



Effect of exercise on bone density and osteoporosis of menopausal women: A review study

*¹ Amitava Ghosal, ² Dr. Nita Bandyopadhyay

¹ Research Scholar, Department of Physical Education, University of Kalyani, Kalyani, West Bengal, India

² Assistant Professor, Department of Physical Education, University of Kalyani, Kalyani, West Bengal, India

Abstract

In India 61 million population suffered from Osteoporosis. 20% rise in last decade and 50% rise expected in next 10 years. The purpose of this study was to find out the effect of exercise on bone density of menopausal women. Researcher selected 18 experimental research paper from different journal through PubMed, Google scholar from 1987 to 2017. The subjects of all paper were pre and post-menopausal women. All they were measured bone mineral density. Researcher tabulate the authors name, problem, training types and procedures and their finding and other details related to this review in result section and discussed. From this review it was concluded that physical activity was important non-pharma logical component for improved BMD and prevention of osteoporosis of pre and post-menopausal women. High impact loading activities may be supervised or unsupervised among with the awareness and nutrition were very necessary to improved BMD and prevent osteoporosis.

Keywords: pre & post-menopausal women, BMD, osteoporosis, exercises

1. Introduction

Osteoporosis was a global public health problem, currently affecting more than 200 million people worldwide ^[1]. In India 61 million population (1 in 3 women and 1 in 8 men) suffered from Osteoporosis. 20% rise in last decade and 50% rise expected in next 10 years ^[2]. In urban areas 48% of osteoporosis occurs in the lumbar spine and 17 % in the femoral neck ^[1]. Low bone density was a condition where the tissue inside the bones begins to thin, or becomes less dense as get older, the body loses bone tissue faster than it can be replaced. This makes the bones less solid and weaker due to hormonal loss and less physical activity and lack of proper diet. Physical activity was beneficial in many physiological processes like bone turnover. The purpose of this study was to

find out the effect of exercise, on bone health and osteoporosis of post-menopausal women.

2. Materials and Methods

Researcher selected 18 experimental research paper of different journal from PubMed, Google scholar etc. 1987 to 2017. The subjects of all paper were pre and post-menopausal women. And measuring criteria were bone mineral density and bone turn over markers. Researcher tabulate the authors name, problem and their finding and other details related to this review in result section. BMD were measured through Dual X ray absorptiometry, CT scan, Ultrasound radiography and bone formation and resorption marker by blood serum.

3. Results & Discussion

Table 1: showed name of authors, no. of subjects, age & type, type of activities & frequencies and measuring site of BMD of 18 Interventional Studies

Authors	Sub No	Sex	Age (Years)	Type	Type of Activities	Duration	Day	Time	BMD Measured site
Chow <i>et al.</i> , 1987	48	F	50 – 62	Canadian Post-menopausal Sedentary women	Aerobic and Aerobic + Low intensity strengthen ex.	1 yr.	3day/week. 80% and 10RM of intensity.	40 & 55 min.	Calcium Bone Index of the trunk and upper thigh.
Bassey <i>et al.</i> , 1998	55	F	36 - 38	Pre and post, menopausal Sedentary women of United Kingdom.	High Impact Ex.	12 month.	6d/wk 50jump/day	10 min	Proximal femur (neck and trochanter) and Lumbar spine and bone turn over marker.
Walker <i>et al.</i> , 2000	89	F	60 - 68	Canadian Post-menopausal Sedentary women	Aerobic + Strengthen ex.	5 yrs.	2 day/week	50 min. (30 + 20)	Lumbar and Femoral neck
Vainionpaa <i>et al.</i> , 2005	120	F	35 - 40	Sedentary Pre-menopausal women of Finland.	Progressive high impact exercise	12 month	3 day/week	60 min	Lumbar spine, femoral neck, ward triangle, radius, ulna, calcaneal and Distal radius.

