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ORIGINAL ARTICLE

Association of bone mineral density and body mass index in a cohort of Pakistanis: Relation to gender, menopause and ethnicity

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KEYWORDS

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Body mass index;
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Osteoporosis

Abstract *Aim of the work:* To assess association of body mass index (BMI) with bone mineral density (BMD) in a sample of Pakistanis and explore their relation with age, gender, menopausal status and ethnicity.

Patients and methods: A cross-sectional study at a tertiary care rehabilitation medicine center included apparently healthy individuals referred for an assessment of BMD through dual energy X-ray absorptiometry (DXA). Subjects with any associated disorder, history of malignancy, intake of steroids, or under osteoporosis treatment were excluded. Patients were sub-grouped according to the age ($\leqslant$50 and $>$50 years) and menopausal status. The ethnicity was based on the provinces the patients came from.

Results: Out of 600 people, 253 (42.2%) were males with a mean age of 65 ± 10 years (range: 28–100 years) and 347 (57.8%) were females (56 ± 10 years; range: 18–92 years). The majority of males had normal BMI and osteopenia while majority of females were overweight and had osteopenia. Most individuals among sub-groups based on age and menopausal status had their BMI in the overweight range. The mainstream of the subjects $\leqslant$50 years and premenopausal women had a normal BMD and those $>$50 years had osteopenia. The majority of postmenopausal women had osteoporosis. The ethnicity (based on provinces) did not affect BMI or BMD. In both genders, the underweight individuals were more likely to develop osteoporosis than individuals who were overweight or had normal BMI.

Conclusions: Majority of Pakistani women were overweight while men had a normal BMI. Younger age and premenopausal status was directly associated with a normal BMD. Both genders were significantly prone to have a low BMD if they had a lower BMI.

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1. Introduction

Osteoporotic fractures are a serious health problem all over the world. Worldwide, osteoporosis causes more than 8.9 million fractures annually. In other words, it means an osteoporotic fracture every three seconds [1]. The combined lifetime risk for hip, forearm and vertebral fractures coming to clinical attention is around 40%, equivalent to the risk for cardiovascular diseases [2]. Of interest, the knowledge of osteoporosis among Alexandrian women was moderate as regards its risk factors, preventive measures and consequences [3].

Osteoporotic fractures are directly related to the bone strength. Bone strength is measured through bone mineral density (BMD), which refers to the amount of mineral per unit of space or mass per volume of the bones. There are many factors influencing BMD and the probability of osteoporotic fractures. Among these, age, gender, race, height, weight, and body mass index (BMI) are considered independent predictors of osteoporotic fractures [4]. It has been reported that the fat mass has a role in bone metabolism [5] and osteoarthritis does not prevent the occurrence of osteoporosis [6] in postmenopausal women.

So far, the research on osteoporosis and osteoporotic fractures in Pakistan is limited. With this study, we intended to add additional information to the current data with an aim to improve country-level preventive strategies. It would also supplement important information to the global statistics especially focused on developing countries. The study was aimed at assessment of the association of BMI with BMD in a sample of Pakistani men and women. Exploring association of BMI and BMD with age, gender, menopausal status, and ethnicity based on provinces were secondary goals.

2. Patients and methods

The cross-sectional study was done at Armed Forces Institute of Rehabilitation Medicine, Rawalpindi, Pakistan, which is a tertiary-care rehabilitation center, from January 2010 to 2014. Before commencing the study, the permission was acquired from hospital committee on research ethics. All included subjects gave an informed consent.

Apparently healthy individuals referred for an assessment of BMD through dual energy X-ray absorptiometry (DXA) scan were included. Subjects with rheumatoid arthritis, thyroid, parathyroid, adrenal, hepatic or renal disorders, history of malignancy, history of intake of steroids, thyroxin or anticonvulsants or under osteoporosis treatment were excluded. Height and weight were recorded in centimeters and kilograms respectively and the body mass index (BMI) was calculated. The subjects were submitted to DXA examination using Discovery BMD analysis machine (Discovery A; Hologic, Bedford, MA) according to the manufacturer's guidelines. To ensure that the measurement is reliable, a standard phantom was scanned daily before starting the tests and the machine was recalibrated to adjust for potential changes. DXA measurements were taken at the lumbar spine (L2 → L4) and at both femoral necks. The lowest BMD was noted and expressed in the form of T-score.

After calculation of BMI and DXA estimation for BMD, the sample was sub-grouped into "underweight", "normal" and "overweight" based on the BMI (BMI <18.5, 18.5–24.9 and >24.9 respectively) and sub-grouped into "normal", "osteopenia" and "osteoporosis" based on the BMD (T-score >-1, -1.1 to 2.5 and <-2.5, respectively) according to the World Health Organization guidelines [7,8]. For identification of the effect of age on BMI and BMD, the sample was also sub-grouped into "$\leqslant 50$ years" and ">50 years". The age limit of 50 years was selected because there are more chances of having low BMD and increased fracture risk at age over 50 years [2,9]. The women in the sample were further grouped into pre- and postmenopausal based on their menopausal status. The provinces were used as markers of ethnicity because the ethnicity and ethnic conflicts in Pakistan are primarily determined by provinces that generally share common cultural and linguistic traits [10,11]. Thus, the sample was divided into people hailing from Punjab, Sindh, Khyber Pakhtunkhwa, Balochistan or Azad Jammu and Kashmir as in previous studies from the same center [12,13].

2.1. Statistical analysis

Using Statistical Package for Social Sciences version 20 (IBM Corp., Armonk, NY, USA), descriptive statistics were performed. Univariate analysis using general linear model was used to find the association between BMI and BMD, and of age, gender, menopausal status, and ethnicity based on provinces. During analysis of BMI and BMD with age, gender, menopausal status, and ethnicity based on provinces, the other variables were taken as covariates being potential cofounders. A p-value < 0.05 was considered significant.

3. Results

Out of 600 people, 253 (42.2%) were males with a mean age of 65 ± 10 years (range: 28–100 years) and 347 (57.8%) were females (mean age 56 ± 10 years; range: 18–92 years). One patient failed to get a measurement of BMI and BMD and was excluded while analyzing the association of BMI and BMD with other variables. Among 347 females, 195 had reached menopause, 72 were still having menstruation while 80 denied to comment on the question (Table 1).

Bulk of the sample was overweight, in the age-group of >50 years, that hailed from the Punjab province and had BMD in the osteopenia range (Table 1). Majority of males had a normal BMI and BMD in the osteopenia range (Table 2). Majority of females were "overweight" and had BMD in the osteopenia range. Most individuals among both age groups were having BMI in the "overweight" range. The mainstream in the age group $\leqslant 50$ years had a normal BMD while most individuals in the age group >50 years had a BMD in the osteopenia range. The relationship of BMI and BMD with menopausal status and ethnicity based on provinces is provided in Table 2.

Considering the relation of BMI with BMD, in males, the underweight individuals were more likely to develop osteoporosis than individuals who were overweight or had normal BMI ($p < 0.001$). In females too, the underweight individuals were more likely to develop osteoporosis than individuals who were overweight or had normal BMI ($p < 0.001$) (Table 3).