Effectiveness of a recommended in-water training program on bone mineral density and some physical variables for post-menopausal women

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Abstract: The current research aims to identify the effects of in-water exercises on improving bone mineral density and some other physical and physiological variables in post-menopausal women. The researcher used the experimental approach (two-group design) with pre- and post-measurements. Participants (n=38) were purposefully chosen from female workers (45-55 years) at Jordan University. They were divided as follows: (8) participants for the pilot sample – (15) participants for the experimental group – (15) participants for the control group. Results indicated that: **-** The recommended in-water exercises program improved leg and back muscle strength, right/lift femur flexibility and spine flexibility in post-menopausal women. **-**The recommended in-water exercises program improved pulse, relative vital capacity and systolic/diastolic blood pressure in post-menopausal women. **-**The recommended in-water exercises program improved bone mineral density in femur and spine in post-menopausal women. **-** There is statistically significant correlation between BMI and other variables under investigation.
[Nihad Moneer Othman Al-Bateky. **Effectiveness of a recommended in-water training program on bone mineral density and some physical variables for post-menopausal women.** *Researcher* 2017;9(9):18-24]. ISSN 1553-9865 (print); ISSN 2163-8950 (online). http://www.sciencepub.net/researcher. 3. doi:10.7537/marsrsj090917.03.

Key Words: in-water exercises – post-menopausal – osteoporosis.

1. Introduction and Research Problem:

Scientific research is a major base for developing societies in all field and especially in sport through identifying human abilities and powers and making the best use of scientific theories. Physical education and sport affect human beings as they represent basic components in preparing individuals according to scientific bases.

Fawzy, A. (1990) indicated that swimming is an aquatic sport that uses water as a medium for movement. Arms and legs are responsible for the major part of moving forward. Bones of these limps are the livers against water resistance using muscles as moving power. Therefore, the body advances in water as a reaction to this resistance (14: 7).

In-water exercises decrease loads on knees during performance compared with dry-land exercises. No matter how heavy the individual is, he/she does not feel this weight as water serves as a cushion for knee joints during performance. this makes individuals more involved in intense effort without pain or pressure over joints. Donna (1986) indicated that in-water exercises are characterized by additional effects of water resistance, floatability, water pressure and other positive effects on the body (11: 20).

Salem, W. (1997) indicated that swimming is a catalyst in therapeutic programs as the body floats over water and this decreases effort over muscles during vertical position with decreased gravity. It aims to maintain body position in water while moving limps and muscles (25: 14).

Mary & Pappas (1997) indicated that in-water exercises are safe and suitable for all age groups and fitness levels. It is used for improving muscle tuning, post-injury rehabilitation, increasing muscular strength, improving physical fitness components and providing body with energy (21: 11).

Al-Sokkary, K. & Berekaa, M. (2000) indicated that in-water exercises decrease weight and improve heart rate. In addition, it decreases cholesterol and improves functional capacity of body systems (3: 5).

Darwish, K. (1998) indicated that using aquatic medium is very effective in restoring vitality and increasing personal motivation for facing life demands as it increases joy and happiness. In addition, it is a positive way to protect health in elderly population as it increases the efficiency of vital systems (8: 27).

Frangoulis et al (2001) indicated that in-water exercises received major attention recently, especially in-water running as protective, therapeutic and rehabilitation exercises (13: 75).

Sports organizations try to provide post-menopausal women with variety of programs as this stage is very important in woman's life due to physiological, physical and psychological changes happening during this stage. Post-menopausal women suffer from major health problems due to hormone deficiency with all its complications especially for bones that were already affected by repeated pregnancy and breastfeeding. Post-menopausal osteoporosis results from estrogen deficiency, a feminine hormone that helps integrating calcium in bones. Symptoms usually appear between 51-75 years but may appear earlier or later than that age. Not all women are vulnerable to this disease but women with light skin or of oriental origins are more vulnerable to this disease compared with dark-skinned women.

National Council of Women (2004) indicated that osteoporosis is a common disease among women as they express symptoms in far higher rate compared to men (6:1) and it is related to post- menopausal stage. The disease develops quietly along the woman's life span after menstrual cycle stopes (19).