Chubak <i>et al.</i> , 2006	173	F	50- 75	Post-menopausal sedentary women of USA.	Aerobic ex.	12 month	5 days/ week. 60 – 75% or moderate intensity	45 min	Total bone mineral density.
Engludu <i>et al.</i> , 2009	34	F	73 -88	Older sedentary women of Sweden.	Combined Weight bearing programme.	5 yr.	-		Femoral neck, Trochanter, ward triangle.
Bello <i>et al.</i> , 2014	20	F	61.3	Brazilian post-menopausal Diabetic Patient	Multicomponent ex.	32 wk.	3 day/week Moderate to vigorous intensity	40 – 60 min.	Femoral neck, greater trochanter, ward triangle, total hip and whole body.
Angin <i>et al.</i> , 2015	41	F		Turkish post-menopausal sedentary women.	Pilates Exercise		-		Lumbar spine.
Anek <i>et al.</i> , 2015	60	F	35 - 45	Working women of Thailand.	1. Aerobic Ex. 2. Resistance Ex. 3. Combine aerobic and resistance ex.	16 wk.	-		Bone turnover markers. (β cross laps, P1NP, Osteocalcin.)
Hakestad <i>et al.</i> , 2015	42	F	>50	Norwegian post-menopausal women	Weight vest rehabilitation programme	6 month	3day/week Intensity 80%	60 min	Hip, Femoral neck and trochanter, Lumbar spine and total body.
Jeihooni <i>et al.</i> , 2015	120	F	30 - 50	Iranian Sedentary Women.	Educational Programme based training	6 month	8 educational session	55 – 60 min speech	Lumbar spine and Femur.
Kemmler <i>et al.</i> , 2015	137	F	55	Post-menopausal Sedentary women of German.	Multipurpose ex programme	16 yrs. 49 – 50 wk./yr.	2 supervised group and home training session. Intensity was regular adapted.	60 – 65 and 20 – 25 min	Lumbar spine, Femoral neck.
Liu <i>et al.</i> , 2015	383	F	50 - 75	Patients and sedentary post-menopausal women of China.	Modified Eight Section Brocade Exercise.	12 month	7 day/wk. Daily 3 time with 7 rep.		L ₂ to L ₄ and Proximal femur.
Movaseghi, Sadeghi. (2015).	1	F	57	Iranian post-menopausal Sedentary women	Multicomponent ex. Including stretching, Aerobic, Resistance ex. With band.	3 yrs.	2 – 3 d/wk.	70 – 90 min	Lumbar and Proximal Femur. Ward triangle.
Sukkeaw <i>et al.</i> , 2015	63	F	35 - 45	Thai working women.	Aerobic dance on trampoline and hard wood.	12 wk.	3d/wk. Intensity 60 – 80%.	40 min	Bone Turn over markers. N-terminal propeptide of procollagen type I: P1NP, Telo peptide cross linked: β -CrossLaps.
Watson <i>et al.</i> , 2015	100	F	60	Australian post-menopausal Sedentary women.	High intensity progressive resistance training	8 month	2d/wk 5 sets and 5 rep. Intensity 80 – 90%	30 min	Whole body, Femoral neck. Lumbar spine.
Bowtell <i>et al.</i> , 2016	56	F	38	Sedentary post-menopausal women of UK.	Short and long term football and vibration ex.	-	-	13.5, 4 * 13.5, 13.5 min.	BMC, femur BMD, CTX – I, P1NP, Osteocalcin.
Bimonte <i>et al.</i> , 2017	28	F	53	Sedentary adult obese Female of Rome, Italy.	Unsupervised aerobic training	12 month	7 d/wk	60 min.	Whole body BMD, P1NP,

Chow *et al.*, 1987 investigated on the effect of two randomized exercise programmes for bone mass of healthy post-menopausal women. After 1 year of exercise both aerobic and aerobic plus strength training group developed the aerobic capacity and calcium bone index but no difference found between this group. And significant difference found between control group and aerobic exercise group and aerobic plus strength training group [3]. Anek *et al.*, 2015 investigated on the effects of Aerobic Step Combined with Resistance Training on Biochemical Bone Markers, Health-Related Physical Fitness and Balance in Working Women. After 16 weeks of exercise training for combine aerobic step with resistance exercise group and aerobic step exercise group

improved the none formation markers like β cross laps, P1NP and Osteocalcin but not in resistance aerobic exercise group. Balance ability also improved for combined group better than the remaining two groups. And concluded that aerobic step exercise and combined exercise are effective for improving bone formation for working aged people [11]. Kemmler *et al.*, 2015 investigated on Long-Term Exercise and Bone Mineral Density Changes in Postmenopausal Women-Are There Periods of Reduced Effectiveness. After 16 years of combined strength and endurance training a significant change was found on BMD of lumbar spine and femoral neck. The gap between exercise and control had increased significantly, indicating that exercise is an effective and sustainable option

