*Journal of Clinical Densitometry: Assessment & Management of Musculoskeletal Health,* vol. ■, no. ■, 1–8, 2016

1094-6950/■:1–8/$36.00
http://dx.doi.org/10.1016/j.jocd.2016.10.009

**Original Article**

# Bone Variables in Active Overweight/Obese Men and Sedentary Overweight/Obese Men

*Georges El Khoury,[1,2] Hassane Zouhal,[3] Geneviève Cabagno,[2] César El Khoury,[1,4] Maroun Rizkallah,[5] Ghassan Maalouf,[5] and Rawad El Hage[1,*]*

*[1]Department of Physical Education, Faculty of Arts and Social Sciences, University of Balamand, El-Koura, Lebanon; [2]Laboratoire VIP'S, UFR-APS, Campus la Harpe, Université Rennes 2, Rennes, France; [3]Laboratoire Mouvement Sport Sante, UFR APS, Rennes, France; [4]I3MTO, EA 4708, Université d'Orléans, Cedex 1, France; and [5]Bellevue University Medical Center, Faculty of Medicine, Saint Joseph University, Mansourieh, Lebanon*

## Abstract

The aim of this study was to compare bone variables in active overweight/obese men and sedentary overweight/obese men. Thirty-seven active overweight/obese men and 45 sedentary overweight/obese men participated in this study. Weight and height were measured, and body mass index was calculated. Body composition and bone variables (bone mineral content [BMC], bone mineral density [BMD], geometric indices of hip bone strength, and trabecular bone score) were measured by DXA. Physical activity level, daily calcium intake, daily protein intake, and sleep duration were measured by validated questionnaires. Maximum oxygen consumption ($VO_2$ max) was determined by direct measurement while exercising on a medical treadmill. One-repetition-maximum half-squat of the lower limbs was measured using a validated protocol. Body weight and body mass index were higher in sedentary overweight/obese men than in active overweight/obese men. In the whole population (n = 82), $VO_2$ max (in liter per minute), lean mass, and one-repetition-maximum half-squat were positively correlated to BMC, BMD, and geometric indices of hip bone strength (cross-sectional area and section modulus [*Z*] of the femoral neck [FN]). After adjusting for body weight using a 1-way analysis of covariance, active overweight/obese men displayed higher whole-body BMC, lumbar spine BMD, total hip BMD, FN BMD, FN cross-sectional area, and FN *Z* values than sedentary overweight/obese men. In conclusion, the current study suggests that physical activity level positively affects bone variables in overweight/obese men. Optimizing lean mass and muscular strength of the lower limbs can help to prevent osteoporosis in overweight and obese men.

**Key Words:** Bone strength; clinical tests; muscular strength; obesity.

## Introduction

The prevalence of obesity and overweight among young men is increasing in Lebanon and in the Middle East region *(1,2)*. A study conducted in Lebanon has shown that the prevalence of overweight in adult men was 57.7% *(1)*. In men, being overweight is associated with higher bone mineral density (BMD) at weight-bearing sites *(3–6)*. However, several studies have indicated that BMD and bone geometry indices are not adapted to the increase in body weight in obese subjects *(7–15)*. Therefore, implementing strategies to increase BMD in obese and overweight men may be beneficial to prevent bone-related disorders in this population *(16–18)*. Many studies have investigated the effects of longitudinal training programs (resistance and endurance programs) on BMD in obese subjects *(19–23)*. For instance, Mackelvie et al *(22)* examined the effects of a 7-mo jumping intervention (10 min, 3 times per week) on bone

Received 10/1/16; Revised 10/28/16; Accepted 10/31/16.
*Address correspondence to: Rawad El Hage, PhD, Department of Physical Education, Faculty of Arts and Social Sciences, University of Balamand, P.O. Box 100, Tripoli, Lebanon. E-mail address: rawadelhage21@hotmail.com

