

Impact of Sporting activities on Bone Mineral Density

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Abstract

It is known that participating in sports can have a beneficial effect on bone mass. However, it is not well established which type of sporting activity is more beneficial for increased bone mineral density. The objective of the study was to determine the relationship between impact of sporting activities and bone mineral density. As a part of study, bone mineral density of sportspersons was compared with age-matched non-sportspersons. Research design for present study was a cross-sectional design. A total of 70 subjects in the age group of 25-75 years participated in the study. They were divided into two groups: (1) sportspersons group (n=35, mean age=48.05 years, mean BMI=25.99 kg/m²) and (2) non-sportspersons group (n=35, mean age=48.14 years, mean BMI=26.29 kg/m²). Bone mineral density was measured by using Osteopro-ultrasound bone mineral density system. The results revealed statistically significant difference with t value of 4.2061 (**p<0.05**), indicating that sportspersons had higher bone mineral density than their non-sports cohort. A statistically significant positive relationship was exhibited ($r = 0.463$) between impact of sporting activities and bone mineral density which implies that sportspersons involved in high impact sports (basketball, football, and athletics) have greater bone mineral density as compared to athletes involved in moderate impact sports (table tennis and cycling). It is concluded that bone mineral density is higher in sportspersons than their non-sports cohort and sportspersons involved in high impact sports possess substantially higher bone mineral density than sportspersons involved in moderate impact sports.

Keywords: BMI, Bone Mineral Density, High Impact Activities, Low Impact Activities

Introduction

Bone mineral density is used in clinical medicine as an indirect indicator of osteoporosis and fracture risk. There is a statistical association between poor bone density and higher probability of fracture. Fragility fractures, which result from a fall from no greater than standing height, are a significant public health problem leading to much medical cost, inability to live independently, and even risk of death. Bone density measurements are used to screen people for osteoporosis risk and to identify those who might benefit from

measures to improve bone strength. It is estimated that around 40% of US white women and 13% of US white men aged 50 years will experience at least one clinically apparent fragility fracture in their lifetime. At age 50, a white woman has a 17% chance of sustaining a hip fracture, 15% chance of vertebral fracture and 16% chance for forearm fracture, with comparable figures of 6%, 5% and 2.5% respectively, for fractures in white males (Cummings & Melton, 2002). The 1st year total direct cost of osteoporotic fractures is estimated to be 25 billion Euros in Europe (Melton *et al*, 1992). The report of

the *European Commission (1998)* estimates an increase in the incidence of hip fractures in Germany from 117,000 in the year 2000 to 240,000 in the year 2040 (*Hausler et al, 2007*). Thus, osteoporosis and osteoporotic fractures have become one of the major health problems in western countries (*Kannus et al, 1999*). Nevertheless, in Asia, Osteoporosis is greatly under-diagnosed and undertreated even in the most high risk patients who have already fractured. The problem is particularly acute in rural areas. In the most populous countries like China and India, the majority of the population lives in rural areas, where hip fractures are often treated conservatively at home instead of by surgical treatment in hospitals (*International Osteoporosis Foundation, 2009*).

In India, osteoporosis is highly prevalent, with an estimated 30 million women diagnosed to have osteoporosis (*Shah & Savardekar, 2005*). Expert groups peg the number of osteoporosis patients at approximately 26 million (2003 figures) with the numbers projected to increase to 36 million by 2013 (*Osteoporosis Society of India, 2003*). In a study among Indian women aged 30-60 years from low income groups, BMD at all the skeletal sites were much lower than the values reported from developed countries with a high prevalence of osteopenia (52%) and osteoporosis (29%) thought to be due to inadequate nutrition (*Shatrugna et al, 2005*). Thus, it is critically important to diagnose osteoporosis at the earliest. Currently, bone mineral density testing is the most objective method to diagnose osteoporosis in asymptomatic individuals (*National Osteoporosis Foundation, 1998*). Because bone mineral density accounts for 70% of bone strength, low bone mineral density is