Mohamed, H. (1987) indicated that bones and muscles in elderly people lose its flexibility and strength due to aging. Therefore, these people often feel tired with effort in addition to decreased concentration and tendency towards to isolation. They feel annoyed due to the lack of activity and vitality (20: 26).

Ganong (1987) indicated that bones are made of living tissues with proteins and minerals (especially calcium and phosphor). Bone tissues are the store for body calcium which works on balancing other minerals in addition to maintaining acidic/alkaline balance in lung and kidney (15: 300).

WHO (2000) indicated that estimations of osteoporosis in USA alone reached (25) million persons. As a result of this disease, more than 250.000 people sustained femur fractures, 240.000 sustained wrest fracture and 500.000 sustained spinal fracture in one year, in addition to other less common fractures. It is estimated that nearly 1.3 million persons sustained fractures due to decreased bone mineral density and this rate is in one single country (18).

This led the researcher to try to identify the effects of in-water exercises on improving bone mineral density and some other physical and physiological variables in post-menopausal women.

Aims:

The current research aims to identify the effects of in-water exercises on improving bone mineral density and some other physical and physiological variables in post-menopausal women through identifying:

- Difference significance between pre- and post-measurements of the experimental group on bone mineral density and some physical variables under investigation.
- Difference significance between pre- and post-measurements of the control group on bone mineral density and some physical variables under investigation.
- Difference significance between post-measurements of the experimental and control groups on bone mineral density and some physical variables under investigation.
- Correlations between bone mineral density and some physical variables under investigation.

Hypotheses:

1. There are statistically significant differences between pre- and post-measurements of the experimental group on bone mineral density and some physical variables under investigation in favor of post-measurement.
2. There are statistically significant differences between pre- and post-measurements of the control group on bone mineral density and some physical variables under investigation in favor of post-measurement.
3. There are statistically significant differences between post-measurements of the experimental and control groups on bone mineral density and some physical variables under investigation in favor of experimental group.
4. There are statistically significant correlations between bone mineral density and some physical variables under investigation.

2. Methods:

Approach:

The researcher used the experimental approach (two-group design) with pre- and post-measurements.

Participants:

Participants (n=38) were purposefully chosen from female workers (45-55 years) at Jordan University. They were divided as follows: (8) participants for the pilot sample – (15) participants for the experimental group – (15) participants for the control group. Participants were chosen according to the following criteria:

- All of them do not participate in regular physical activities.
- Al of them are willing to participate in the study.
- All of them are non-smokers.
- All of them are free of chronic diseases (heart disease – hypertension – diabetes).

Homogeneity of participants on all research variables is shown in table (1).

Data collection instruments:

A medical balance for weights – a restameter for heights – a stop-watch – a swimming pool – Digital Electronic - Blood Pressure Monitor – rubber cords for arm exercises – a dynamometer for grip strength and leg and back muscles strength – a spirometer for vital capacity – a goniometer for flexibility – safety hoops – ruler – medicine balls (3kg) – handballs and tennis balls – DEXA device for bone mineral density – data recording form.

Table (1) showed that squewness values were between (±3). This indicates data normality and participants homogeneity.

Table (1): Characteristics of participants (n=38)

Variable	Measurement	Mean	SD	Median	Squewness
BMI	Kg/m^2	27.91	4.55	28.34	- 0.28
Age	Year	52.07	0.49	52.15	- 0.49
Menopausal period	Year	5.23	2.34	6.01	1.00
Pulse (rest)	Bpm	76.83	7.64	78	- 0.46
Systolic BP	mmHg	131.60	11.43	132	- 0.10
Diastolic BP	mmHg	90.7	8.37	90.24	0.16
Back muscles strength	Kg	55.41	3.98	53.48	1.45
Leg muscles strength	Kg	61.78	4.11	62.55	- 0.56
Spine flexibility	Cm	13.45	2.34	13.80	- 0.38
Right hip joint flexibility	Degree	44.36	1.95	44	0.55
Lift hip joint flexibility	Degree	43.71	1.68	43.92	- 0.38
Bone mineral density on femur neck	g/cm^2	0.415	0.05	0.412	0.18
Bone mineral density on femur rotator	g/cm2	0.395	0.07	0.391	0.17
Bone mineral density on spine	g/cm2	0.411	0.03	0.412	- 0.10

