

The effect of moderate-intensity physical load and concentration of PTH hormone on raising bone density in women

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Research introduction:

The risk of physical injury has increased significantly, not only among athletes, but also among ordinary individuals. That risk has become common among women especially in advanced age. Technological development has led to a lack of movement and consequent health problems. This prompted people to practice sports in order to maintain health and prevent injuries. (9: 47)

Many countries are interested in conducting research and studies in analyzing the relationship between sport activity and human health. Abu Al-Ela (2003) emphasized that regular physical activity reduces health risks, increases the individual's ability to face challenges of life, and reduces mobility diseases such as neck pain, low back pain, arthritis, osteoporosis, and feeling tired quickly. Pain makes individual loses the ability to exert effort and continue life. (9: 629)

Samira Orabi and Manar Salama (2010) also emphasize that practice of sport has a great effect on maintaining woman fitness and physical health, especially with the technological progress and modern life that led to lack of movement. The best way to prevent injury is through full awareness of the importance of physical activity. (20) Physical activity raises physical and physiological fitness of the

individual so that his vital organs are capable of performing their required functions well. (30: 331) Physical activity is also considered the main tool of making positive physiological effects to the body, taking into account the gradient increasing of the load because the efficiency of the body systems works at its maximum for a certain period of time until the desired effect occurs. (19: 28-29)

Many specialists believe that directed and regulated physical effort by controlling size, intensity and load prevents women injuries and that there are levels of physical loads. (30: 237)

The appropriate load must be taken into account for each individual, as indicated by Abu Al-Ela Abdel-Fattah and Mohamad Sobhi (2003) that increasing the training load more than the individual's ability leads to a weakening of the immune system that leads to individual injuries. (12: 4)

Bones are the main reservoir for calcium salts. Bones are living tissue that has a collagen protein origin impregnated with calcium and phosphates, and these two elements are always changing, meaning that the bone is in a state of remodeling between resorption and deposition (26 : 238)

The lack of movement and lack of physical exercise are the main reasons for women that cause osteoporosis, the lack of mineral salts in the bones, which leads to the risk of fractures, especially in women after menopause. In osteoporosis, the bone is less strong than normal and there is a great decrease in bone mass and it is susceptible to fracture. Women after menopause lose bone at accelerated rates, therefore bone density must be measured continuously. Physical exercise is one of the means to help prevent and even treat osteoporosis. (2 : 110)

Physical activities and exercise have a noticeable effect on the skeleton, as continuous movement is necessary to get healthy and strong bones. Physical activities help in increasing the size of the bones due to the pressure exerted on the bone during the practice of sports activities. As for the lack of movement, it leads to a defect in the bones or a defect in its function. Among the benefits of sports activities for the bones is that they help to stimulate blood circulation in the bone tissue to supply this tissue with the vital elements that it needs in its construction, and they also help to activate the bone marrow that produces red blood cells. Therefore, physical activities enhance the bone marrow to produce more red blood cells. (24:24) (15:30)

Mohamed Ibrahim and Sabah Farooz (2010) add that during regular activity, the muscle tension exerted on the bones maintains the integrity and health of bone tissue. (28 :20)

The hormonal system, along with the nervous system, regulates the rates of chemical activity of the body's cells and bone tissue.

(29 : 968)

Khaled Nammoura (2017) states that the Parathyroid hormone is a regulator of calcium exchange and its function to maintain calcium concentration in the extracellular fluid. (17 :22)

Formica (2011) noted that this hormone maintains the level of calcium in the blood, as it works to replenish calcium from the bones in a feedback regulation process in which the calcium released from the bones controls the release of the hormone from these glands and decrease it (3)

Disorders of the secretion of Parathyroid hormone from the parathyroid glands (increase and decrease) lead to a decrease in the

amount of calcium and phosphorous in the body, and consequently the bones are affected and become more susceptible to fracture. The measurement of Parathyroidhormone concentrations in the blood is done by "radioimmunoassay method".