the greatest predictor of risk for bone fractures (*Follin & Hansen, 2003*). Consequently, a better understanding of mechanisms leading to low bone mineral density is a crucial step in the identification of patients at risk of osteoporosis and for designing therapeutic and prevention programs. Bone mineral density peaks at 20-30 years of age in both women and men. Remodelling maintains bone mass and mechanical competence in the adult skeleton by replacing the damaged and degraded bone tissue with new tissue. With ageing and osteoporosis, however, the remodelling tends to remain uncoupled in that packets of bone removed during resorption are not completely replaced during bone formation, resulting in a net loss of bone (*Suominen, 2004*). Thus, bone is metabolically active tissue with continuous remodelling occurring throughout life. Accordingly, it is reasonable to believe that mechanical force exerted on skeleton is of critical importance to maintain and improve bone mineral density. Animal studies have demonstrated a significant relationship between mechanical loading and bone formation. In humans, physical exercise, especially weight bearing activity has been reported to have beneficial effects on the skeleton in both adolescent and the elderly (*Scerpella et al, 2003*). Bone mineral density has been demonstrated to be higher in male athletes than in less active individuals (*Pettersson et al, 1999*). Additionally, athletes especially those who are strength trained, generally have greater bone mineral density than non-athletes, and that maximum strength levels and muscle mass correlates with bone mineral density (*Chilibeck et al, 1999*). A number of studies have demonstrated a beneficial effect of

physical exercise and sport training on bone mineral density (Dalen & Olsson, 1971; Cooper et al, 1988; Snow et al, 1992; Yung et al 1994; Bennell et al, 1997; Blanchet et al, 2003).

Overall, these studies provide evidence that there is a protective effect of sporting activity on bone mineral density. However, whether there is a direct relationship between the impact of various sporting activities and bone mineral density is less clear. To examine this issue further, the present study was undertaken to investigate the relationship between sporting activity and bone mineral density. As a part of study bone mineral density of sportspersons was compared with age-matched non-sportspersons.

Material and Methods

Participants: This was a cross-sectional study, which was performed in the Department of Physiotherapy, Punjabi university, Patiala in accordance with ethical considerations of the Institute. A total of 70 subjects in the age group of 25-75 years participated in the study. Informed consent was taken from all the participants prior to the study. They were divided into two groups: (1) sportspersons group (n=35, mean age=48.05 years, mean BMI=25.99 kg/m²) and (2) non-sportspersons group (n=35, mean age=48.14 years, mean BMI=26.29 kg/m²). Males and females engaged in any sport were included in sportspersons group. Males and females less than 25 years and more than 75 years were excluded. Subjects with a previous history of bone disease, illness or drug use that could affect bone mass were excluded. All the subjects underwent anthropometric measurement. The subject's vitals were examined and the detailed physical

examination was done. The sportspersons were ranked from 1- 10 for moderate to high impact sports including table tennis, cycling, throwing, wrestling, badminton, gymnastics, athletics, handball, football and basketball respectively.

Bone mineral density: The subjects were then made to undergo, bone mineral density test. Bone mineral density was measured by using Osteopro - ultrasound bone mineral density system. The bone mineral density was measured in the form of T- score. The subjects were classified as normal if T-scores were ≥ -1 , osteopenic if the lowest T-score was between -1 and -2.5 and osteoporotic if either T-score was ≤ -2.5 .

Results

Table 1: Comparison of mean value for age, BMI and bone mineral density (BMD) between sportspersons and non-sportspersons

| Variables | Sportspersons | | Non-Sportspersons | | T value | P value |
|--------------------------|---------------|-------|-------------------|-------|---------|---------|
| | Mean | SD | Mean | SD | | |
| Age (yrs) | 48.05 | 15.23 | 48.14 | 14.71 | 0.02 | P>0.05 |
| BMI (Kg/m ²) | 25.99 | 3.25 | 26.29 | 4.83 | 0.30 | P>0.05 |
| BMD (T-score) | -0.98 | 1.76 | -2.56 | 1.36 | 4.21* | P<0.05 |

