

Effects of high impact exercises on physical activity, bone mineral density, body mass index and body fat percentage among osteopenic young females

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Farah Iqbal , Amna Aamir Khan , Sumaira Imran Farooqui , Al-Wardha Zahoor 

Ziauddin College of Rehabilitation Sciences, Ziauddin University, Karachi, Pakistan

Abstract

Introduction. While osteopenia was once considered an older disease, it is now commonly seen in young individuals. The low bone density in the young population is alarming, leading to demands to improve physical activity. The study aims to determine the effectiveness of high impact exercise among young females with osteopenia.

Methods. A quasi-experimental study was conducted in the out-patient department of Jinnah Sindh medical university among forty-five females aged 18 to 30 years, with osteopenia. The participants were enrolled through convenience and a purposive sampling technique. A training program involving high impact exercise was given for 4 weeks following an initial screening using a DEXA scan. The outcome was measured with the pre- and post-intervention of an exercise program on bone mass density (BMD), body mass index (BMI) and body fat percentage (BFP).

Results. At the end of the four weeks, BMI, BMD and BFP showed significant improvements ($p < 0.05$). The BMD was improved from -1.95 to -1.89 . It was found that BMD was significantly associated with age (0.04).

Conclusions. Our study confirmed that the bone health of young females needs special attention to avoid osteoporosis in the future. The high impact exercises did show significant improvements through training, but additional studies are required on a larger scale.

Key words: osteopenia, bone mineral density, body mass index, body fat percentage, high impact exercise

Introduction

Osteoporosis is a nationwide condition marked by the degradation of bone mass and modification of bone architecture, leading to increased bone fragility and the risk of fracture [1]. The prevalence of osteoporosis is growing rapidly, particularly in developing countries. In Pakistan, it has been estimated that 40.18 million people have osteopenia while 9.91 million have osteoporosis out of a population of 171 million. This figure is expected to increase by 12.91 million by 2050 [2]. A recent study reported 43.7% of osteopenia and 14.6% of osteoporosis in premenopausal women, with 56.3% osteopenia and 85.4% osteoporosis in postmenopausal women, which implies a major risk of developing osteopenia at a very early age among females [3]. The low rate of literacy, economical dependency and lacks in family planning are also the factors which cause a decrease in bone mass due to repeated pregnancies and prolonged lactation decreasing the calcium levels among young females. Along with the advancement in technology, young people have indulged in using computer systems and cell phones, hence decreasing physical activities [4]. This situation has to be addressed by incorporating a physical activity that can result in significant enhancements in bone density and power in developing children and teenagers.

Exercise is one of the most modifiable variables associated with improved results in bone health, such as bone mineral density (BMD) and strength [5]. With the advent of time, the concept of exercise as medicine has been shifted to non-pharmacological treatments, mainly involving exercise and active lifestyles for maximizing peak bone mass in young females, conserving bone loss in middle age females and

decreasing bone loss rate, preventing falls and fractures in older age females [6]. It has been suggested that the identification of osteopenia during the younger ages can help to treat and reduce the changes in osteoporosis in the future. Furthermore, it is imperative and practical to prevent osteoporosis rather than to treat it [7]. WHO has recommended physical activity guidelines for public health, recommending children and adolescents to do at least an average of 60 min/day of moderate-to-vigorous intensity aerobic physical activities during the week; whereas adults aged 18–64 should do 150–300 min/week of moderate-intensity or at least 75–150 min of vigorous-intensity aerobic physical activity, and also muscle strengthening more than 2 times per week [8, 9]. These recommendations of moderate-intensity also apply to the elderly population [10].

McMillan et al. [11] reported that exercise and physical activity has the potential to deal with osteoporosis among females. Several studies have documented the effect of exercise on BMD among postmenopausal women with osteopenia and osteoporosis, yet the amount of exercise differs, depending on the individual. Recently, 24 weeks of aerobic exercise has shown significant improvement in BMD among postmenopausal women [12], while a study conducted among older adults showed improvements in BMD after 12 weeks of osteoanabolic training [13]. On the contrary, circuit training has also been used to produce positive effects on bone mineral markers in older women [14]. There is a disparity present in the literature regarding the type and amount of exercise needed to improve BMD, and this study aims to determine the effects of high impact training on body mass index (BMI), body fat percentage (BFP) and BMD among young females with osteopenia.