(29 : 976)

Through reviewing many researches and scientific studies, the two researchers noted that there are studies on the relationship between exercise and the concentration of the PTH hormone, such as the study of Hodsman RM (2016), Anissa bouassida (2014) aiming to identify the effect of sport on the secretion of the Parathyroid hormone. Some studies on the relationship of exercise on increased bone mineral density, such as the study of Nabil Jaafar, Al Ameer Mohamed (2009) which aimed to identify the effect of an exercise program with nutritional supplement to reduce osteoporosis in women aged (45-55) years, and the study of Amjad Mohamed Hussein Mohamed Lama (2007), which aimed to identify The effect of weight training on bone mineral density, muscle strength and the level of skill performance of football juniors, and the study of Walid Mostafa Darwish, Azza Ibrahim Khalil (2007) which aimed to identifying the effect of shock training exercises to develop muscle capacity on bone mineral density, speed, and accuracy of passing among basketball juniors. However, up to the knowledge of the two researchers, there is a shortage in research linking the relationship between exercise with the concentration of the PTH hormone and the increasing bone mineral density. Hence the idea of the current research, which is "the effect of moderate-intensity physical load and the concentration of the PTH hormone on raising bone density in women" (1) (5) (38) (15) (40)

Research Objectives:

- 1 .To identify the effect of moderate intensity physical load on the concentration of the PTH hormone in the research sample of women.
- 2 .To identify the effect of moderate intensity physical load on the bone mineral density in the research sample of women
- 3 .Identify the effect of a moderate-intensity physical program on the muscle strength and joint flexibility in the research sample of women.

Research hypotheses:

- 1 .There are statistically significant differences between the pre and post measurements in the PTH hormone concentration in the research sample of women.
- 2 .There are statistically significant differences between the pre and post measurements in the bone mineral density in the research sample of women.
- 3 .There are statistically significant differences between the pre and post measurements in the muscle strength and joint flexibility in the research sample of women.
- 4 .There is a significant positive effect of applying moderate intensity physical load on the concentration of the PTH hormone in the research sample of women.
- 5 .There is a significant positive effect of applying moderate intensity physical load on the bone mineral density in the research sample of women.
- 6 .There is a significant positive effect of applying the moderate intensity physical program on the muscular strength and joint flexibility in the research sample of women.

Research Vocabulary:

Parathyroid hormone (PTH):

It is the hormone produced by the parathyroid gland that controls the concentration of calcium ions in the extracellular fluid by controlling the absorption of calcium from the intestine, the excretion of calcium by the kidneys, and the release of calcium from the bones.

(31: 970)

Research procedures:**Research Methodology:**

The two researchers used the experimental method due to its suitability to the nature of the research, by using a single experimental group, and a pre and post measurement was performed for all the variables of the research.

Research Scope:**The human scope:**

Women from 40 to 55 years old.

Place scope:

The research was applied in the Physical Fitness Unit of the faculty of Physical Education for Girls.

Time scope:

Physical load (exercise program) was applied in a period of 3 months (3 units per week) from 15/9/2020 to 15/12/2020.

The research sample:

The research sample was deliberately selected and included women whose age range from 40 to 55 years. The total research sample was (20 women)

Sample inclusion conditions:

1- The research sample agree to participate in the research.

- 2- Age is not less than 40 years.
- 3- The research sample are not subjected to any other sports programs.
- 4- The research sample suffer from bone problems.
- 5- The research sample volunteer to conduct a research experiment.
- 6- The research sample are not practicing any sporting activity
- 7- The research sample are committed to the sports program during the research period

Sample homogeneity:

Table (1)
Statistical description of the research sample data in the primary variables before the experiment
(n = 20)

Statistical Parameters Primary variables	Arithmetic mean	standard deviation	Skewness coefficient
Age (years)	49.771	3.293	-0.396
Height (cm)	162.368	5.090	0.870
Weight (Kg)	81.00	6.455	0.496
concentration level of PTH hormone in the blood (Pg/ml)	26.494	3.631	0.403

Table (1) shows the statistical description of the research sample data in the primary variables before the experiment (age, height, weight, blood analysis before load). The Skewness coefficient ranged between (-0.396 to 0.870), and these values are close to zero, which confirms the homogeneity of the data and that it is not dispersed.

Tools and devices

- Restameter device to measure height to the nearest (cm), medical scale to measure weight to the nearest (kg).
- Plastic syringes for single use only, medical cotton and medical patches.

