and electrical stimulation cause similarly weight loss, BMI, body fat percentage, and increase in body mass without lipid (LBM) (17). But, since despite all the researches done little has been about the influence of physical activities and especially electromagnetic pulses on estrogen level and different cellular signals effective in anabolism and catabolism processes, final conclusion would be possible with further research. And also, the majority of researchers especially those in medical community have only examined the effect of drugs and supplement on estrogen.

However, a research has not been done on the combined effect of exercises such as running and electromagnetic therapy in the long term where serum estrogen levels are controlled and castrated animal subjects have lost their ovaries and uteruses. So according to what was said till now and the importance of the research, this study aims to compare the effects of electromagnet therapy and exercises on estrogen in Sprague dawley ovariectomized female rats.

MATERIALS AND METHODS

The current study is of the clinical trial kind with double blind pattern accompanied by control group, which was done hoping to analyze and compare the effects of the two methods of electromagnet therapy and exercising on estrogen levels after the removal of ovaries from Sprague dawley female rats. The expected sample size is 40 rats with the weight range of 200 ± 20 (gm) that were procured randomly and from different phases of menstruation from Shiraz University of Medical Sciences Laboratory.

These samples were then examined upon and their ovaries were removed and after 12 weeks of rest to reach menopause, were sorted by random allotment to 4groups, control group (C), electromagnetic pulse therapy group (M), exercise group (E), and electromagnetic therapy – exercise group (ME), and continued their exercise program for 10 weeks. After 10 weeks of examinations, all the rats were first anesthetized and then after determining the location of the heart, 4 mg of blood was taken from their heart with syringes to determine the estrogen amount. The stages in which the study was conducted will be explained in the following section:

a) The program to learn operating the treadmill
All subjects were taught how to operate on treadmill for a period of one week. And then the exercise program was executed for 3 times a week, for 10 weeks on a 7 channel tilt free treadmill. The treadmill's speed was increased from 15 to 19 meters per minute and time was from 6 to 18 minutes, and each exercise session was conducted every morning at the same time. A mild electric shock was embedded at the back of the device to stimulate running, and to prevent possible effects of electrical shocks, by using conditioning method animals were taught to avoid nearing and resting in the rear part of the device. Table1 shows the exercise protocol.

Table1: exercise program protocol (Ivamoto 2005)

Week	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Speed (m/min)	15	15	15	15	15	19	19	19	19	19
Time (min)	6	6	9	9	12	12	15	15	18	18

b) Electromagnetic pulse performance protocol
Subjects in electromagnetic pulse group and electromagnetic pulse – exercise group were put inside the English made BTL magnet device model 5000, with 51 MT/10 intensity and 30 Hz frequency, for 10 weeks and 3 day in a week for 30 minutes.

c) Animal surgery
After preparing the operation spot, rats were first anesthetized with a mixture of 10 to 80 mg of ketamine to zyloxitine for every kg body weight and then the operation spot was shaved with razor and soap and water solution then it was sterilized with betadine and a wound was made on the stomach parallel to the spine and for the size of 3

cm linea alba, the white line in the middle of stomach was lowered and ovary and uterus were extracted and the uterus cut spot was first tied and then cut with scissors. And then the wound was sewed with single sutures pattern. To prevent the cut from infecting, penicillin and Streptomycin were used. And also an OTC spray was used to sterilize and drive away insects from the wound.

D) Bloodletting
First the rats were weighed with a digital balance and then were anesthetized with a mixture of 10 to 80 mg of ketamine to zyloxitine for every kg body weight and then after determining the location of the heart, 5 mg of blood was taken from their heart with syringes.

E) Measuring the estrogen in blood serum
First the collected blood samples were centrifuged in the centrifuge device (model Behdad Iran) for 10 minutes at the rate of 3000 rounds per minute, and then the serums were segregated and kept in minus 20 degrees centigrade until all the blood samples were collected. When the experiment was finished serums were put in room temperature to reach the room temperature.