to fight osteoporosis after menopause and suggest that exercise still will be reserved for motivated post-menopausal women willing and able to regularly attend intense exercise programme [14]. Sukkeaw *et al.*, 2015 compared between the effects of aerobic dance training on mini-trampoline and hard wooden surface on bone resorption, health-related physical fitness, balance, and foot plantar pressure in Thai working women. After 12-week training of both exercise group (Aerobic dance with mini trampoline and hard wooden surface) decreased the level of bone resorption markers (β cross laps) but increased the level of bone formation markers (P1NP). Balance and foot plantar pressure significantly better than control group. And the aerobic dance on mini trampoline group showed better leg muscular strength, balance and foot plantar pressure than aerobic dance on hard wooden surface. And considered appropriate exercise programme for working women [17]. Bimonte *et al.*, 2016 investigated on the effect of daily aerobic training based on walking on the affected women of abdominal obesity. And measured body composition, osteoblastic cell, Wnt β catenin signaling and after 12 months of intervention protocol subjects body composition was significantly improved β catenin signaling begin to increase after 4 months of training and diet and maximal effect reach after 12 months. And also increase the TCF and LEF protein as a same way. AdipoR1 protein level increase 3 fold after 12 months which was play a very crucial role for improved β catenin signaling and improved osteoblast homeostasis [19]. Bassey *et al.*, 1998 investigated on the effect of high impact exercise regime on Bone Mineral Density of pre and post-menopausal women. In the pre-menopausal exercise group BMD increased in all measured sites. The increase in the exercise group were significantly greater than those in the control group at the trochanter and femoral neck. And improvement in leg extension power and dynamic balance but not significantly. The changes in the dynamic balance were significantly associated with changes in the trochanteric BMD. Post-menopausal HRT, the exercise group improved more than the control women and significantly so for dynamic balance score increase. Body mass and composition did not change significantly and there was no significant difference in BMD either for deplete women or for those on HRT group. There was no change in markers of bone turn over. And finding reflect that change found after 12 months in the larger deplete group [4]. Watson *et al.*, 2015 investigated on heavy resistance and impact loading training programme on postmenopausal women for eight months of twice weekly 30 min and measures BMD, body composition, and functional performance. The HiPRT group increased height (0.4cm), femoral neck BMD, lumbar spine BMD, lean mass, back extensor strength, sit to stand, functional reach test, time up and go test than the control group. But there was no significant difference found in fat mass and whole body BMD between this group. The marked improvement in back extensor strength in the exercise group coincide with a nit benefit in stature of 7mm and enhance the quality of life and reduce the risk of osteoporosis. The finding of this study suggest that the HiPRT and impact loading was very time efficient, safe and effective therapeutic option for postmenopausal women with low to very low bone mass [18]. Bowtell *et al.*, 2016 investigated on short duration small sided

football and vibration exercise and observed the changes in Bone turn over markers. For this purpose, investigator divide three groups. Short duration (13.5 min.), long duration (4*13.5min.) football, and whole body vibration exercise (13.5min.). and concluded that 13.5 min small sided football exerting favorable effect on the markers of bone formation, osteocalcin and P1NP for up to 48 hours after exercise. In contrast the same duration of whole body vibration exercise elevated osteocalcin but not P1NP and there was not any evidence on metabolic effects. this acute response may contribute to musculoskeletal health in a variety of population after chronic small sided football [20]. Vainionpaa 2005 investigated on the effect of high impact exercise on bone density of pre-menopausal women. And revealed that regular high impact exercise increases the bone density at loaded site in lower extremities (Femoral neck, Intertrochanteric, Lumbar spine) but not at the non-weight bearing bone sites. These findings confirm the previous information on the positive effects of high impact exercise on weight bearing bones [6]. Walker *et al.*, 2000 investigated on longitudinal evaluation of supervised versus unsupervised exercise programs for the treatment of osteoporosis. Average percentage increase was observed for lumbar spine and femoral neck BMD in both hospital and home groups. Result of this study observed the fact that DPA and DXA differ slightly in their precision of measurement. And no correlation found between BMD and weekly caloric expenditure. The incidence of fracture was reduced over the 5-year study period either they participate supervised or unsupervised exercise programme [5]. Chubak *et al.*, 2006 investigated on the effect of exercise on Bone Mineral Density (BMD) and Lean Mass (LM) in post-menopausal women. And the result of this study suggest that one-year moderate intensity aerobic exercise does not affect total BMD in over weight post-menopausal women [7]. Englund *et al.*, 2015 investigated on the beneficial effects of exercise on BMD are lost after cessation: a 5-year follow-up in older post-menopausal women. And result of this study suggest that gains in bone density and neuromuscular functions achieved by training are lost after cessation of training. And concluded that continuous high intensity weight loading physical activity is probable necessary to preserve bone density and neuromuscular function in older women [8]. Bello *et al.*, 2014 investigated on the effect of a long term community exercise program on bone mineral density in post-menopausal women with pre diabetes and type 2 diabetes. And the result shows that there was no significant difference between control and multicomponent exercise group. But the Wilcoxon scores identified significant changes in fat free mass for both groups. For the multicomponent group there was a significant increase in fat free mass after 32 weeks where control group significant decrease. There were no changes in body fat content. And identified significant changes in ward triangle in multicomponent group. There were no changes in BMD for the femoral neck, greater trochanter, total hip and whole body [9]. Movaseghi, Sadeghi., 2015 investigated on effect of Three-year Multi-Component Exercise Training on Bone Mineral Density and Content in a Postmenopausal Woman with Osteoporosis: A Case Report. End of the multicomponent long term moderate training programme had last some weights but BMD and BMC both