- Special tubes for collecting blood samples, sealed to reserve blood for analysis.
- A form for the approval of the research sample to draw blood samples
- Muscular strength and joint flexibility tests
- DEXA device to measure bone mineral density
- The goniometer device to measure joint flexibility.
- A centimeter tape, adhesive tape, Swedish seat.

Laboratory Measurements:

- PTH hormone analysis
- X-ray measurement of mineral bone density.

Anthropometric measurements:

- Measure of height.
- Measure of weight.

Physical measurements:

- Measurement of muscle strength: arms, abdomen, back, and legs.
- Flexibility measurement: shoulders, spine, thighs.

Research Executive Steps:

1- **Exploratory studies:** (8) women were identified, and tests (strength and flexibility) were applied on them as a first Exploratory study, and (4) women were chosen to apply the second exploratory study on them, where the sports program was tried on them.

2- **The sports program:** (20) women were chosen to represent the research sample, for whom moderate intensity physical load was applied, ranging between (50: 60% pulse/ minute) of maximum tolerance.

First: Warm-up: (5 minutes): It aims at:

- Preparing the body for the upcoming activity.

- The transition from a state of rest to a state of activity through the warm-up phase.
- Protect the individual from the occurrence of injuries.
- Preparing the respiratory system to work.
- Increase the heart rate for training.
- Activate muscles gradually.
- It increases the capacity of the circulatory system.

Second: Physical preparation: (30 minutes) (Muscular strength - joint flexibility): It aims at:

- Strengthening working muscles and ligaments in every exercise.
- Increase the range of working joints in each exercise.
- Increase muscle elasticity and working ligaments in every exercise.
- Activate the involuntary physiological functions necessary for the body activity.
- Place the central and peripheral nervous system in the best condition to perform effectively.

Third: Cool down (5 minutes): It aims at:

- Return of the body to its normal state before training.
- Elimination of metabolic waste products that resulted during exercise

3- Pre measurements:

The following measurements were taken:

- Measuring the bone mineral density of the research sample in the Department of Radiology and Medical Imaging at Mabaret Al-Asafra Hospital in Alexandria from (1/9/2020 to 4/9/2020)
- Measuring the concentration of the PTH hormone at Mabaret Al-Asafra laboratory from (6/9/2020: 7/9/2020)
- Taking anthropometric measurements (height and weight) and physical measurements (joint flexibility and muscle strength) in the

fitness hall of the Faculty of Physical Education for Girls, Alexandria University from (9/9/2020 to 11/9/2020)

4- Application of the sports program:

The sports program was implemented from (15/9/2020 to 15/12/2020).

5- Post measurements:

The following measurements were taken:

- Measuring the bone mineral density and analyzing the PTH hormone for the research sample in the Electromagnetic waves department at Mabaret Al-Asafra Hospital in Alexandria during the period (16/12/2020 to 17/12/2020)
- Taking anthropometric measurements (height and weight), physical measurements (joint flexibility and muscle strength) in the fitness hall of the Faculty of Physical Education for Girls, Alexandria University on (18/12/2020 to 20/12/2020).

Statistical Analysis:

- 1- Arithmetic Mean
- 2- Standard Deviation
- 3- T test
- 4- Improvement Percentage
- 5- Effect coefficient.

Results and discussion:

The first hypothesis: There are statistically significant differences between the pre and post measurements in the PTH hormone concentration in the research sample of women., and the fourth hypothesis: There is a significant positive effect of applying moderate intensity physical load on the concentration of the PTH

hormone in the research sample of women.

Table (2)
Differences between pre-load measurement and post-load measurement in the concentration level of PTH hormone in the blood sample under investigation (moderate load) (n = 20)

Statistical Parameter	Pre load		Post load		Difference between means		t value	Effect value	Effect size
	mean	± SD	mean	± SD	mean	± SD			
concentration level of PTH hormone in the blood (Pg/ml)	26.680	3.297	49.210	4.233	22.530	3.087	23.079*	7.298	high

* Significance at 0.05 level = 2.093

effect size value (weak 0.2, average 0.5, large / high 0.8 and more)

It is evident from Table (2) and Figure (1) the presence of significant differences in the concentration of the PTH hormone at the level of 0.005, as the value of t reached 23.079, and this value is greater than its tabular value. The effect value was (7.298), which are high effect size.