And then using the American made Monobind kit and Elisa method, the amount of estrogen in blood serum was calculated by pictogram unit of measurement. In the end all the collected data were analyzed by SPSS software 20th edition which provides the possibility of performing different descriptive and inferential statistics. However, to analyze the assumptions of descriptive average index and to check the meaning of the difference between the groups, One-Way ANOVA and Scheffe test were used.

RESULTS

The analyses of the data were adjusted in two parts of descriptive and inferential statistics. First descriptive indexes like average, standard deviation, minimum and maximum were used. And then to answer the main question of the study, One-Way ANOVA was used to compare the variances between study groups. Table 2 shows the descriptive information related to estrogen variant in the groups.

Table2: Distribution of estrogen statistical indicators (pg./ml) in the groups after the removal of ovaries.

Groups	Number	Average	Standard deviation	Minimum	Maximum
Control group	10	3.41	1.29	1.69	5.67
Exercise group	10	6.78	1.39	4.38	9.22
Electromagnetic group	10	8.52	1.01	6.35	9.76
Electromagnetic – exercise group	10	9.06	2.60	5.10	12.55

As the results of table 2 show, the average and standard deviation of the variant in electromagnetic – exercise group (SD= 2.60, X= 9.06) is in the lead and after that in electromagnetic group (SD= 1.01, X= 8.52), exercise group (SD= 1.39, X= 6.78) and control group (SD= 1.29, X= 3.41) were obtained.

Therefore, it can expected to see a meaningful difference between the groups' variances. So further experiments were conducted. Table 3 shows the primary results of the variance comparison between the estrogen variant in subjective groups.

Table 3: primary results of the variance comparison between the estrogen variant in subjective groups

Estrogen	ANOVA experiment for variance comparison			
	Standard deviation	DF	F	Sig
Intergroup – outer group variance	64.91	3	22.68	0.000
	2.86	36		

As the results of table 3 show, and with assumption that the variances are equal, the f ratio for intergroup effect (the treatment effect) is 22.68 and has meaning in 0.000 level. In other words, between the different groups there is a meaningful difference in estrogen variant. Therefore, to clear the orientation of these differences, the model was fitted with scheffe experiment. Table 4below shows the results of this experiment.

Table4: fitting Scheffe experiment model for estrogen variant in groups

Groups	Number	Subset for alpha = 0.05		
		(a)[3]	(b)[2]	(c)[1]
Control group	10			3.41 c
Exercise group	10		6.78 b	
Electromagnetic group	10	8.52 a		
Electromagnetic – exercise group	10	9.06 a		
Meaning level		0.482	1.000	1.000

As the results of table 4 show, model fitting has meaningful differences, so that the Scheffe results show that the data in column 3 is better that column 2 and the data in column 2 is better that column 1. Thus, there is a possibility to say that the average number of electromagnetic – exercise, electromagnetic, and exercise groups are significantly better that control group and this difference is meaningfully considered 95% approved ($p<0.05$).

So, the research hypothesis is approved and the statistic hypothesis is disapproved. Therefore we could say that estrogen is significantly increased in the subjective groups under therapeutic teachings of electrotherapy – exercise, electrotherapy, and exercise. Also, the results show that there is a significant difference between electromagnetic – exercise group and exercise group ($P= 0.042$, $SD= 0.756$, $M= 2.27$). Therefore, the average number of electro-exercise in significantly higher than the average of exercise group and this difference is 95% approved in a meaningful level ($p<0.05$). But, other differences have no significant meaning.

CONCLUSION

The results and finding of this research gives an insight that, after the menopause, the therapeutic method of simultaneous electromagnetic pulse – exercise, and electromagnetic pulse and exercise individually, will meaningfully increase the estrogen level compared to control group. In other words, we could say that under the influence of therapeutic trainings of electrotherapy – exercise, electrotherapy, and exercises, estrogen increased in the studied rats.

