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# **Sports and Bone Health: The Impact of Physical Activity on Bone Mineral Density**

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## **Abstract**

### **Introduction**

Bone health is a critical component in maintaining physical fitness and overall quality of life. Among the factors influencing bone tissue structure, an appropriate level of physical activity plays a pivotal role. Numerous studies in the literature report the beneficial effects of regular exercise on bone mineral density (BMD).

### **Objective**

This study aims to review current scientific reports and summarize the state of knowledge regarding the impact of physical activity on bone mineral density.

## **Materials and Methods**

A review of randomized controlled trials (RCTs) published between 2022 and 2024 was conducted to evaluate the effects of physical activity on bone mineral density. Four studies meeting predefined selection criteria were identified.

## **Results**

The findings demonstrate that physical activity significantly impacts bone mineral density. Both aerobic and resistance training contribute to increased BMD. Resistance training, particularly when combined with other forms of physical activity or dietary interventions, offers notable benefits, especially in populations with excess body fat.

## **Conclusions**

Regular physical exercise, particularly resistance training, plays a significant role in improving bone mineral density.

## **Introduction**

Bone health is a fundamental component of physical fitness and quality of life. The skeletal system is essential for maintaining stability and facilitating movement. Various factors influence the maintenance of healthy bone tissue, including diet, lifestyle, genetic predisposition, and physical activity. Research indicates that genetic factors account for 60 - 80% of peak bone mineral density, with the remaining 20 - 40% influenced by diet, lifestyle, and physical activity. [1] Physical activity has garnered attention as a modifiable factor positively influencing bone mineral density. Longitudinal studies have revealed that systematic exercise not only increases BMD but also reduces the prevalence of osteoporosis in older populations. [2,3] Given the contemporary sedentary lifestyle and rising prevalence of lifestyle diseases, the significance of physical activity for bone health has become increasingly relevant. This study examines the influence of various forms of physical activity on bone mineral density.

## **Aim of the study**

The primary objective of this research is to review and summarize current scientific knowledge on the effects of physical activity on bone mineral density. The analysis is based on a review of scientific literature and the results of recent clinical studies to provide a comprehensive understanding of the current state of knowledge and identify areas requiring further research.

## **Materials and Methods**

A review of the available literature was conducted in December 2024 using the PubMed database. Articles were identified using the keywords “physical activity” and “bone mineral density.” The analysis was restricted to the most recent publications from 2022 to 2024. The search results were limited to clinical studies conducted in adult populations. Following an initial screening, 37 randomized controlled trials (RCTs) were identified. The inclusion criteria were as follows:

1. Randomized controlled trials (RCTs),
2. Interventions involving increased physical activity,
3. Studies published in peer-reviewed journals.

The exclusion criteria included:

1. Studies that were not RCTs.

## Results

The final analysis included four studies published between 2022 and 2024. The characteristics of the studies are presented chronologically in Table 1.

Lead Author, Publication Date:	Participants and Age:	Study Duration:	Inclusion Criteria:	Intervention Group:	Control Group:
Videira-Silva A, September 2023 [4]	165; 15.1 [±1.6] years	6 months	BMI $\geq$ 85th percentile	Weekly supervised physical exercise sessions	Low physical activity
Kobayashi T, March 2023 [5]	28; 18–25 years	5 months	Women aged 18–25 with a normal menstrual cycle (26–35 days) over the past year	Squats and deadlifts at 60–85% 1RM, one session of five sets of five repetitions, twice weekly for 16 weeks	Non-sporting control
de Araújo TB, November 2022 [6]	43; 58 $\pm$ 4.06 years	22 weeks	Patients with stage 2 chronic kidney disease	Supervised, progressive resistance exercises performed at home	Low physical activity
Madrid DA, January 2023 [7]	249; mean age 66.8 years	18 months	Obesity (BMI: $33.8 \pm 3.6$ kg/m <sup>2</sup> ), cardiovascular disease (CVD; 26.1%), and/or metabolic syndrome (84.3%), self-reported mobility disability (difficulty walking $\frac{1}{4}$ mile)	Weight loss induced by diet combined with either aerobic or resistance training	Weight loss induced by diet alone

**Table 1.** Characteristics of the scientific studies included in the literature review.

Videira-Silva et al.