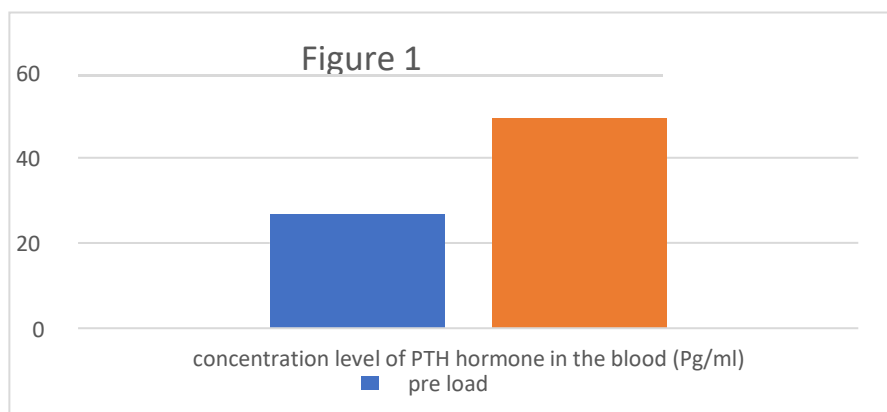


Figure (1)
Differences between pre and post-load measurement in the concentration of the PTH hormone in blood

The researchers attribute these results to that moderate physical load led to the secretion of the hormone at an optimal rate>

This result is confirmed by Ahmad Nasr Al-Din and Abu Al-Ela Abd El Fattah (2003) that moderate-intensity physical loads have a positive effect on the concentration of hormones and its secretion in the blood. (13: 148) (11: 163)

- Abu Al-Ela Abd El Fattah (2003) also adds that physical load has an effect on hormonal functions, as scientific results confirm the vital role of sport with regard to positive health effects on controlling the hormonal system, and that the Parathyroid hormone secreted by the parathyroid gland increases its secretion during physical load.

(11: 165)

Mohamed Othman (2010) and Osama Riyad (2009) agree that the practice of sport activity through physical effort rated in load, size and intensity represents a basic mean of influencing the functional level of vital systems and endocrine glands. (35:237)(14:24)

- The results of the current study are consistent with the results of the study of both Fathi Abd Al-Rahman (2012) and Tariq Salah El-Din (2011), as their results showed that there is an effect of practicing sport activities of different intensities on increasing the secretion of hormones in the blood. (27) (23)

This is confirmed by Abu Al-Ela Abd El Fattah (2003) that moderate-intensity physical exercise affects the increase in hormone secretion in the blood, and high-intensity sports activities have a harmful effect on the body due to the massive increase in hormone secretion. (11: 439)

- Mohamed Adel Rushdi (2009) explains that simple exercise does not affect the rates of secretion of the glands, and that

moderate exercise protects the individual from injuries, while violent and strenuous exercise affects the hormonal system and the glands.

(34: 194)

Tammy Thachuk (2014) noted that moderate-intensity athletic activities play a large role in the secretion of hormones and an increase in the level of mineral salts, and that high-intensity exercises have negative effects on the secretion of hormones in the blood. (7)

Hence, the first hypothesis, which states that there are statistically significant differences between the pre and post measurements in the PTH hormone concentration in the research sample of women., and the fourth hypothesis which states that there is a significant positive effect of applying moderate

intensity physical load on the concentration of the PTH hormone in the research sample of women, are achieved

The second hypothesis: There are statistically significant differences between the pre and post measurements in the bone mineral density in the research sample of women and the fifth hypothesis: There is a significant positive effect of applying moderate intensity physical load on the bone mineral density in the research sample of women.