Table (2): A model for a training unit

Part	Duration	Objective	Level	Repetition
Warm-up	**5-10 min**	Preparing muscles and body systems to effort	Running around the pool Jumping in place	
Main part	**25-30 min**		Standing open with water to chest level – jumping while opening and closing legs Standing open – a rubber cord is fixed to the pool stairs – stand with back to stairs and try to pull the cord	6-10 rep 3 reps
Cool down	**5-10 min**	Relaxation and recovery	Cool down exercises and games	

Pre-measurements:

1. The researcher started with measuring weight and height.
2. The researcher measured pulse and blood pressure (systolic/diastolic) using Digital Electronic - Blood Pressure Monitor (Ds-115). Measurements were taken during rest using the right arm. Reading appeared on a digital monitor and recorded for analysis.
3. The researcher used a dynamometer for measuring leg muscles strength. Each participant calibrated the metal chain according to her height and stood with flexed legs holding the handles in her hands while the back and arms were straight. Participant extended her legs and the best reading from three trials was recorded.
4. The same device was used for measuring low back muscles strength with slight modifications. Participant held the handle in a reversed way while arms and legs fully straight and trunk leaning forward. Participant extended trunk till back was straight. Best reading from three trials was recorded.
5. Dual Energy X-ray Absorptiometry (DEXA - Norland Arm Model 333 A063) was used for measuring bone minerals density. According to review of literature on best places for measuring bone mineral density, X-ray was performed on:

- 2nd, 3rd and 4th lumbar vertebrae.
- Lift femur (femur neck – femur rotator).

The recommended in-water exercises program:

Objectives:

- Improving general physical condition.
- Improving bone mineral density.
- Forming social relations.

Principles:

- Achieving program objectives.
- Using previous studies related to program design.
- Flexibility and modifiability.
- Focusing on major muscle groups and progression from easy to hard to facilitate adaptation.
- Suitability of content to age group.
- Preventing exertion and pain.

Contents:

After designing the preliminary form of the program, the researcher presented it to experts to identify the following: total duration – number of units per week – duration of each unit. Experts' opinions indicated that the program should be (12) weeks with (36) units (3 units per week). Each unit included (3) parts: warm-up – main part – cool down. Unit duration increased from (40) minutes at the beginning of the program to (70) minutes at the end. Table (2) shows a model for a training unit:

Pilot study:

The researcher performed the pilot study on a pilot sample (n=8) from the same research community and outside the main sample from 13-4-2017 to 18-4-2017 to identify the suitability of program contents to age group and to validate instruments in addition to discovering any difficulties that may face main application. Results indicated the validity of program, instruments and contents.

Program application:

The researcher applied the program to the experimental group (n=15) from 20-4-2017 to 25-7-2017 for (12) weeks (3 units per week).

Post-measurements:

Following the same protocol of pre-measurements, the researcher took post-measurements from 26-7-2017 to 28-7-2017.

Statistical treatment:

Using SPSS software, the researcher calculated the following: mean – SD – squewness – (t) test – correlation coefficient – improvement percentage.

3. Results:

Table (3) indicated statistically significant differences between pre- and post-measurements of the experimental group in favor of the post-measurement. Improvement percentages ranged from 0.771% for bone mineral density at femur rotator to 13.38% for spine flexibility.

Table (3): difference significance and improvement percentages between pre- and post-measurements of the experimental group on research variables under investigation (n=15)

Variables	Measurements	Pre-		Post-		Improvement (%)	(t)
		Mean	SD	Mean	SD		
BMI	Kg/m^2	27.91	1.33	26.11	1.55	6.35	7.78*
Age	Year	79.27	3.91	77.20	2.37	2.61	8.60*
Menopausal period	Year	130.33	9.87	128.11	7.36	1.79	5.12*
Pulse (rest)	Bpm	73.7	8.37	69.28	6.32	7.26	17.67*
Systolic BP	mmHg	58.00	3.63	61.87	3.52	6.67	8.29*
Diastolic BP	mmHg	63.30	3.79	68.33	3.31	7.78	12.85*
Back muscles strength	Kg	13.00	0.93	13.87	1.13	13.38	7.80*
Leg muscles strength	Kg	51.73	3.89	53.37	3.25	5.30	6.90*
Spine flexibility	Cm	38.37	1.30	31.33	1.35	7.33	17.35*
Right hip joint flexibility	Degree	0.321	0.006	0.325	0.001	0.950	7.80*
Lift hip joint flexibility	Degree	0.389	0.008	0.392	0.007	0.771	10.69*
Bone mineral density on femur rotator	g/cm^2	0.302	0.009	0.309	0.008	1.39	8.93*