Correspondence address: Al-Wardha Zahoor, Ziauddin University, 4/B Shahrah-e-Ghalib Rd, Block 6 Clifton, Karachi, Pakistan 75600, e-mail: alwardha.zahoor@zu.edu.pk, alwardha.zahoor@gmail.com; <https://orcid.org/0000-0002-5446-9950>

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Subjects and methods

The quasi-experimental study was conducted between September 2018 and October 2019, at the outpatient department of Jinnah Sindh Medical University (JSMU). The young adults aged 18 to 30 years were voluntarily enrolled in JSMU through a convenient and purposeful sampling technique that was available at the time of the study. Almost all the 97 participants who volunteered to be a part of this study were initially screened through a peripheral DEXA scan to be eligible, according to the inclusion criteria. Individuals with a T-score between -1.0 and -2.5 were included in the study. Those individuals who had a previous history of bone disease, a recent fracture within the last year, an ambulatory issue and were taking any drugs that could interfere with bone mass or pregnancy were excluded from the study. Only 45 participants were found to be eligible following the screening process. Enrolment of the participants is illustrated in Figure 1.

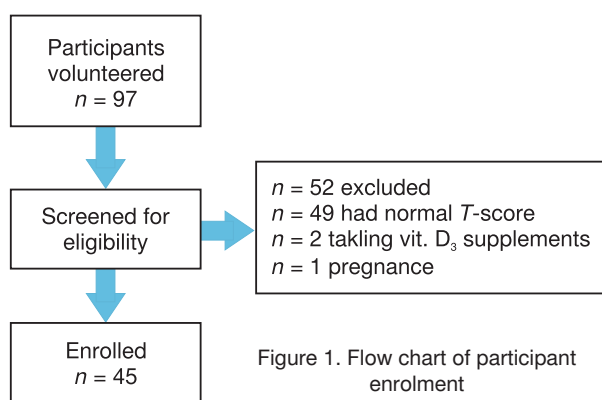


Figure 1. Flow chart of participant enrolment

Written informed consent was taken for their voluntary participation before initiating any intervention. Following the consent, the general demographic data of the participants were taken, including marital status, education level and socioeconomic status. All the subjects were given guidance regarding

the explanation of the study. The training program was designed according to the American College of Sports Medicine for physical activity that includes moderate or high intensity strengthening of the major muscles in the body for > 2 days per week. The participants were asked to perform 10 minutes of warm-up exercises involving a moving range of motions and rhythmic movements for the different joints of the body, followed by a high impact training session that included skipping (50 jumps) and then resistive exercise for the major muscles of the body (deltoid, biceps, triceps, pectoralis major, abdominals, latissimus dorsi, gluteus maximus, hamstring, quadriceps, gastrocnemius), 1 set for each muscle group (1 set -15 repetitions). Resistive exercises included bicep curls, tricep halter, lateral raise, chest fly, abdominal crunch, one arm row back, bent leg kickbacks, squatting, hamstring curls and calf rises, as shown in Figure 2. The intensity of the weights was measured with 1 repetition maximum. The intervention was given for a total of 4 weeks, 3 days per week, with each session lasting approximately 80 minutes. The BMD through peripheral DEXA scan, which has good reliability and validity [15], was measured at the right-sided calcaneal bone, before and after the intervention, the BMI through weight and height and BFP via the skinfold thickness method measured at the tricep, suprailium and thigh.

Data analysis

The data were analysed through the statistical package for social sciences, version 2.0. Mean and the standard deviation were analysed for a quantitative variable, like age. Frequency and percentage were calculated for a categorical variable. The normality test was analysed for the distribution of data. To compare the differences between pre- and post-body mass density and BFP, a paired t-test was analysed while the Wilcoxon signed-rank test was applied for BMI. A chi-square test was analysed for the association of the demographic variable with BMD, and a Pearson correlation was identified in BMD, BMI and BFP. The p-value was set at < 0.05 to be considered significant.



Figure 2. Resistance training performed in the study

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Departmental review committee of Ziauddin University (approval No.: MED/SH/30/18).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

Between September 2018 and October 2019, a total of forty-five participants with osteopenia and a mean age of 23.97 ± 2.02 were asked to undertake high impact exercises. Most of the participants were single (68.9%) and were of lower middle class (37.8%). The average education level was intermediate (51.1%), see Table 1.