Table (3)
Differences between pre and post measurements in physiological measurements (bone mineral density) (YA T score) (n = 20)

Parameter/Tests	Pre load		Post load		Difference between means		t value	Effect value	Effectsize
	mean	± SD	mean	± SD	mean	± SD			
Neck	-1.527	0.430	-1.207	0.428	-0.320	0.063	16.045*	-5.079	high
Wards' triangle	-1.696	0.490	-1.337	0.455	-0.359	0.099	11.436*	-3.626	high
Troc	-0.682	0.102	-0.448	0.089	-0.234	0.071	10.391*	-3.296	high
Total	-1.224	0.281	-0.906	0.230	-0.318	0.142	7.084*	-2.239	high

* Significance at 0.05 level = 2.093

effect size value (weak 0.2, average 0.5, large / high 0.8 and more)

It is evident from Table (3) and Figure No. (2) of the differences between the pre- and the post-measurement in physiological measurements (bone mineral density) and the presence of significant differences between the two measurements at a level of 0.05 in favor of the post-measurement in all measurements, where the calculated value of t ranged between (7.084 to 16.045) and these values are greater than the tabular value of t. The effect value ranged between (2.39 to 5.079), which are high effect size.

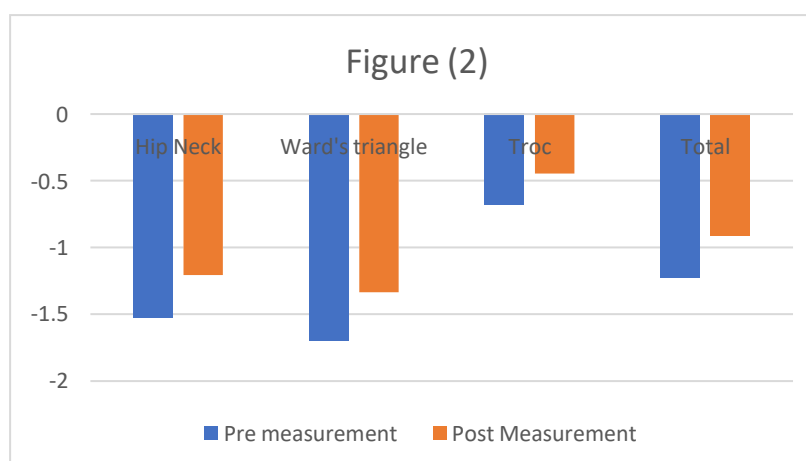


Figure (2) average pre- and post- physiological measurements (bone mineral density)

The two researchers attribute these results to that the moderate-intensity exercise program helped increase bone mineral density.

This is also in agreement with the results of Reem Abdel Sattar study (2014) that sports programs are effective in improving the percentage of osteoporosis and preventing the increase in the rate of fragility among women. (20)

This is in consistent with the study of Hala Yahya Al-Sayed (2015), who concluded that there are statistically significant differences between the pre and post measurements in bone density in favor of the post measurement. (39)

The shock exercises, as the jump exercises, work to develop the muscle strength and its role extends to increasing bone mineral density of the body. Abu Al-Ela (2003) states that physical exercise in general is considered one of the means to increase bone density. (11)

This was confirmed by the results of Nabil Jaafar study (2009) that the practice of sporting activity and physical exercises improves the level of bone density of the spine and thigh for women after the age of (55) years. (38)

Mohamed Al-Hamahami (2000) states that exercises on the ground have a greater effect on bones, as shock exercises with the ground increase muscle strength and its role extends to the bone mineral density. (36)

This is in agreement with the results of Walid Mostafa and Azza

Khalil (2017) that shock exercises have a positive effect on the muscular capacity of the legs and on the mineral density of the spine and pelvis. (40)

Talha Hosam Al-Din (2012) also emphasizes that stresses on the bone works to deposit salts properly, and therefore most of those who practice sports are heavier, and this is what the results of the current study brought about in that it increased bone density.

(24 :37)

O'brien, M (2011) added that the practice of continuous sports activities during the different stages of life leads to the prevention of bone loss in old age due to the increased deposition of bone calcium resulting from the regular and continuous increase in the deposition process more than the resorption process, which helps to increase bone mass and always preserve it (5: 62)

Abu Al-Ela Abd El-Fattah (2003) also indicated that as a result of sports training, morphological functional changes occur in the locomotor system (muscles - bones - tendons - ligaments). Muscles and bones increase in size, as it has been proven to increase in the transverse position of the bones and the thickness of their shell, which leads to improvement of the mechanical properties of the bones. (165:11)

JOHN (2010) added that there is a direct relationship, the more a person exercises physical activity, the stronger the bones and increased hardness and density increased. (4)

Hence, the results of the second hypothesis, which states that there are statistically significant differences between the pre and post measurements in the bone mineral density in the research sample of women and the fifth hypothesis which

states that there is a significant positive effect of applying moderate intensity physical load on the bone mineral density in the research sample of women, are achieved.