* significant on $P \leq 0.05$

Table (4): difference significance and improvement percentages between pre- and post-measurements of the control group on research variables under investigation (n=15)

Variable	Measurement	Pre-		Post-		Improvement (%)	(t)
		Mean	SD	Mean	SD		
BMI	Kg/m^2	27.11	1.55	27.33	1.36	0.88	0.97
Age	Year	79.20	2.37	79.22	3.79	2.66	0.60
Menopausal period	Year	131.62	8.09	130.26	7.85	1.03	0.37
Pulse (rest)	Bpm	72.36	7.67	71.93	7.33	0.718	1.07
Systolic BP	mmHg	61.87	3.52	57.36	3.30	7.29	0.33
Diastolic BP	mmHg	68.33	3.31	63.51	3.89	5.59	0.33
Back muscles strength	Kg	13.87	1.13	13.00	1.00	12.58	0.80
Leg muscles strength	Kg	53.37	3.25	51.30	3.87	5.63	0.90
Spine flexibility	Cm	31.33	1.35	39.09	1.36	5.32	1.35
Right hip joint flexibility	Degree	0.322	0.001	0.320	0.007	0.373	0.80
Lift hip joint flexibility	Degree	0.391	0.007	0.388	0.007	0.767	1.69
Bone mineral density on femur rotator	g/cm^2	0.308	0.008	0.302	0.007	1.37	0.93

* significant on $P \leq 0.05$

Table (4) indicated that there were no statistically significant differences between pre- and post-measurements of the control group on all research variables as improvement percentages were all negative.

Table (5): difference significance and improvement percentages between post-measurements of the experimental and control groups on research variables under investigation (n=30)

Variable	Measurement	Experimental		Control		(t)
		Mean	SD	Mean	SD	
BMI	Kg/m^2	26.11	1.55	27.33	1.36	2.36*
Age	Year	77.20	2.37	79.22	3.79	1.92
Menopausal period	Year	128.11	7.36	130.26	7.85	0.85
Pulse (rest)	Bpm	69.28	6.32	71.93	7.33	1.16
Systolic BP	mmHg	61.87	3.52	57.36	3.30	3.92*
Diastolic BP	mmHg	68.33	3.31	63.51	3.89	3.18*
Back muscles strength	Kg	13.87	1.13	13.00	1.00	5.19*
Leg muscles strength	Kg	53.37	3.25	51.30	3.87	2.58*
Spine flexibility	Cm	31.33	1.35	39.09	1.36	3.77*
Right hip joint flexibility	Degree	0.325	0.001	0.320	0.007	2.50*
Lift hip joint flexibility	Degree	0.392	0.007	0.388	0.007	2.00
Bone mineral density on femur rotator	g/cm^2	0.309	0.008	0.302	0.007	2.33*

* significant on $P \leq 0.05$

Table (5) indicated statistically significant differences between post-measurements of the experimental and control groups in favor of experimental group on BMI, relative vital capacity back muscles strength, leg muscles strength, spine flexibility, right femur flexibility, lift femur flexibility, bone mineral density on femur neck, bone mineral density on spine but not on pulse (rest), blood pressure (systolic/diastolic) and bone mineral density on femur rotator.

4. Discussion:

Table (3) indicated statistically significant differences between pre- and post-measurements of the experimental group in favor of the post-measurement. Improvement percentages ranged from 0.771% for bone mineral density at femur rotator to 13.38% for spine flexibility. Table (4) indicated that there were no statistically significant differences between pre- and post-measurements of the control group on all research variables as improvement percentages were all negative. Table (5) indicated statistically significant differences between post-measurements of the experimental and control groups in favor of experimental group on BMI, relative vital capacity back muscles strength, leg muscles strength, spine flexibility, right femur flexibility, lift femur flexibility, bone mineral density on femur neck, bone mineral density on spine but not on pulse (rest), blood pressure (systolic/diastolic) and bone mineral density on femur rotator.