The data was analyzed with the help of SPSS 13 software. Initially mean and standard deviation were calculated of both sportspersons and non- sportspersons. Later on, unpaired t test was used to analyze the significant difference of variables between sportspersons and non-sportspersons. Pearson correlation was applied to establish the relationship between the impact of various sporting activities and bone mineral density. Significance level was set at 0.05. Table 1 describes, the Mean values and T values of Age, BMI and Bone mineral density (BMD) for the sportspersons and non-

sportspersons. The t value of Age, BMI and BMD is 0.24, 0.30 and 4.21 respectively, which is statistically significant for bone mineral density (BMD) and non-significant for Age and BMI indicating that two groups are homogenous and bone mineral density of sportspersons is more than non-sportspersons.

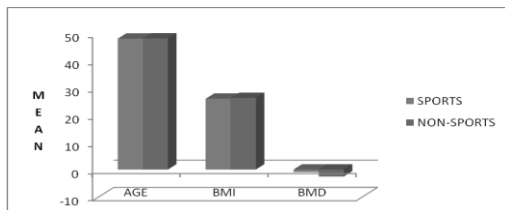


Figure 1: Comparison of mean value for Age, BMI and Bone mineral density (BMD) between sportspersons and non-sportspersons

Table 2: Description of the Mean and SD of bone mineral density for different sporting activities

| Name of Sporting Activity | Bone Mineral Density (T-SCORE) | |
|---------------------------|--------------------------------|-------|
| | MEAN | SD |
| Table tennis | -2.373 | 0.546 |
| Cycling | -2.473 | 1.67 |
| Throwing | -2.03 | 1.668 |
| Wrestling | 0.515 | 0.219 |
| Badminton | -0.72 | 1.33 |
| Gymnastics | 0.075 | 1.378 |
| Athletics | 0.078 | 2.105 |
| Handball | -1.123 | 0.779 |
| Football | -1.295 | 0.799 |
| Basketball | 0.232 | 2.014 |

Table 3 describes, about the correlation of impact of sporting activities with BMD. The correlation (r) of impact of sports with BMD is 0.463 which is statistically significant indicating that with an increase in impact of sporting activities, there is an increase in bone mineral density.

Table 3: Correlation of Bone mineral density (BMD) with impact of sporting activities

| Variable | Pearson Correlation | N | Sig. |
|--------------------------------------|---------------------|----|----------|
| BMD Vs Impact of sporting activities | 0.463 | 35 | P < 0.05 |

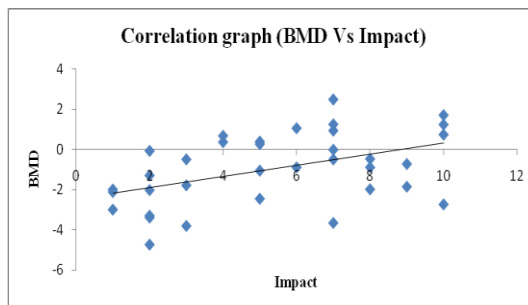


Figure 2: Correlation graph of Bone mineral density (BMD) Vs impact of sport

Discussion and Conclusion

Bone mineral density is the amount of mineral per square centimeter of bones, used in clinical medicine as an indirect indicator of osteoporosis and fracture risk. The primary intent of the present study was to evaluate the impact of sporting activities on bone mineral density. To achieve this objective, the research work was carried out in two phases:

Phase I: Comparative study in which, bone mineral density of sportspersons was compared with that of non- sportspersons and

Phase II: Correlational study in which the relationship between the impact of different sporting activities and bone mineral density was investigated amongst sportspersons.

The results of the comparative study revealed statistically significant difference in the mean values of bone mineral density between sportspersons and non- sportspersons with t value 4.2061, indicating that sportspersons had significantly greater bone mineral density than their non-sports cohort. It is imperative here to mention that the difference in mean values of age and body mass index between sportspersons and non-sportspersons was found to be statistically non- significant (t

value=0.0240 and 0.3043 respectively), suggesting that the two groups in the present study, were homogenous in terms of age and body mass. These findings further suggest that sporting activity is a reasonable indicator of bone mineral density and may exert its effects independently of age and body mass.