The third hypothesis: There are statistically significant differences between the pre and post measurements in the muscle strength and joint flexibility in the research sample of women and the sixth hypothesis: There is a significant positive effect of applying the moderate intensity physical program on the muscular strength and joint flexibility in the research sample of women.

Table (4)

The differences between pre-measurement and post-measurement in physical tests for the two components of muscular strength, characterized by velocity and muscular endurance (n = 20)

Statistical Parameter Physica Test		Pre load		Post load		Difference between means		t value	Effect value	Effectsize
		mean	± SD	mean	± SD	mean	± SD			
strength, characterized by velocity	number of Bent-Knee Situp in 10 seconds	2.400	0.843	4.200	0.632	1.800	1.033	5.511*	1.742	high
	number of torso is lifted up from prone in 10 seconds	2.300	0.675	4.200	0.632	1.900	0.568	10.585*	3.345	high
	Wide jump (cm)	44.612	5.444	64.900	4.149	20.288	7.052	9.098*	2.877	high
muscular endurance	time for raising the legs inclined high and steadiness from lying down (sec.)	9.800	1.619	14.200	1.619	4.400	2.011	6.919*	2.188	high
	number of times to bend the arms from a tilted prone modified for girls in 30 seconds	10.100	2.132	15.900	1.197	5.800	2.300	7.975*	2.522	high

* Significance at 0.05 level = 2.093

effect size value (weak 0.2, average 0.5, large / high 0.8 and more)

It is evident from Table (4) and Figure No(3) of the differences between the pre-and post measurement in physical tests (strength characterized by velocity) that the presence of significant differences between the two measurements at a level of 0.05 in favor of the post-measurement in all tests. The calculated value of t between (5.511 to 10.585), these values are greater than the tabular t value, and the effect value ranged between (1.742 to 2.877), which are high effectsize

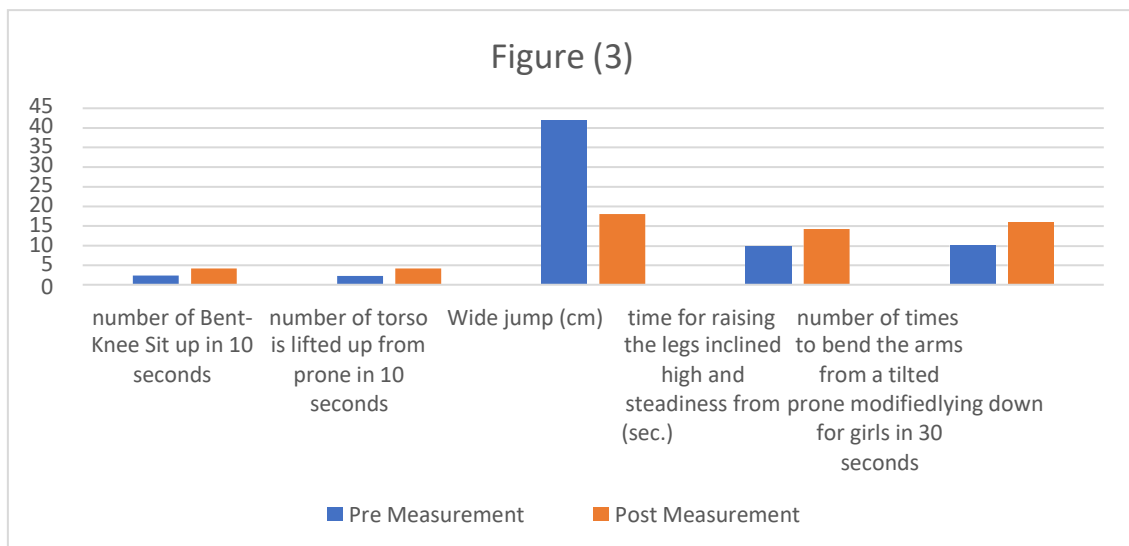


Figure (3)
Pre- and post-measurement in physical tests for the strength characterized by velocity and muscular endurance