mineral gain in prepubertal Asian and white boys *(22)*. Jumping exercise increased bone mineral accrual at several regions equally in prepubertal Asian and white boys of average or low body mass index (BMI), and intervention effects on bone mineral were undetectable in prepubertal boys with high BMI *(22)*. The authors stated 2 hypotheses to explain the lack of a positive osteogenic response to jumping exercise in obese boys *(22)*. First, the skeletons of heavy boys may not respond to a loading exercise program when already under substantial adaptive stress because of the boys' weight *(22)*. Second, an alternative hypothesis is that the boys with high BMI in the intervention group were not motivated to perform the jumping exercises and might have found this type of intervention difficult to execute *(22)*. In contrast, we have previously shown that endurance training is effective in increasing whole-body (WB) bone mass and BMD in a group of obese adolescent girls *(23)*. Thus, the osteogenic response to exercise in obese subjects remains unclear, and to our knowledge, cross-sectional studies comparing bone status in active overweight/obese subjects to that of sedentary overweight/obese ones are missing. Consequently, the aim of the present study was to compare bone variables (bone mineral content [BMC], BMD, hip geometry indices, and trabecular bone score [TBS]) in active overweight/obese men and sedentary overweight/obese men. The current study may have clinical implications in the field of prevention of osteoporotic fractures in overweight and obese men.

## Materials and Methods

### *Subjects and Study Design*

Eighty-two overweight and obese (body mass index [BMI] > 25 kg/m$^2$) young men whose ages ranged from 18 to 35 yr participated in the present study. The 82 participants were recruited from 3 private universities located in North Lebanon. The participants were divided into a group of active overweight/obese men (n = 37) and a group of sedentary overweight/obese men (n = 45). The active overweight/obese men were regular participants in university or regional team sports competitions and had been training in their clubs 2–5 times per week, for 3–10 h/wk for the past 5 yr. The sedentary overweight/obese men were practicing less than 2 h of physical activity per week and were not involved in impact sports. All participants were nonsmokers and had no history of major orthopedic problems or other disorders known to affect bone metabolism or physical tests of the study. Other inclusion criteria included no diagnosis of comorbidities and no history of fracture. An informed written consent was obtained from the participants. The current study was approved by the University of Balamand Ethics Committee.

### *Anthropometrics*

Height (in centimeter) was measured in the upright position to the nearest 1 mm with a standard stadiometer. Body weight (in kilogram) was measured on a mechanical scale with a precision of 100 g. The subjects were weighed wearing only underclothes. BMI was calculated as body weight divided by height squared (in kilogram per square meter). Body composition was evaluated by dual-energy X-ray absorptiometry (DXA; GE Healthcare, Madison, WI).

### *Bone Variables*

BMC (in gram) and BMD (in gram per square centimeter) were determined for each individual by DXA at the WB, lumbar spine (L1–L4), total hip (TH), and femoral neck (FN, GE Healthcare). FN cross-sectional area (CSA), FN section modulus (*Z*), and L1–L4 TBS were also evaluated by DXA *(24)*. The TBS is derived from the texture of the DXA image and has been shown to be related to bone microarchitecture and fracture risk *(25,26)*. The TBS score can assist the health-care professional in assessing fracture risk *(25,26)*. In our laboratory, the coefficients of variation were <1% for BMC and BMD *(27–30)*. The same certified technician performed all analyses using the same technique for all measurements.

### *Questionnaires*

Daily calcium intake, daily protein intake (DPI), sleep duration, Pittsburgh Sleep Quality Index score, and physical activity level were evaluated using validated questionnaires as previously described *(16,31–35)*.

### *Maximal Strength*

A one-repetition-maximum (1-RM) test, following the protocol established by the National Strength and Conditioning Association, was performed to measure back half-squat maximal strength on a Smith machine *(36)*.

### *Maximum Oxygen Consumption ($VO_2$ max) Testing*

Two hours after breakfast, we directly assessed the $VO_2$ max of the participants using a COSMED Fitmate PRO device (version 2.20, COSMED, Rome, Italy) while exercising on a medical treadmill. A progressive 2-min step protocol (1.5–2.0 km/h/step) was used as previously described *(16,37,38)*.

### *Blood Samples*

Serum 25-hydroxyvitamin D level was measured by the Nichols Advantage competitive binding chemiluminescence immunoassay (San Clemente, CA) *(29)*. The sensitivity of the assay was estimated to be ≤4 ng/mL. The within-run variation was estimated to be between 3% and 4.5% (mean: 3.75%) and the total imprecision was between 6.4% and 14.5%. Serum intact parathyroid hormone was measured using the Nichols Advantage 2-site chemiluminescence immunoassay *(29)*. The calculated sensitivity of the assay was 1 pg/mL. The intra-assay variation was calculated to be between 3.8% and 12.5% (mean: 6.2%) and the interassay variation was between 7.5% and 9.2% (mean: 7.9%).