Thus, findings of present study were suggestive of higher bone mineral density and therefore better bone strength in sportspersons when compared with age matched non- sportspersons. This is well in line with the study done by *Andreoli et al. (2001)* who stated that the athletes had significantly greater bone mineral density than the non-athletes of similar age. It appears that mechanical stress in the form of sporting activity may be a major factor in bone mineralization, though the physiological mechanisms involved in the response of bone cells to mechanical stress are still unclear. A possible explanation may be that osteocytes, acting as mechanoreceptors, respond and release chemical factor capable for promoting osteoblast proliferation at the local bone site. Thus, increased mechanical load is a contributory mechanism in sportspersons. However, it is possible that these beneficial effects of sporting activities on bone mineral density are impact reliant. Because the present study has demonstrated a significant relationship ($r = 0.463$) between impact of sporting activity and bone mineral density, indicating that with an increase in impact of sport, there is an increase in bone mineral density. The sportspersons included in the present study were athletes, throwers, wrestlers, gymnasts, cyclists, basketball, football, handball, badminton and table tennis players. With all of them being the national level

players, it was observed that athletes involved in high impact sports (basketball, football, and athletics) had greater bone mineral density as compared to athletes involved in moderate impact sports (table tennis and cycling). These findings suggest that sporting activities having higher impact and produce greater effects on bone remodelling than sporting activities with lower or moderate impact. This may be because of the application of strain magnitudes and rates of force development closer to the optimum for stimulating bone remodelling.

These findings of the present study support the previous reports of the positive effects of high impact activities on bone mineral density. The study done by *Block et al (1989)* has reported that weight bearing forms of vigorous exercise are associated with greater levels of bone mineral density. Another study done by *Lanyon et al (1989)* stated that physical activity involving high impact or weight bearing movements provides an osteogenic stimulus that may enhance bone mass at any age. *Heinonen et al (1993)* reported that the form of exercise has been shown to affect bone mineral density since weight bearing activities are associated with higher BMD while non-weight bearing exercises such as cycling and swimming do not seem to increase bone mineral density in young adults. *Barlet et al (1995)* have demonstrated the importance of weight bearing physical activity as well as mechanical loading for maintaining skeletal integrity. *Fehling et al (1995)* also demonstrated that a group of athletes who is engaged in a sport that loads the skeletal system with high magnitude, short duration stimuli had greater BMD than athletes who participated in a sport that actively taxes

their muscular system, but does not evoke ground reaction forces, suggesting that the type of mechanical loading regimen plays an integral part in influencing bone mineral density. Klesges et al., (1996) has also shown that training using loaded weight bearing exercises causes significant higher bone mineral density. Regular exercise, especially resistance and high impact activities, contributes to development of high peak bone mass and may reduce risk of falls and osteoporotic fracture in later life (Wallace & Ballard, 2000). It has been widely accepted that engaging in weight bearing activity can elicit significant positive bone mass adaptation (Blanchet et al., 2003).

On the whole, these studies, done over the period of last three decades, suggest that impact of physical exercise and sport training is an important factor in the acceleration and maintenance of bone mineral density. The present study has also demonstrated a significant correlation between the impact of sporting activity and bone mineral density. Furthermore, the study has revealed an osteogenic effect of sporting activity that is independent of age and body mass of an individual. In conclusion, present study analysis reveals that sporting activity has a positive effect on bone status and such a positive effect is increased by the higher impact of sporting activity that involves weight bearing loading. This implies that age-related loss in bone mineral density is preventable by the appropriate exercise program that includes increased mechanical loading with sporting activity of higher impact. Clinically, this information is important, as it can be utilized while designing preventive and treatment plans for osteopenic and osteoporotic individuals respectively.

Acknowledgement The authors are grateful to University grants commission, New Delhi, (India) for funding the research project and Institutional ethical committee, Punjabi University, Patiala, (India) for approving the project.

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