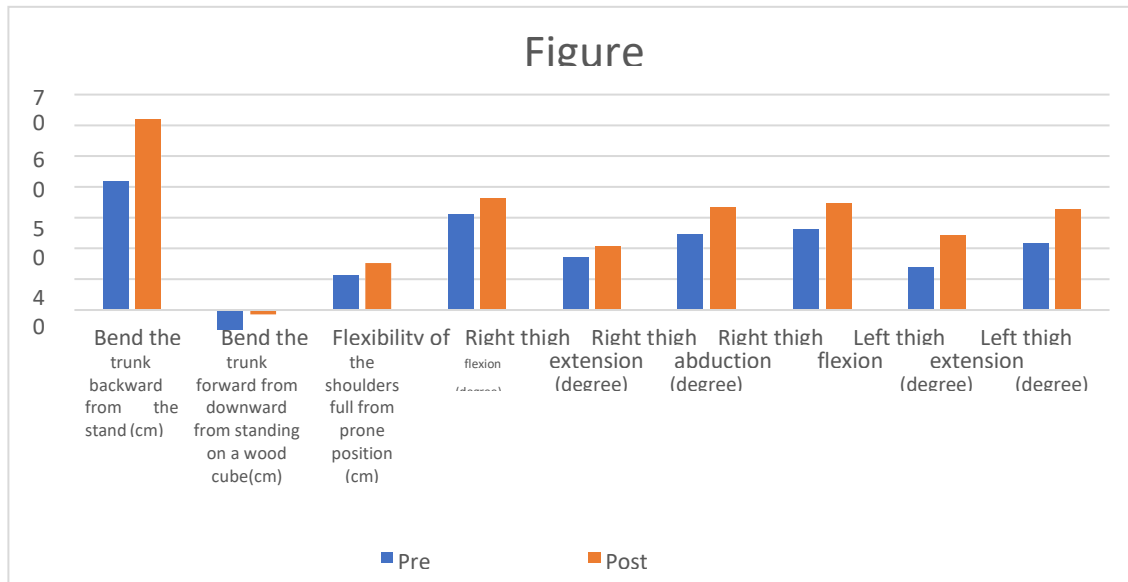
Table (5)
Differences between pre- and post-measurement in physical tests
(flexibility)(n = 20)

Statistical Parameter Physical tests (flexibility)	Pre load		Post load		Difference between means		t value	Effect value	Effectsize
	mean	± SD	mean	± SD	mean	± SD			
Bend the trunk backward from the stand (cm)	41.900	2.234	62.000	3.742	20.100	4.795	13.257 *	4.192	high
Bend the trunk forward from downward from standing on a wood cube (cm)	-6.400	2.119	-1.500	1.269	-4.900	1.912	8.104 *	-2.563	high
Flexibility of the shoulders full from prone position (cm)	11.100	1.853	15.200	1.476	4.100	2.378	5.452 *	1.724	high
Right thigh flexion (degree)	30.900	4.864	36.300	3.529	5.400	4.600	3.713 *	1.174	high
Right thigh extension (degree)	16.900	2.424	20.500	1.581	3.600	2.503	4.548 *	1.438	high
Right thigh abduction (degree)	24.600	5.016	33.200	1.814	8.600	5.379	5.056 *	1.599	high
Left thigh flexion (degree)	26.200	5.203	34.700	2.869	8.500	5.380	4.996 *	1.580	high
Left thigh extension (degree)	13.800	2.700	24.300	4.270	10.500	5.442	6.102 *	1.929	high
Left thigh abduction (degree)	21.500	3.629	32.800	2.044	11.300	4.762	7.504 *	2.373	high

* Significance at 0.05 level = 2.093 effect size value (weak 0.2, average 0.5, large / high 0.8 and more)

It is evident from Table (5) and the Figure No. (4) of the differences between pre- and post-measurement in physical tests (flexibility). The presence of significant differences between the two measurements at a level of 0.05 in favor of the post-measurement in (all tests). The calculated value of t ranged from 3.713 To 113.257 and these values are greater than the tabular t value. The effect value ranged from 1.174 to 4.192, which are high effect size.