This finding is in line with the results of researches of Compston(18), Vainionpaa*et al*. (19), and Habibzadeh*et al*(20). The results of these studies significantly show that the secretion of bone-building hormones like estrogen, amplify with exercising. This hormone causes Collagen to be made and therefore bone strength increases.

In fact, estrogen actually activates Vitamin D and causes the calcium to be reabsorbed, so calcium is absorbed in bones and therefore the bones become stronger (18). Many researches have shown that bone density depends on body composition and the amount of daily activity, and Scientific and experimental evidences have always shown that those who have a reasonable physical activity program, also have a higher bone density than those with less physical activity. Scientists believe that changing living habits like performing aerobic activities such as 30 minutes of walking and behavior therapy for half an hour or an hour a day and 3 to 4 sessions, decreases the dangers of osteoporosis in postmenopausal women by increasing bone-building hormones' density (21).

Walking, as many sports scientists believe, is a suitable physical activity and effective in maintaining and recovering the Physical and mental health (17, 22, 23)of all the sections of society and this claim has been mentioned in distinguished articles and sources of this filed. Based on this, researchers like Puntila in 2001 indicated that young and active postmenopausal women are less prone to reduced bone density. He mentioned walking as the most common exercise pattern (24). Also, the findings of Korpelaninen *et al*. in 2006 are in line with the findings of this study.

They showed that 35 minutes of walking for 3 sessions a week and for 3 months in middle-aged women, will cause a meaningful change in estrogen level in the serum of these people compared to base and group amount, and muscle mass increased in subjects too. Also Korpelaninen*et al*. think muscle mass and serum estrogen gain are the reason bone density maintains in these people (25). Ebrahimian and Kazemi showed in their own studies that physical activities and exercises will cause blood flow and body's other physiological activities like estrogen production to stabilize in menopause, and proposed that exercise plays a major role in decreasing menopause symptoms(26). Also Minor *et al*. showed in their studies in 2006 that femur and tibia strength was higher in the group that had confronted exercises and estrogen. And biomechanical properties in group and estrogen intake increased meaningfully (27).

However, the findings of this study are not in line with the studies of Shim(28), Evelyn *et al*. (29), and Kristin *et al*.(30). The results of these studies show that aerobic and endurance exercises have no significant impact on estrogen level. To explain this disruption we could say that from the results of different studies we can deduct that for the effectiveness of exercises on the density of bone-building hormones like estrogen, we should pay attention to many different factors like intensity, durance, speed, distance, age, time, nutrition and etc.

Furthermore, another reason to this disruption could be the parameters we assess in this study and other studies, which require more attention in further studies. Also, Rashley states that the impact of the type of training on the density of bone elements is a category that can affect the results of different studies(31).

About the effect of electromagnetic pulse on estrogen changes in postmenopausal rats, as the findings showed, massive and meaningful differences have been sighted between the group under electromagnetic pulse therapy and control therapy. Consequently, instead of exercises in people incapable or in danger from doing these exercises, using electromagnetic field pulses can be a suitable substitute for endurance training; because effectiveness of this therapeutic method is rather more than exercises and this statement was proved in this study.

Although, both electromagnetic therapy and exercise therapy were accompanied by a meaningful increase in estrogen compared to control group, it seems that using electromagnetic field pulses is effective in increasing the density of bone tissue and from this point of view, is coordinated with exercises and would be helpful in people who might get injured because of exercises. To explain this finding we could say the exposure of some parts of body to magneto statics field has some helpful impacts on health and magnetics can aide in increasing blood flow and the density of bone-building elements such as estrogen.

Electromagnet pulse therapy produces osteoclast cells by gradual decrease of localized factor and can be effective in preventing ovariectomy based osteoporosis (14). Also this field causes an increase in the recovery speed of connective tissue, and also causes production and regulation of outer cell matrix (15). Parhampour realized in an article named “The effects of endurance training and electromagnet therapy on osseous metabolism and knee, ankle, and elbow function improvement” that in endurance training group and endurance training – electromagnet therapy group, phosphate alkaline metabolism had a meaningful increase.