Morel et al (2001) indicated that in-water exercises are the best type for individuals with weak bone density as dry-land exercises are considered dangerous for them due to the fact that they may be vulnerable to bone fractures. In addition, in-water exercises decrease pressure on bone inside water. (22).

Hammad, M. (1998) and Bassey & Rumsdal (1993) indicated that exercises are important for normal growth of bones. They have no relation to bone length but actually they increase bone width and density through depositing more minerals on them and this increases its strength. (17) (5).

David (1993) indicated that in-water exercises maintain muscle and bone strength as mechanical stress over bones due to motor activities deposits calcium in bone cells. Therefore, the amount of bone growth depends on frequency and intensity of movement (9).

Mary & Pappas (1997) indicated that in-water exercises are safe and useful for all age groups and fitness levels as it is used for improving muscle tune, injury rehabilitation, muscular strength, physical fitness and energy production (21).

Al-Sokkary, K. & Berekaa, M. (2000) indicated that in-water exercises decrease weight, improve heart rate and enhance vital capacity of body systems (3).

Darwish, K. (1998) indicated that water as a medium plays a vital role in restoring vitality and activity as it provides individuals with motives for facing life demands through adding joy and happiness to activity. It is a positive way for maintaining health in elderly population through improving efficiency of vital systems (8).

The researcher thinks that although increases in bone mineral density for experimental group were small, the same values were negative for the control group. This indicates the importance of sports participation in general and especially in-water exercises for post-menopausal women. These exercises change life style for this age group and prevents health deterioration and decreases in bone minerals that is considered very dangerous for this age group. In addition, in-water exercises are ideal for preventing bone deterioration in post-menopausal women due to decreased levels of estrogen.

Abd El-Rahman, N. (2000) and Sanders (1996) indicated that swimming decreases vulnerability to injuries as floating helps decreasing stress on bones and joints (2) (26).

This is consistent with Abd El-Moneam, L. (1991), Glodstein et al (1993), Bravo et al (1997), Darby & Yaekle (2000), Deborah (2013), Tanya & Christine (2005), Ay & Yurkuran (2005) and Piotrowska et al (2005) in that in-water exercises improve health condition including bone mineral density in post-menopausal women. (1) (16) (6) (7) (9) (27) (4) (13).

Fleck & Kraemer (1993), Ribert et al (1998) and Vorster et al (2001) indicated that regular sports training increases bone mineral density and neuro-muscular pathways in addition to enhancing physical efficiency as it increases connectivity between nervous system and muscle fibers. This happens through changing neuro-pathways, enhancing coordination between nervous signal and muscle reaction. This rearranges nervous signals in a manner that enables muscle fibers to be identified more clearly during movement (12) (14) (29).

5. Conclusions:

According to this research aims, methods and results, the researcher concluded the following:

1. The recommended in-water exercises program improved leg and back muscle strength, right/lift femur flexibility and spine flexibility in post-menopausal women.
2. The recommended in-water exercises program improved pulse, relative vital capacity and systolic/diastolic blood pressure in post-menopausal women.
3. The recommended in-water exercises program improved bone mineral density in femur and spine in post-menopausal women.
4. There is statistically significant correlation between BMI and other variables under investigation.

Recommendations:

- Applying the recommended program with in-water exercises on post-menopausal women.
- Post-menopausal women should undergo regular check-up.
- Using BMI as an indicator for symptoms of osteoporosis.

References:

