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The Relationship between Body Weight, Body Mass Index (BMI) and Bone Mineral Density (BMD) of the Lumbar Spine and Femoral Neck in Professional Cyclists of Iran and Tour-de-France

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Abstract

Purpose: The aim of this study was to investigate the relationships between body weight and Body Mass Index (BMI) and Bone Mineral Density (BMD) of the lumbar spine and femoral neck in professional cyclists of Iran and Tour-de-France.

Material and Methods: 40 professional cyclists [(13 professional cyclists having participated in Iran's first class cycling competitions and 27 professional cyclists of Tour-de-France, age26.17±4.23 yr, height 178.85±7.09 cm, weight 72.50±9.48 kg, cycling participation background 7±2.4 yr))] took part in this study. Data were collected using the BMD assessing device Dual Energy X-Ray Absorptiometry (DXA). A medical history form was also filled out by a specialist physician. In this research BMD of the lumbar vertebral and femoral neck was measured. Data analysis included descriptive and inferential (Pearson-Correlation Coefficient) statistics was done using SPSS software.

Results: The results of this study showed that there was not any significant relationships between BMI and body weight, and BMD of the lumbar spine and femoral neck in professional cyclists ($p>0.05$).

Discussion and Conclusion: Therefore, BMI and body weight are not good predictors of BMD in professional cyclists. However further studies are required to investigate the effect of other factors such as exposure to sunlight, calcium intake, and individual habits like diet, on the BMD of professional cyclists.

Keywords: Osteoporosis, Body weight, BMI, BMD, Cycling

Introduction

Bones serve various functions in the body including mechanical support against gravity, protection of organs and tissues, and a lever system assistance in muscle movements. They also play an important role in several metabolic functions, serving as a reservoir for calcium and other minerals. Bone tissue is continually being remodeled due to the dynamic state of calcium balance. Calcium balance is a state in which there is sufficient dietary calcium to achieve and equate bone mineralization and intracellular calcium levels [1]. Several non-modifiable and modifiable determinants of bone mass are known to date. Non-modifiable factors consist of heredity [2, 3], race, and gender [4]. These factors account for approximately 50-70% of the variation in total body BMD. Modifiable factors account for the remaining 20-50% variation in bone mass including body composition, pubertal status, nutrition, and physical activity. Body weight and body composition are strong determinations of BMD [5, 6]. A few studies showed a significant positive relationship between body weight and BMD [7, 8 9, 10]. For instance, in a study that investigated the correlation between eight measures of body composition and BMD [11], it was shown that total weight, body mass index (weight corrected for height; kg/m^2), lean mass, and fat mass were positively correlated with lumbar spine and hip BMD in elderly males and females. Among the eight composition measures, total body weight was most strongly correlated with BMD. Thus it could be concluded that body weight and lean mass increase BMD due to the stress that body weight places on the bones, which in turn increases bone formation as an adaptive influence [12].

Among the anthropometric variables, low BMI and low weight were also interrelated with the occurrence of osteoporosis. Osteoporosis, a disease defined as bone density being 2.5 standard deviation units (SD) or more below the average peak of young adult BMD, along with microarchitectural deterioration that results

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in susceptibility to bone fractures with little or no trauma [13], is reaching epidemic proportions in the U.S [14]. A study conducted by Iqbal et al [15] found that low BMI was a good indicator of BMD, whereas Robbines et al [16] indicated that it was not. . Also, it is well known that body weight is associated with BMD [17-23]. However, body weight is composed of fat mass (FM) and lean mass, and there is no consensus on which has a greater effect on BMD [24-29]. Moreover, identifying influential factors on BMD of professional cyclists is of great importance and may provide these athletes with beneficial information. Johnov (1994) hypothesized that since a large portion of body weight is exerted on lumbar vertebral and femoral neck, and the highest probability of osteoporosis-induced fracture is seen in these limbs, their bone density can be considered as an index for evaluating the total BMD [13]. The present study, therefore, was conducted to assess the relationships between body weight and BMI, and BMD of the lumbar spine and femoral neck in professional cyclists of Iran and Tour-de-France.