improved in anteroposterior spine and hip although the increase in age and weight loss had adverse consequence on bone mass density and aggravates osteoporosis. This result indicates that this type of exercise programme would be beneficial for bone health of post-menopausal women ^[16]. Angin *et al.*, 2015 investigated on the effects of Clinical Pilates Exercises on BMD, physical performance and quality of life of women with postmenopausal osteoporosis. And result of this study found that BMD value of lumbar spine and physical performance increased in pilate group and decrease in control group. Pain intensity level in the Pilate group significantly decrease but unchanged for control group. Parameter of quality of life significantly increase for Pilate exercise group ^[10]. Hakestad *et al.*, 2015 exercises including weight vests and a patient education program for women with osteopenia: a feasibility study of the Osteo active rehabilitation program. After 1 year of follow up no significant difference between Osteo ACTIVE group and the control group were found for quadriceps strength, BMD, dynamic balance, walking capacity, physical activity level and Quality of life ^[12]. Jeihooni *et al.*, 2015 investigated on the effect of an educational program based on health belief model and social cognitive theory in prevention of osteoporosis in women. Immediately after 6 months after intervention, the experimental group showed a significant increase in the knowledge, perceived susceptibility, severity, benefits, barriers, self-efficacy, internal cues to action. Nutrition and walking performance compared to control group. Six month after intervention, the value of lumbar spine and hip BMD T score in the experimental group increased where decreasing for control group ^[13]. Liu *et al.*, 2015 investigated on the Effect of the Modified Eighth Section of Brocade on Osteoporosis in Postmenopausal Women: A Prospective Randomized Trial. After 12 month of exercise the VAS of chronic back pain of MESE plus Ca group and MESE group was lower than that of Ca and control group. BMD of MESE plus Ca group significantly increased than MESE group, though significant improvement of BMD shows in all three groups compared to control group. MESE and MESE plus Ca groups recurred much better performance up and go test, one leg stance test than those in the control and Ca group after the treatment of 12 months. This study indicates that this type of exercise programme is safe, feasible and well tolerated by previously untrained but otherwise healthy older women ^[15].

4. Conclusion

From this review it was concluded that physical activity was a very important non-pharma logical component for improved BMD and prevention for osteoporosis of pre and post-menopausal women. High impact loading activities may be supervised or unsupervised among with the awareness and nutrition were very necessary to improved BMD and prevent osteoporosis.

5. Acknowledgments

We are very thankful to all of the faculty members of Department of Physical Education, University of Kalyani. And few friends who give instruction for fulfillment of this work.