1. Abd El-Moneam, Laila (1991): Effects of a recommended swimming program on some physiological variables and physical effecincy for elderly. Journal of Arts and Sciences of Physical Education – Faculty of Physical Education for Women – Helwan University, Vol.6, No.1 (in Arabic).
2. Abd El-Rahman, Neamat A. (2000): Aerobic Activities, 1st Ed. Munshaat Al-Maaref – Alexandria – Egypt (in Arabic).
3. Al-Sokkarym K. & Berekaa, M. (2000): In-water exercises. Munshaat Al-Maaref – Alexandria – Egypt (in Arabic).
4. Ay, Alev; Yurtkuran, Merih (2005): Influence of Aquatic and Weight-Bearing Exercises on Quantitative Ultrasound Variables in Postmenopausal Women, American Journal of Physical Medicine & Rehabilitation. 83(1):52-61.
5. Bassy B. and rumsdal G. (1993): Physiological effects of deep water running following a land-based training program, Res Q Exer Sport 1993; 65(3):386-9.
6. Bravo G., P. Gauthier, P. M. Roy (1997): A weight-bearing, water-based exercise program for osteopenic women; its im-pact on bone, functional fitness and well-being. Arch. Phys. Med. Rehabil. 78:1375-1380.
7. Darby G., Yaekle S. (2000): physiological responses during two types of exercise performed on land and in the water, the journal of sports medicine and physical fitness, vol (30) – no (3)-303-311.
8. Darwish, Kamal El-Din (1998): Effects of a sports program on some components of physical fitness in elderly. Journal of Faculty of Physical Education for Men – Helwan University (in Arabic).
9. David L, Costill (1993): introduction to nutrition exercise and health, fourth edition, lea, London.
10. Deborah (Mushi) Harush (2003): The Effect of a Water Exercise Program on Bone Density among Postmenopausal Women, Thesis submitted in partial fulfillment of the requirements for Master Degree, University of Haifa, School of Education, Department of Education, December.
11. Donna de Varona's (1986): Hydro-Aerobics Swim Your Way to Total Fitness, First

Paperback Edition, New York: Fawcett Columbine.
12. Fleck. S. J. Kraemer W., (1993): Strength training for young atheletes champion, il: humank inectics, pp. (593-600).
13. Frangoulis C, Belkhiria S, Goffart A, Hecq JH (2001): Dynamics of copepod faecal pellets in relation to a Phaeocystis dominated phytoplankton bloom: characteristics, production and flux. J Plankton Res 23:75–8.
14. Gamal, Adel F. (1990): Competitive Swimming Technique. Egypt Printing Co. – Cairo – Egypt (in Arabic).
15. Ganong (1987): Review of medical physiology, Chapter 21 pp. (300-60).
16. Goldstein J, Simkin E. (1993): The influence of weight-bearing water exercise on bone density of post-menopausal women, Movement J. of Physical Education & Sport Sciences;2: 3-7.
17. Hammad, Mufty I. (1998): Modern sports training: planning – application – leadership, 1st ED. Dar Al-Fikr Al-Araby – Cairo – Egypt (in Arabic).
18. http://www.emro.who.int/Arabic/ncd/.
19. http://www.ncwegypt.com/.
20. Kenawy, Huda M. (1987): Psychology of Elderly. Center for Human Resources Development – Cairo – Egypt (in Arabic).
21. Mary Beth, Pappas Gaines (1997). Water workouts. human kinetics. London.
22. Morel J, Combe B, Francisco J, Bernard J (2001): Bone Mineral Density of 703 Amateur Sportsmen Involved in Different Physical Activities, Osteoporosis International, Volume 12, Number 2, 152 – 157.
23. Piotrowska-C., Wajszczyk J. Ch., Brennan D, Wilder R, (2005): the efects of a 23-week deep water aerobic training program on bone density.
24. Robert JM, Hoeger W, Hopkins D, Barber D (1998): Aquatic therapy programming. Guidelines for Orthopedic rehabilitation, Human Kinetics Publishers, Ill.; 3-3.
25. Salem, Wafika M. (1997): Aquatic Sports: objectives – methods of teaching – evaluation. Munshaat Al-Maaref – Alexandria – Egypt (in Arabic).
26. Sanders Ch, (1996): The effect of a single bout of exercise on mood, self-esteem and self-efficacy. Aquatic Fitness Res J;1(1):10-31.
27. Tanya R. Littrell,. and Christine M. Snow, (2005): Bone Density and Physical Function in Postmenopausal Women After a 12-Month Water Exercise Intervention, Medicine & Science in Sports & Exercise: Volume 36(5) pp.289-290.
28. Tsai, H. Hsu, Y. Fong, C. Chiu, A. Kao, C. Lee (2003): Bone mineral density in young female Chinese dancers, International Orthopaedics, Volume 25, Number 5 / October, pp 283-285.
29. Vorster Szczerba JE, Jackson ML. (2001): The effects of an eleven-week aqua program on relatively inactive college age women. Med Sci Sports Exerc; 6(5):103 abstract.

9/12/2017