Material and Methods

The statical population of this study included professional cyclists who participated in national and international competitions such as Tour-de-France, International tours, Azerbaijan tours, and Singapore tours. 40 professional cyclists [13 professional cyclists having participated in Iran's first class cycling competitions and 27 professional cyclists of Tour-de-France, (age 26.17±4.23 yr, height 178.85±7.09 cm, weight72.50±9.48 kg, BMI 22.69±3.00 kg/m^2, and cycling participation background 7±2.4 yr)] took part in this study. Before the study the participants were familiarized with the study conditions and the data collection procedure. Participation criteria included: (1) no history of bone fracture; (2) no history of hereditary Osteoporosis or former Diabetes, Thyroid or Parathyroid hyperactivity, neurological diseases and surgery, and heart and respiratory diseases; and (3) no background of smoking or taking drugs affecting BMD such as Corten or anticonvulsant medicines [13]. This screening was performed based on the questionnaires answered by the participants and was confirmed by a specialist physician. Iranian Participants had been practicing professional cycling at least for five years, four sessions a week and 1.5 to 2 hours per session. Tour-de-France cyclists had a seven-year background, practicing 6 sessions per week and 3.5 to 4 hours per session. The data were recorded by a specialist using Dual Energy X–ray Absorptiometry (DXA), scales, a height meter and a medical questionnaire.Each Participant's weight was measured using digital scales (Beurer Company, Germany) accurate to 100 grams and their height was measured using a wall height meter (Beurer Company, Germany) accurate to 1 mm. the BMD of each participant was measured by a specialist in Densitometry center, using DXA method. . In this study, lumbar vertebral and femoral neck, each having special clinical values in measuring BMD, were examined [30]. The results of each part were separately recorded in the computer and the final data and colored photographs were printed and then analyzed by a lab specialist. The total BMD of each participant was calculated by the authors. The BMI (kg/m^2) was calculated as body weight (kg) divided by body height squared (m^2).

Statistical methods

The statistical analysis included descriptive and inferential statistics using SPSS software (version 16). Criteria such as mean, standard deviation (S.D) and frequency distribution table of age, height, weight, and BMI of the participants' were used. Kolmogorov–Smirnov test was applied to confirm the normality of the data. Pearson-Correlation Coefficient test was applied to study the relationship between body weight and BMI, and BMD of the lumbar spine and femoral neck. P values less than 0.05 were considered significant.

Results

The data presented in Table 1, indicated that there were no significant relationship between BMI and body weight, and BMD of the lumbar spine and femoral neck in professional cyclists (p>0.05).

Table 1: Correlation analysis of BMI and body weight, and BMD of the participants

Variables	BMD (gr/cm^2)	BMI		Body Weight	
	Mean±SD	r	p	r	p
Lumbar Spine	1.02±0.13	0.017	0.916	0.131	0.420
Femoral neck	0.927±0.11	0.151	0.352	0.202	0.212

* Significance level was set at $P < 0.05$.

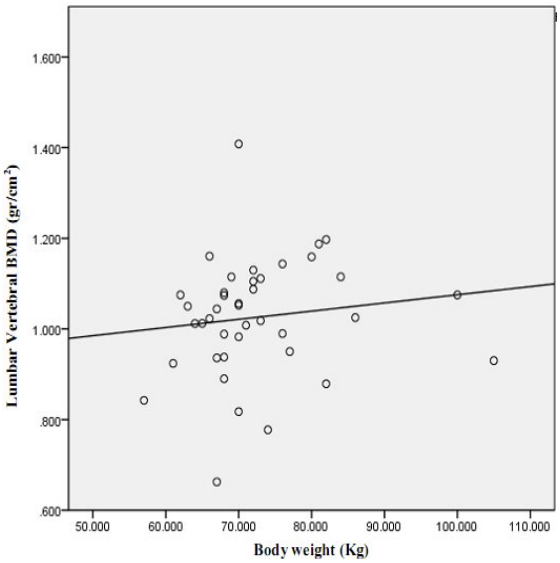

Figure 1: Correlation between body weight and lumbar vertebral BMD of the participants

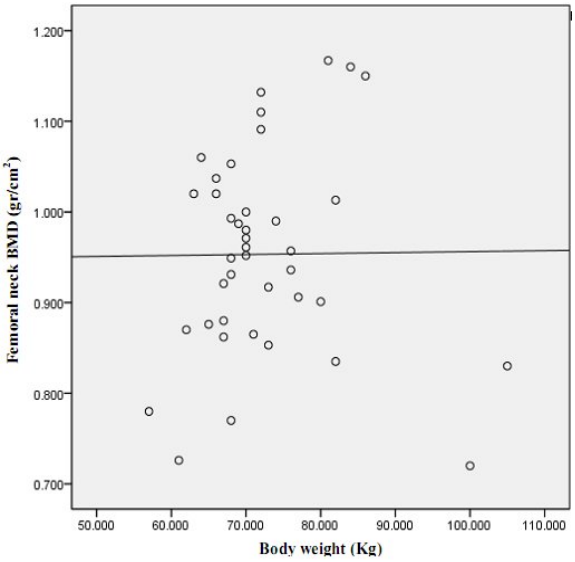

Figure 2: Correlation between body weight and femoral neck BMD of the participants