And knee, ankle, and elbow functions improved meaningfully in training – electromagnet therapy group and in endurance training group, and also knee function improved in electromagnet therapy group (31) which represents the similar effects of electromagnet therapy method and exercises on performance and bone element density. Therefore, it is expected that electromagnetic pulses have a similar effect on estrogen changes.

Besides, Parhampur showed in his research that electromagnetic pulse had an effect on the femurs of rats too and maybe this method can be used to increase bone strength (by improving the density of bone-building hormones like estrogen etc. Then he proposed it to those who can’t perform exercises, like the elders. And he benefited from the positive effects of bone strength increase that were based on using the magnetic field in all ages. This field can especially be used in the youth to prevent osteoporosis and hence prevent all the fractures in later years that are due to reduction of bone density and bone-building hormones. Of course it should be used with suitable durance and intensity to prevent negative effects like cancer, or disruption of body hemostat and electrolyte performance (31).

However, Akpolat *et al.* studied the impacts of electromagnet therapy on osteoporosis in animal subjects of postmenopausal rats, the results showed that 6 months of electromagnet therapy for 1 hour a day and in low intensities can have a therapeutic effect on osteoporosis and also increase the density and mass of minerals and bone-building elements significantly(32).

Rubin *et al*. also realized by analyzing the electromagnet therapy impact on osteoporosis in animal subjects of postmenopausal rats that electromagnetic pulses could cause an increase in bone-building cells and elements in spine without putting a mechanical energy on bones(33, 34).

So, considering the findings of this study it can be said that electromagnetic pulse method is effective on estrogen level which is one of the most important bone-building and strengthening elements. Therefore, we can deduct that the therapeutic method of electromagnetic pulses can be used as a suitable substitute therapeutic method for exercise method, especially for people who are incapable or might get hurt.

As the findings about the impact of the combined method of electromagnetic pulse – exercise on estrogen changes demonstrate, there is a significant difference between the rats that are under electromagnetic pulse – exercise therapy and control group rats. These findings are in line with the results of Parhampour's study(31) that checks the effects of the combined therapeutic method of endurance training and electromagnetic therapy on the metabolism of bone-building elements like phosphate alkaline.

To explain this finding, it could be argued considering the effects of electromagnetic pulse method and exercise method on estrogen increase, it's not impossible that a combined method of these two can have significant impacts on estrogen increase. Also, it should be said that there is a significant difference in the estrogen variant of the rat group that was treated with electromagnetic pulse and the group that was treated with exercises, and such difference was not seen in other groups.

According to the findings of these three postmenopausal rat groups we can say that there is a significant difference in estrogen variant between electromagnetic pulse – exercise group, exercise group, and control group. In other words, all three groups (electromagnetic pulse – exercise, electromagnetic pulse, exercise) cause a significant increase in estrogen compared to control group.

However, it should be said that the highest difference rate between the averages was between the electromagnetic pulse – exercise group and control group. After those electromagnetic group and exercise groups come in the mentioned order the results showed that there are a significant differences between electromagnetic pulse – exercise group and exercise group. So that the average point of estrogen variant in electromagnetic – exercise group was significantly higher than exercise group.

Ethical considerations

According to ethical fundamentals of working with animals, the picking of the animals, blood tests, the surgery to extract ovary and killing method were all conforming to the charter of Iran's Animal Care Committee and were performed according to the ethical rules of Shiraz University's Faculty of Veterinary Medicine.

Also, the animals used in this study were kept in groups of 4 and in transparent polycarbonate cages in room temperature of 21 ± 2 centigrade degrees and the lighting to darkness loop was 12:12 hours and the humidity was kept on 60 ± 5 percent. They were fed with pellet and able to move freely inside their laboratory cages. Water was given to them in standard 300 cc bottles specially designed for lab animals.

