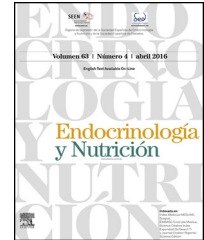




# ENDOCRINOLOGÍA Y NUTRICIÓN

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## REVIEW ARTICLE

### Impact of obesity on bone metabolism<sup>☆</sup>

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#### KEYWORDS

Obesity;  
Bone turnover;  
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**Abstract** High weight is a protective factor against osteoporosis and risk of fracture. In obesity, however, where overweight is associated to excess fat, this relationship does not appear to be so clear, excess weight has sometimes been associated to decreased bone mass. Obesity interferes with bone metabolism through mechanical, hormonal, and inflammatory factors. These factors are closely related to weight, body composition, and dietary patterns of these patients. The net beneficial or harmful effect on bone mass or risk of fracture of the different components of this condition is not well known. We need to recognize patients at a greater risk of bone disease related to obesity to start an adequate intervention.

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#### PALABRAS CLAVE

Obesidad;  
Remodelado óseo;  
Adipocitocinas;  
Vitamina D

#### Influencia de la obesidad sobre el metabolismo óseo

**Resumen** El peso elevado es un factor protector de la osteoporosis y el riesgo de fractura. Aunque en el caso de la obesidad, donde el sobrepeso se encuentra asociado a un acúmulo excesivo de grasa, esta relación no parece estar tan clara y, en ocasiones, se ha relacionado la misma con un descenso de la masa ósea. La obesidad interfiere con el metabolismo óseo a través de factores mecánicos, hormonales e inflamatorios. Estos factores se encuentran íntimamente relacionados con el peso, composición corporal y patrón dietético de estos pacientes. El efecto perjudicial o beneficioso neto sobre la masa ósea o sobre el riesgo de fractura de los distintos componentes de esta enfermedad todavía no es bien conocido. Es necesario reconocer a aquellos pacientes con mayor riesgo de padecer enfermedad ósea relacionada con la obesidad para la realización de una intervención adecuada.

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## Introduction

Bone is an active organ on which a great number of factors act. Osteoporosis and increased risk of fracture are conditions which have gained relevance in recent years because of gradual aging of the population and their effects on quality of life and financial impact for society as a whole. In 2010, prevalence rates of osteoporosis in population older than 50 years in the European Union were 6.6% in males and 22.1% in females, and 5.5% in the overall population. In the most populated countries (Germany, France, Italy, Spain, and United Kingdom), approximately 21% of females aged 50 to 84 years meet the criteria for osteoporosis.<sup>1,2</sup>

Obesity is the most prevalent metabolic disease in developed countries and one of the main causes of morbidity and mortality. In 2008, the WHO estimated that 1400 million adults over 20 years were overweight, more than 200 million males and approximately 300 million females were obese. To sum up, one out of every 10 people in the worldwide adult population were obese.<sup>3</sup> According to the ENRICA study, conducted from 2008 to 2010 in a Spanish population, prevalence of obesity in Spain was 22.9% (24.4% in males and 21.4% in females).<sup>4</sup>

The relationship between overweight and bone metabolism is controversial. Increased body weight has been considered a factor that increases bone mass and decreases risk of fracture.<sup>5</sup> On the other hand, increasing evidence has been found in recent years showing that overweight, particularly accumulation of fat mass, may have a negative impact on risk of fracture, particularly when adjusting for bone mass of the patient.<sup>6</sup>

The available evidence shows that postmenopausal women with obesity have an increased risk of humeral fractures and osteoporotic fractures of the ankle and lower limb, and a decreased risk of hip, pelvis, and wrist fractures. Fewer studies are available in males, but they have a pattern similar to females.<sup>7</sup> It has been postulated that increased risk of fracture may be related to difficult mobility and increased falls in patients with obesity.<sup>8</sup> In any case, there is no clear explanation yet for the effect of obesity on bone and its consequences.

Prevalence of obesity is greatly increasing in recent years, and population is gradually aging. These two circumstances are intrinsically associated to bone health, and this review is therefore intended to:

- Ascertain the mechanisms that relate obesity to changes in bone metabolism.
- Detect the factors associated to obesity with a negative impact on bone mineral density and risk of fracture.
- Determine the intervention required to prevent or improve the impact on bone of these factors related to obesity.

## Methods of the review

A narrative review was carried out. An online search was conducted in the medical databases PUBMED and EMBASE for the following terms: "Obesity" [MESH] AND "Bone metabolism" [MESH]; "Body Composition" [MESH] AND "Bone Metabolism" [MESH]; "Obesity" [MESH] AND

"Bone" [MESH]; "Obesity" [MESH] and "Vitamin D" [MESH] or "PTH" [MESH]. Original articles, meta-analyses, systematic reviews, and narrative reviews were considered. The search was done on February 1, 2016, and no limits were established for the publication date.

Priority was given to articles with methodology of higher scientific evidence (clinical guideline, meta-analysis, randomized clinical trial, systematic review, original article, and narrative review) published in the last five years.

## Body composition

When the concept of obesity is considered, it is very important to assess the contribution of the different components of weight (lean mass, fat mass, and water). Lean mass and fat mass are independent determinants of bone mass, and each of them will therefore have a different influence and will depend on several factors.<sup>9</sup>

## Lean mass and bone

Increases in lean or fat-free mass are associated to increased bone mass. The reason for this may be an increased mechanical load on bone related to weight and muscle hypertrophy. In this regard, a meta-analysis by Ho-Pham et al. showed that correlation between lean mass and bone mineral density in the femoral neck was greater than that of fat mass ( $r=0.39$  [0.34–0.43] vs  $r=0.28$  [0.22–0.33]). The effect of lean mass was greater in men ( $r=0.43$ ) and postmenopausal women ( $r=0.45$ ).<sup>10</sup>

The positive effect of increased lean mass is attributed to factors related to lifestyle such as exercise and diet, estrogen sufficiency, genetic influences, or a combination of these factors. On the other hand, an increase in muscle mass has an independent effect on risk of fracture by decreasing fragility and falls related to osteoporotic fracture.<sup>11</sup>

Although obesity is characterized by a predominant increase in fat mass, there is also an increase in lean mass that may partly account for the beneficial effect of this on bone mineral density. This situation was studied by Neubecker et al., who compared bone mineral density, bone fragility, and risk of fracture in obese patients and patients with anorexia nervosa and found that female obese patients (with greater lean mass) had greater bone mineral density and less bone fragility, which suggests a lower fracture risk.<sup>12</sup>

In elderly patients or obese patients with associated severe disease, the so-called *sarcopenic obesity* is acquiring special interest. In sarcopenic obesity, weight increase is related to a relative decrease in muscle mass.<sup>13</sup> The genesis of this disease is related to muscle damage caused by inflammatory mediators in the setting of a vicious cycle of progressive physical inactivity that increases adipose tissue and diseases related to obesity, which increase inactivity in turn. Sarcopenia is enhanced by other factors such as loss of sensitivity to alpha motor neurons, changes in anabolic hormones, and malnutrition.

Several circumstances occur in this pro-inflammatory condition: (1) preferential mobilization of muscle instead of fat for energy consumption; (2) a high inflammation level that causes a progressive decrease in muscle mass; and

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