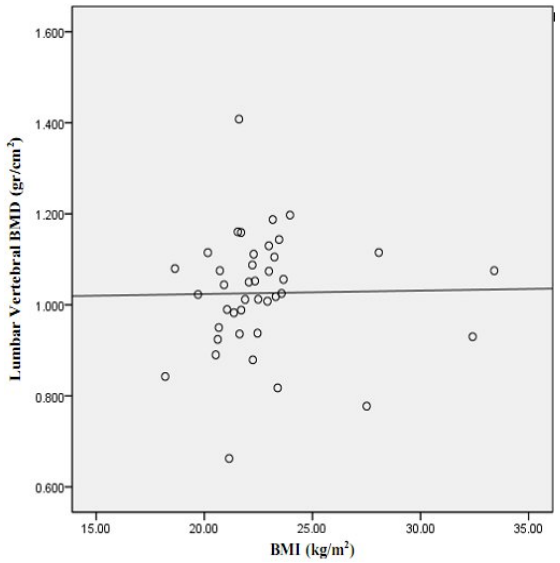

Figure 3: Correlation between BMI and lumbar vertebral BMD of the participants

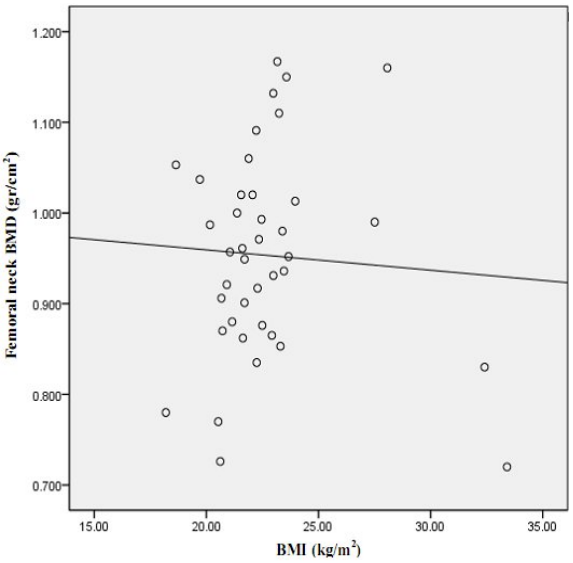

Figure 4: Correlation between BMI and femoral neck BMD of the participants

Discussion and Conclusion

Results of the present study indicated that there were no significant relationships between BMI and body weight, and BMD of the lumbar spine and femoral neck in professional cyclists so BMI and body weight may not be good predictors of BMD. This finding is in line with the results reported by Hsu et al (2006) and Robbines et al (2006) [31, 32] but is incontrast with those of Kerr (2007) and Arabi (2004) who reported significant positive relationships between body weight and BMI, and BMD, suggesting both body weight and BMI as good indicators of BMD of the present study [33, 34].

As mentioned above, there have been contradicting attitudes among researchers regarding the relationship between body weight and BMI, and BMD. Our results suggest that body weight cannot be a reliable predictor for BMD by itself. There is a positive relationship between BMD and lean body mass (LBM) mainly composed of muscles. As cyclists are engaged in endurance activities they have low muscle mass and consequently lower stress on their bones, that is probably not high enough to improve their BMD.

Muscles constitute half of a female's and one third of a male's weight and bones constitute 14%

of total body weight. Low BMD in professional cyclists probably suggests low mineral density of their bones with the bones having lower contribution to their weight [13]. In other words, their body weight apparently does not influence BMD, as it is not high enough to stimulate osteoblasts. This may explain the insignificant relationship between body weight and BMD of the lumbar vertebral and femoral neck in the professional cyclists. As fat tissue is the source of adipocytes and osteoblasts [35], and is considered a metabolically active tissue, its influence on the bones may be related to its physiological functions (such as hormonal metabolism of adipocytes) and not limited to its weight effect[36]. Since the cyclists in this study had normal BMI values (19 to 25; according to WHO definition) and cycling is a non-weight-bearing exercise, the exerted weight stress on the lumbar vertebral and femoral neck of the participants was apparently not enough to stimulate osteoblasts in these two body parts. in the participants [13, 37]. This may justify the absence of significant relationship between the participants' body weight and BMI, and their BMD.

In general, our results showed that body weight and BMI cannot be good predictors of the lumbar vertebral and hip bone BMD in professional cyclists.

The results of this study suggest that BMI and body weight are not reliable predictors of BMD. However further studies are required to investigate the effects of other factors such as exposure to sunlight and individual habits like diet on the BMD of cyclists. Thus, we recommend the professional cyclists to:

- Practice exercises other than cycling and swimming, such as cross-training, to improve their BMD and bone mineral content (BMC).
- Consider adding weight training to their daily training program ;
- Have a balanced diet, supplemented with calcium and dairy products; and
- Avoid consuming energizing foods which reduce bone density, in order to maintain normal weight, body fat percentage, and consequently reduce negative effects of weight changes on bone density and BMI.

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