6. References

1. Sridevi A, Ragi V. Management of osteoporosis in women - A prevalence and interventional study. 2016; 3(4):140-145.
2. Singh T, Singh S, Sharma R, Kapila R. Prevalence and Analysis of Risk Factors of Osteoporosis in Persons of Above 40 Years Age Group in Amritsar - A Study of 500 Cases. J Med Thesis. 2013; 1(1):23-28. doi:10.13107/j.
3. Chow R, Harrison JE, Notarius C. Effect of two randomised exercise programmes on bone mass of healthy postmenopausal women. Br Med J (Clin Res Ed). 1987; 295:1441-1444. doi:10.1136/bmj.295.6611.1441.
4. Bassey EJ, Rothwell MC, Littlewood JJ, Pye DW. Pre- and postmenopausal women have different bone mineral density responses to the same high-impact exercise. J Bone Miner Res. 1998; 13(12):1805-1813. doi:10.1359/jbmr.1998.13.12.1805.
5. Walker M, Klentrou P, Chow R, Plyley M. Longitudinal evaluation of supervised versus unsupervised exercise programs for the treatment of osteoporosis. Eur J Appl Physiol. 2000; 83(4-5):349-355. doi:10.1007/s004210000266.
6. Vainionpää A, Korpelainen R, Leppäluoto J, Jämsä T. Effects of high-impact exercise on bone mineral density: A randomized controlled trial in premenopausal women. Osteoporos Int. 2005; 16(2):191-197. doi:10.1007/s00198-004-1659-5.
7. Chubak J, Ulrich CM, Tworoger SS, *et al.* Effect of exercise on bone mineral density and lean mass in postmenopausal women. Med Sci Sports Exerc. 2006; 38(7):1236-1244. doi:10.1249/01.mss.0000227308.11278.d7.
8. Englund U, Littbrand H, Sondell A, Bucht G, Pettersson U. The beneficial effects of exercise on BMD are lost after cessation: A 5-year follow-up in older postmenopausal women. Scand J Med Sci Sport. 2009; 19(3):381-388. doi:10.1111/j.1600-0838.2008.00802.x.
9. Bello M, Sousa MC, Neto G, *et al.* The Effect of a Long-Term, Community-Based Exercise Program on Bone Mineral Density in Postmenopausal Women with Pre-Diabetes and Type 2 Diabetes. J Hum Kinet. 2014; 43(1):43-48. doi:10.2478/hukin-2014-0088.
10. Angin E, Erden Z, Can F. The effects of clinical pilates exercises on bone mineral density, physical performance and quality of life of women with postmenopausal osteoporosis. J Back Musculoskelet Rehabil. 2015; 28(4):849-858. doi:10.3233/BMR-150604.
11. Anek A, Kanungsukasem V, Bunyaratavej N. Effects of aerobic step combined with resistance training on biochemical bone markers, health-related physical fitness and balance in working women. J Med Assoc Thai. 2015; 98(8):S42-S51. <http://www.jmatonline.com>.
12. Hakestad KA, Torstveit MK, Nordsletten L, Risberg MA. Effect of exercises with weight vests and a patient education programme for women with osteopenia and a healed wrist fracture: a randomized, controlled trial of the Osteo ACTIVE programme. BMC Musculoskelet Disord. 2015; 16(1):352. doi:10.1186/s12891-015-0811-z.

13. Jeihooni AK, Hidarnia A, Kaveh MH, Hajizadeh E, Askari A. The effect of an educational program based on health belief model on preventing osteoporosis in women. *Int J Prev Med.* 2015, 1-11. doi:10.4103/2008-7802.170429.
14. Kemmler W, Engelke K, von Stengel S. Long-Term Exercise and Bone Mineral Density Changes in Postmenopausal Women-Are There Periods of Reduced Effectiveness? *J Bone Miner Res.* 2016; 31(1):215-222. doi:10.1002/jbmr.2608.
15. Liu B-X, Chen S-P, Li Y-D, *et al.* The Effect of the Modified Eighth Section of Eight-Section Brocade on Osteoporosis in Postmenopausal Women. *Medicine (Baltimore).* 2015; 94(25):e991. doi:10.1097/MD.0000000000000991.
16. Movaseghi F, Sadeghi H. Effect of three-year multi-component exercise training on bone mineral density and content in a postmenopausal woman with osteoporosis: A case report. *Iran J Public Health.* 2015; 44(5):701-704. <http://ijph.tums.ac.ir>.
17. Sukkeaw W, Kritpet T, Bunyaratavej N. A comparison between the effects of aerobic dance training on mini-trampoline and hard wooden surface on bone resorption, health-related physical fitness, balance, and foot plantar pressure in thai working women. *J Med Assoc Thai.* 2015; 98(8):S58-S64. <https://www.ncbi.nlm.nih.gov/pubmed/26529816>.
18. Watson SL, Weeks BK, Weis LJ, Horan SA, Beck. BR. Heavy resistance training is safe and improves bone, function, and stature in postmenopausal women with low to very low bone mass: novel early findings from the LIFTMOR trial. *Osteoporos Int.* 2015; 26(12):2889-2894. <https://www.ncbi.nlm.nih.gov/pubmed/26243363>.
19. Bimonte VM, Fittipaldi S, Marocco C, *et al.* Physical activity and hypocaloric diet recovers osteoblasts homeostasis in women affected by abdominal obesity. *Endocrine.* 2016, 1-9. doi:10.1007/s12020-016-1193-1.
20. Bowtell JL, Jackman SR, Scott S, *et al.* Short duration small sided football and to a lesser extent whole body vibration exercise induce acute changes in markers of bone turnover. *Biomed Res Int.* 2016, 10. doi:10.1155/2016/3574258.