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REFERENCES

[1] Enjezab B, Mozafary B, Khosravi H, Khoshbin A, Farajkhodam T, Bokai M. Consumption of soy nuts on hot flashes in postmenopausal women. Yazd University of Medical Science Journal. 2009;17(4):242-8.
[2] Aidelsburger P, Schauer S, Grabein K, Wasem J. Alternative methods for the treatment of post-menopausal troubles. GMS health technology assessment. 2012;8.
[3] Askari F, Basiri Mk, Basiri Mm, Torabi S, Gholamfarkhani S, Mohareri M, et al. Age of natural menopause and the comparison of incidence of its early complications in menopause transition stages in women from Gonabad city. 2012.
[4] Sadat HM KA, Kavei B, Ghorbani R, Askari Majdabadi H. Kalaliyan H. . Pattern of natural menopause women Semnan. Payesh Health Monit. 2009;8(2):155-62.
[5] Ebrahimi M, Taghizadeh M. The effect of soy protein on menopausal symptoms in postmenopausal women Urmia. Hakim Research Journal. 2009;11(4):16-20.
[6] Atari AaMA. Preventation and treatment of osteoporosis. mashhad: Mashhad Ketab Darmani Publication; 2004.
[7] Lindsay R. The menopause and osteoporosis. Obstetrics & Gynecology. 1996;87(2):16S-9S.
[8] Drinkwater BL, Nilson K, Chesnut III CH, Bremner WJ, Shainholtz S, Southworth MB. Bone mineral content of amenorrheic and eumenorrheic athletes. New England Journal of Medicine. 1984;311(5):277-81.
[9] Swaim RA, Barner JC, Brown CM. The relationship of calcium intake and exercise to osteoporosis health beliefs in postmenopausal women. Research in Social and Administrative Pharmacy. 2008;4(2):153-63.