Figure (4)
Average pre- and post-measurement in physical tests of the flexibility component



The two researchers attributed these results to the application of moderate- intensity physical load, which includes exercises for muscle strength and flexibility. Zakaria Hassan (2004) emphasized that muscle strength is one of the basic elements for practicing sporting activity. Owais Al-Jubaili (2000) and Abu Al-Ela Abd El Fattah (2003) believe that muscle strength training is one of the basic elements to gain physical fitness and works to improve the strength component that works to increase muscle mass and strengthen the connective tissue. (21 :97) (25 :24) (11:364)

Mohamed Hassan Allawi (2000), Mohamed Jaber Berriqa, and Ihab Fawzi (2005) agree that muscle strength is one of the most important physical traits on which an individual reaches the highest level of physical fitness, and this is what was achieved by the program that was applied on the research sample. (32:19)(33:14)

The Sand strom (2015) found that exercise increases muscle

strength. (6)

Abu El-Ela Abd El Fattah (2003) stresses the importance of sports training for the development of strength as it leads to an increase in muscle mass, strengthen connective tissues and the skeletal system, improving the structure of the individual's body, and developing other physical characteristics. (11 :54)

This is in line with Reem Abd El Sattar's study (2014), which concluded the effect of a proposed program on increasing muscle strength. (20)

Eqbal Rasmy (2008) indicated that developing muscle strength is one of the most important factors that help prevent and reduce injuries. (16 :31)

The study of Amjad Mohamed Husayn Mohamed (2007) noted that the use of a muscle strength program improves the muscular imbalance between the working muscle groups and the opposite muscles, and that the use of strength and flexibility exercises reduces the incidence of injuries. (15)

Mohamed Berriga and Ihab Ihab Fawzi (2005) indicated that standardized flexibility exercises work to preserve the full range of joint movement, which helps reduce the incidence of injuries resulting from lack of joint flexibility. (33)

This is in consistent with the findings of Medhat Qasim Abd El Razek study (2010) regarding the effectiveness of flexibility and stretching exercises in preventing injuries and the necessity that flexibility and stretching exercises to be the most important parts of physical preparation in experimental programs. (37)

Abu El-Ela Abd El Fattah (2003) stresses the importance of linking flexibility and stretching exercises with strength exercises to

ensure work on the balanced development of the musculoskeletal system (11 :15)

Thus, the results of the third hypothesis which states that There are statistically significant differences between the pre and post measurements in the muscle strength and joint flexibility in the research sample of women and the sixth hypothesis, which states that There is a significant positive effect of applying the moderate intensity physical program on the muscular strength and joint flexibility in the research sample of women, were achieved

Conclusions:

Based on the results of the study and in light of the objectives and hypothesis of the research and within the limits and characteristics of the research sample,

the method used, the tests and the measurements applied, the two researchers were able to reach the following conclusions:

1. The moderate-intensity exercise program improved the PTH hormone concentration as shown by blood test results.
2. The medium-intensity exercise program improved the bone mineral density of the research sample as shown by the DEXA device.
3. The increase in the PTH hormone concentration in blood had a positive effect on increasing the bone mineral density.
4. The suggested moderate intensity exercise program and the increase in PTH hormone concentration led to an improvement in the bone mineral density in the research sample as shown by the DEXA device.
5. The proposed moderate-intensity exercise program led to an

improvement in the muscle strength and joint flexibility in the research sample of women.

Recommendations:

In light of the research results and the conclusions reached, the two researchers have the following recommendations that should be directed to all interested parties and all concerned parties specialized in the field of sports and in the fields of health sciences, especially for women and sports units:

1. Paying attention to moderate-intensity sports programs that increase bone density and PTH hormone.
2. Paying attention to periodically checking bone mineral density, hormones of the thyroid glands and parathyroid glands to prevent injuries.
3. Paying attention to physical performance that maintains muscle strength and the range of motion of the women's joints in order to reduce the feeling of pain.
4. Paying attention to developing sports programs for women before and after menopause, which work to develop muscle strength and joint flexibility to gain physical fitness.
5. Establishing physical rehabilitation centers in the Faculties of Physical Education to apply the results of studies that serve the community.
6. Conducting similar studies on other samples of women, as they are more likely than men to lose bone density.
7. Conducting more similar studies on different age stages.
8. Application of this study to a larger sample.