The study investigated the impact of physical activity on bone mineral density (BMD) changes in young individuals undergoing weight-loss diets. Participants in the intervention group attended weekly supervised exercise sessions over six months. The analysis revealed a significant increase in BMD among participants. No differences were observed in BMD between groups engaging in aerobic training versus combined exercises. Nine participants experienced a decrease in BMD, correlated with an increase in waist circumference relative to height. No significant association was found between BMD and the consumption of various types of fats, including saturated and polyunsaturated fats.

Kobayashi et al.

This study examined the effect of resistance training on BMD in female long-distance runners. The control group consisted of women with moderate physical activity levels who were not athletes. The intervention group performed squats and deadlifts at 60–85% of their one-repetition maximum (1RM), completing one session of five sets with five repetitions twice weekly for 16 weeks. Post-intervention measurements of total body BMD, lumbar spine BMD (L2–L4), and femoral neck BMD indicated significant increases in the intervention group. Subgroup analysis showed that participants who combined resistance training with long-distance running experienced greater BMD improvements than those who engaged in running alone.

de Araújo et al.

Researchers assessed the effects of home-based training on BMD in patients with chronic kidney disease. The intervention group performed supervised progressive resistance exercises for 22 weeks. The study found that the intervention led to increases in BMD, improved functional performance, and reduced inflammatory markers. Additionally, a decrease in osteopenia cases was observed within the intervention group. The study also highlighted the protective effects of physical activity on kidney physiology, demonstrated by improved glomerular filtration rates.

Madrid et al.

This research evaluated the impact of exercise combined with a dietary weight-loss program on bone quality changes in older adults with obesity. Participants were randomly assigned to one of three groups: diet-induced weight loss (WL), WL combined with aerobic training, or WL combined with resistance training. The analysis revealed that resistance training was more effective than aerobic exercise or diet alone in improving muscle quality.

The study also demonstrated that bone density improves with higher muscle mass, while excess fat tissue negatively correlates with bone quality. Additionally, weight gain (as indicated by BMI) can adversely affect bone density. However, no association was observed between bone health and fat intake, regardless of the type of fat consumed.

## **Discussion**

A review of the literature highlights the significant impact of physical activity on bone mineral density (BMD). The findings confirm that both aerobic and resistance training contribute to increases in BMD. Furthermore, resistance training, particularly when combined with other forms of physical activity or weight-loss diets, appears to provide specific benefits, especially for populations with excess fat tissue.

The purpose of this study was to investigate the influence of diet and changes in physical activity (PA) on bone mineral content (BMC) and BMD in adolescents with obesity as part of a weight-loss program. This focus is particularly relevant because this population may be at an elevated risk of early-onset osteopenia or osteoporosis. These risks arise not only due to the adverse effects of obesity and metabolic syndrome (MS) on bone metabolism [8].

A review of recent studies further suggests that appropriately tailored exercises can be an effective intervention for individuals with chronic conditions, such as kidney disease. In this group, resistance exercises not only improved bone density but also positively influenced kidney function and reduced inflammation.

Physical activity, particularly resistance training, is a critical factor in the prevention and management of osteopenia and other bone density disorders. Individuals with osteopenia are especially vulnerable to low-energy fractures, underscoring the importance of finding effective strategies to improve BMD and reduce the risk of injury-related complications [9].

The findings of this review emphasize the need for further research to better understand the mechanisms through which exercise impacts the skeletal system and its synergistic effects with diet and other lifestyle factors.

## **Disclosure**

The author does not report any disclosures.

## **Author contribution**

The author is responsible for the conception, literature review, data analysis, and writing of the manuscript. All aspects of the study were conducted independently by the author.

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## **Informed Consent Statement**

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## **Data Availability Statement**

Not applicable.

## **Conflicts of Interest**

The author declares no conflicts of interest.

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