[10] Kasharafifard S, Hojjati S, Daryanoosh F, Mehrabani D, Almasi-Hashiani A, Vojdani S, et al. Reproductive Hormonal Changes after Incremental Exercise in Female Rats. Pakistan Journal of Biological Sciences. 2012;15(8):403-7.
[11] McTiernan A, Tworoger SS, Ulrich CM, Yasui Y, Irwin ML, Rajan KB, et al. Effect of exercise on serum estrogens in postmenopausal women a 12-month randomized clinical trial. Cancer research. 2004;64(8):2923-8.
[12] Zerath E, Holy X, Douce P, Guezennec C, Chatard J. Effect of endurance training on postexercise parathyroid hormone levels in elderly men. Medicine and science in sports and exercise. 1997;29(9):1139-45.
[13] Ebrahim KR, Mohamad Reza ; Ramezani Sahraei, Azadeh. . The impacts of eight weeks of aerobic activities on estrogen changes and some of the effective factors of inactive postmenopausal women's bone density. Iran's endocrine and metabolism journal. 2010;12(4):401-8.
[14] Chang K, Chang WHS. Pulsed electromagnetic fields prevent osteoporosis in an ovariectomized female rat model: A prostaglandin E2-associated process. Bioelectromagnetics. 2003;24(3):189-98.
[15] Aaron RK, Ciombor DM. Therapeutic effects of electromagnetic fields in the stimulation of connective tissue repair. Journal of cellular biochemistry. 1993;52(1):42-6.
[16] Gupta AK, Srivastava KP, Avasthi S. Pulsed electromagnetic stimulation in nonunion of tibial diaphyseal fractures. Indian journal of orthopaedics. 2009;43(2):156-60.
[17] Sekhavati E, Nikseresht A, Najafian M, Taheri S. The effect of aerobic exercise and electrical stimulation on weight loss and reduction of body fat. Journal of Medicine and Life Vol. 8, Special Issue 3, 2015, pp.101-106.
[18] Compston JE. Sex steroids and bone. Physiological reviews. 2001;81(1):419-47.
[19] Vainionpää A, Korpelainen R, Leppäluoto J, Jämsä T. Effects of high-impact exercise on bone mineral density: a randomized controlled trial in premenopausal women. Osteoporosis International. 2005;16(2):191-7.
[20] Habibzadeh S, Rahmaninia F, Daneshmandi H. The Effect of Selected Walking Program on Bone Mass Density, Body Composition and Serum Estrogen in OBESE Girls. 2009.
[21] Turnerc H. Exercise as a therapy for osteoporosis. Bone. 1998;23:83-5.
[22] Sekhavati E., Rahimian Boogar M, Khodadoost M, Afkari R. Explaining Relation between Self-controlling and Child Parenting Styles and Psychological welfare of High School Students. Journal of Medicine and Life Vol. 8, Special Issue 3, 2015, pp.156-168.
[23] Sekhavati E., Rahimian-Boogar M, Khodadoost M, Afkari R. The study on relationship among self- control and performance of family with social adaptation in high school students at Abadeh City. Cumhuriyet University Faculty of Science: Cumhuriyet Science Journal (CSJ). 2015;36(4):21-36.
[24] Puntila E, Kröger H, Lakka T, Tuppurainen M, Jurvelin J, Honkanen R. Leisure-time physical activity and rate of bone loss among peri-and postmenopausal women: a longitudinal study. Bone. 2001;29(5):442-6.
[25] Korpelainen R, Keinänen-Kiukaanniemi S, Heikkinen J, Väänänen K, Korpelainen J. Effect of impact exercise on bone mineral density in elderly women with low BMD: a population-based randomized controlled 30-month intervention. Osteoporosis International. 2006;17(1):109-18.
[26] Ebrahimian M, Kazemi B. Exercise and the occurrence of menopause. 2003.
[27] Narihiko HN, Yoshinobu YK, Minor T, Lue T. UP-01.91: Effects of estrogen on postmenopausal urinary incontinence rat model. Urology. 2006;68:251.
[28] Shim E-J, Mehnert A, Koyama A, Cho S-J, Inui H, Paik N-S, et al. Health-related quality of life in breast cancer: A cross-cultural survey of German, Japanese, and South Korean patients. Breast cancer research and treatment. 2006;99(3):341-50.
[29] Monninkhof EM, Velthuis MJ, Peeters PH, Twisk JW, Schuit AJ. Effect of exercise on postmenopausal sex hormone levels and role of body fat: a randomized controlled trial. Journal of clinical oncology. 2009;27(27):4492-9.
[30] Campbell KL, Westerlind KC, Harber VJ, Bell GJ, Mackey JR, Courneya KS. Effects of aerobic exercise training on estrogen metabolism in premenopausal women: a randomized controlled trial. Cancer Epidemiology Biomarkers & Prevention. 2007;16(4):731-9.
[31] Parhampour B, Torkaman G, Hoorfar H, Hedayati M, Ravanbod R. Effects of short-term resistance training and pulsed electromagnetic fields on bone metabolism and joint function in severe haemophilia A patients with osteoporosis: a randomized controlled trial. Clinical rehabilitation. 2014;28(5):440-50.
[32] Akpolat V, Celik MS, Celik Y, Akdeniz N, Ozerdem MS. Treatment of osteoporosis by long-term magnetic field with extremely low frequency in rats. Gynecological endocrinology : the official journal of the International Society of Gynecological Endocrinology. 2009;25(8):524-9.
[33] C. R. Prevention of osteoporosis by pulsed electromagnetic field. J Bone Joint Surgery AM. 2003;24:189-98.
[34] Rubin C, Recker R, Cullen D, Ryaby J, McCabe J, McLeod K. Prevention of postmenopausal bone loss by a low-magnitude, high-frequency mechanical stimuli: a clinical trial assessing compliance, efficacy, and safety.

Journal of bone and mineral research: the official journal of the American Society for Bone and Mineral Research. 2004;19(3):343-51