Table 1. General demographic data of the patients

Variables	n (%)	Bone mineral density	
		χ^2	p-value
Age (mean \pm SD)	23.97 ± 2.02	386.3	0.04
18–21	5 (11.1)		
22–25	34 (75.5)		
26–30	6 (13.3)		
Marital status		37.2	0.3
Single	31 (68.9)		
Married	14 (31.1)		
Education		103.9	0.4
Primary	3 (6.7)		
Secondary	8 (17.8)		
Intermediate	23 (51.1)		
Higher education	11 (24.4)		
Socioeconomic status		106.08	0.3
Elite	–		
Upper middle	14 (31.1)		
Lower middle	17 (37.8)		
Working class	8 (17.8)		
Poor	6 (13.3)		

The pre-reading of the mean T-score for BMD was -1.95 ± 0.42 , which improved to -1.89 ± 0.41 following the 4 weeks of high impact training exercises. A significant result was found in BMD, with $p < 0.05$. The BFP at the start of the study was found to be 26.70 ± 2.6 , which was reduced to 24.57 ± 3.12 . The pre-post analysis suggested significant results on BFP, with a $p < 0.05$ and a mean difference of -2.12 (-2.62 to -1.63). The exercise was also found to be effective at improving body BMI, as the median was 24 before the intervention and improved to 22 afterwards. The effect of the intervention strategies was found to be significant for BMI as well, with a $p < 0.05$ and a Hodges-Lehmann median difference of -1.00 (-1.50 to -1.00), see Table 2.

Table 2. Within the group analysis of BMD, BFP and BMI

Item	Baseline	Post 4 weeks	Mean difference	p-value
BMD*	-1.95 ± 0.42	-1.89 ± 0.41	-0.054	< 0.00
BFP*	26.70 ± 2.6	24.57 ± 3.12	2.12	< 0.00
BMI**	23.57 ± 2.64	22 ± 4.28	-1	< 0.00

BMD – bone mineral density, BFP – body fat percentage, BMI – body mass index

* paired t-test, ** Wilcoxon signed rank test

The demographic variables were analysed for any association with BMD; however, none of them meaningfully associated with the dependent variable except age ($p = 0.04$).

The correlation to determine the relationship of BMD to BMI and BFP is described in Table 3. A significant moderate and an inverse correlation was found between BMD and BMI ($p = 0.003$); conversely, there was an insignificant correlation found between BMD and BFP.

Table 3. Correlation of BMD with different variables

Variable	Correlation coefficient (r)	p-value
BMI	-0.4	0.003
BFP	0.1	0.2

BMI – body mass index, BFP – body fat percentage

Discussion

The results of the present study were based on four weeks of high impact training using rope skipping with resistance training. The protocol was based on the American College of Sports Medicine and was found to be effective in improving BMD, BMI and reducing the percentage of body fat. The regular participation in physical activity helped to reduce the functional declines and physiological alterations that occur with ageing, and could lead to health improvements, was reported earlier in the study where the combination of strength and aerobic exercises was an effective strategy for enhancing neuromuscular, cardiorespiratory function and ultimately retaining functional capacity during ageing [16]. It has been documented in the literature that strength training and resistance exercises help to increase muscle endurance and power, leading to improved BMI and a reduced percentage of body fat [17].

Numerous studies mentioned that osteopenia was a major problem in the younger female population, aged 20 to 23 years, and was more susceptible to low bone density or osteoporosis [2, 18]. A study reported that 10 weeks of short-term, group-based aerobic exercise did not show a significant improvement in BMD [19]. On the contrary, our study showed significant improvements in BMD, BMI and BFP, which might be due to the differences in the exercise protocol followed and the measurement tools used.

Another study enrolled 400 post-menopausal women into two groups, giving intervened aerobic exercises to one group with moderate intensity, 150 minutes per week, and another with high intensity, 300 minutes per week, and observed that BMD was higher than that of the moderate-intensity group [20]. It has been found that exercise has positive benefits on BMD; however, there was no documentation related to the form, intensity, length and frequency of the exercise programs [21]. Exercise with high impact can improve BMD, but there have been mixed findings in women. In premenopausal women,

progressive, high-impact, unilateral exercise lasting for 6 months has shown enhanced femoral neck BMD [22]. However, it only lasted for 4 weeks. Moreover, a systematic review was carried out that indicated the good impact on the lumbar backbone in both excessive-effect and non-impact sports, while the handiest high-impact exercise brought good impact at the femoral neck [23].

The low BMI was also proven to be related to low body weight and, for this reason, thinner girls were shown to be more liable to the danger of osteoporosis [24]. High impact exercise and resistance training was found to be a very efficient method of enforcing a mechanical load. Exercise is recommended for both osteoporosis prevention and treatment, as well as an appropriate exercise plan for maintaining bone health. Indeed, our study showed greater improvements in BMD in osteopenic females.

Limitations

There are certain limitations in the current study, as the study design was quasi-experimental; we did not use a control group to confirm the findings as there may be a confounding variable to produce such results. Further, it was recommended for future studies to incorporate a larger sample size and both genders, so that the results can be generalizable and used to compare the different genders.

Conclusions

High impact exercise, including jumping and resistance exercise, produces significant improvements in body mass density and reduces BFP and BMI in young females having osteopenia.

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Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

Authors state no conflict of interest.

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