Bone mass and body composition in college students

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Summary

Objective: To compare bone mineral density (BMD) and body composition (BC) of college students with different lifestyles. **Methods:** Transversal study with 85 students of Medicine (MED) and Physical Education (PE) at the Universidade Regional de Blumenau, SC, Brazil. The anthropometric, socio-demographic, clinical, and lifestyle variables were obtained through densitometric anamnesis and densitometric variables by dual-energy X-ray (DXA). The statistical tests used were: Student's t-test, Chi-square test, and logistic regression. **Results:** PE male students showed a higher amount of lean body mass (79.5 ± 5.9 vs. 75.1 ± 5.3; $p = 0.03$) and a lower amount of body fat (16.7 ± 6.1 vs. 21.6 ± 5.6; $p = 0.02$) and PE female students showed a higher amount of lean body mass (68.2 ± 5.5 vs. 65.3 ± 5.5; $p = 0.05$). The BMD of the neck of femur (NOF), total femur (TF), and total body (TB) was higher in PE students of both genders. PE students practiced more physical activities than MED students. Low bone mass (LBM) was more frequent in MED students (34.9% vs. 4.7%; $p = 0.001$), provided that the risk of a MED student to show LBM was nine times higher for lumbar spine (LS), five times for NOF, eight times for TF, and seven times for TB. **Conclusion:** BC and BMD were different among the students; MED students have shown a higher risk of having LBM, and PE students practiced more physical activities.

Keywords: Osteoporosis; students; lifestyle; densitometry; photon absorptiometry; bone density.

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Introduction

Epidemiological evidences reveal that bone development in childhood and adolescence is one of the determinants of bone mass in maturity and senescence, and that the low acquisition thereof or "a low peak of bone mass" would be a risk factor for osteoporosis in adulthood[1-4]. The bone mass peak consists of maximum bone mass achieved at the beginning of adulthood; 90% of this peak is obtained by age 18 and the remaining by age 25, approximately[2,4]. One of the consequences of aging in human beings is the progressive loss of bone mass. A low peak of bone mass at the end of adolescence, an excessive bone loss in adulthood, or the association of both events may lead to osteoporosis. The International Osteoporosis Foundation (IOF) estimates that a 10% increase in the peak of bone mass reduces the risk of osteoporotic fractures in adulthood by 50%[3]. In the last years, several factors related to the occurrence of low bone mass (LBM) have been identified, showing the association of bone mass with genetic factors; gender; race; hormonal profile; use of medications; chronic diseases; and factors related to lifestyle, such as low calcium intake, sedentary lifestyle, smoking, and excessive caffeine, alcohol, and protein consumption[1-8]. Epidemiologic data analyzed by the National Academy of Science showed that the maintenance of a diet with proper intake of nutrients, especially calcium, contributes to achieve the bone mass peak and reduce the osteoporosis level in adulthood[7]. The regular practice of physical activities is another lifestyle characteristic essential to the acquisition of bone mass, as evidenced by studies with children, adolescents, and young adults[9-14].

College students are still in the age group of mineral acquisition and, therefore, their lifestyles may influence this process. It is empirically known that medicine (MED) students have an "unhealthy" lifestyle, as they have their free time reduced due to an intense load of academic activities (full time), with less available time to practice physical activities and to have balanced meals. On the other hand, physical education (PE) students have a lower course load (part time) with a syllabus that contains practical classes of sports that mandatorily represent the practice of regular physical activities. Additionally, many of them practice other activities in their free time, usually related to physical exercises. Thus, in order to evaluate the impact of different lifestyles on bone mass and body composition (BC) in young adults, the bone mineral density (BMD) and BC of MED and PE students was studied and compared.

Methods

An observational, prospective, and transversal study was conducted with a group of individuals comprised of students of both genders in the last semesters of MED and PE courses at the Universidade Regional de Blumenau (FURB). MED students enrolled in the fourth and fifth years and PE students enrolled in the third and fourth years were invited to participate in the study. The MED sample comprised 34.8% (43 students of a total of 124) and the PE sample, 32.1% (42 students of a total of 131). Data was collected at the bone densitometry clinic located in Blumenau, Santa Catarina, in 2008 and 2009.

The socio-demographic, clinical, and lifestyle data were collected by the X-ray technician and densitometer operator through densitometric anamnesis before the densitometric examination and after training. The densitometric anamnesis followed the recommendations of the International Society for Clinical Densitometry (ISCD). The variables studied were: program; age; gender; weight; height; body mass index (BMI); time of physical activity; calcium intake in childhood, adolescence and adulthood; history of fracture; family history of osteoporosis; smoking; use of vitamin and mineral supplement; and use of medication and related diseases. Calcium intake was calculated based on a 24-hour dietary recall and expressed in mg/day. This calculation used the recommendations of the Sociedade Brasileira de Densitometria Clínica (SBDens), which measure daily calcium intake as follows: 1 cup of milk (240 mL) = 300 mg of calcium; 1 cup of yoghurt (240 mL) = 400 mg; one slice of cheese (28.35 g) = 200 mg; calcium from other sources = 250 mg[15]. The calculation was performed through an Excel® spreadsheet. Physical activity was calculated weekly based on the questionnaire applied and expressed in minutes per week. The densitometric variables studied were: BMD in standard score (Z-score) of the lumbar spine, neck of femur, total femur, and total body; percentage of lean body mass, body fat, and bone mass of the total body.

Data on body composition and BMD were obtained through a dual-energy X-ray (DXA) examination. The densitometry was made using the Explorer equipment from Hollogic®. The results of the BMD were expressed in g/cm^2 (grams of mineral tissue per area) and subsequently transformed into a standard deviation of the average age, gender, weight, and height, pursuant to the reference values provided by the manufacturer, generating the Z-score. The examinations were performed by a densitometer operator certified by the SBDens and the reports issued by a clinical densitometrist qualified by the SBDens and by the International Society for Clinical Densitometry (ISCD). During the examinations, the operator verified the position of the patient; if it was not appropriate, she interrupted the examination for repositioning, aiming at ensuring quality.

The densitometric diagnosis was made based on Zemel[16] criteria, where a Z-score lower than -1 standard deviation (SD) was considered as low bone mass (LBM). The determination of the body mass and height was made by the densitometer operator in a Camry® digital scale and an stadiometer-type anthropometer from Tonelli®.

The gender and the program were evaluated with respect to the following variables: age; weight; height; BMI; time of weekly physical activity; calcium intake in childhood, adolescence, and adulthood; and Z-score of densitometric variables using the Student's t- test. The densitometric diagnosis was evaluated with respect to gender and program using the chi-square test. p-values < 0.05 were deemed statistically significance. Procedures of binary logistic regression were used for the multivariable analysis. The programs used were LHStat 2.1® (analysis of data by Cláudio Loesh from the Universidade Regional de Blumenau – 09/18/2008) and Epi Info TM 3.5.1® (Database and statistics software for public health professionals – 10/25/2007). Four models of regression were obtained, whose dependent variables were named as: (1) lumbar spine, (2) neck of femur, (3) total femur and (4) total body, one model to each dependent variable. The level of significance for the inclusion of variables in the models was established as 5%.

This article was filed with the Ethics Committee of the Universidade Regional de Blumenau under the number 008/08 and approved on February 13, 2008, all participants previously signed the informed consent.

Results

Eighty-five college students participated in the study, 42 from the PE program and 43 from the MED program (49.5% versus 50.5%). From the PE students, 27 were female and 15 were male (64.3% versus 35.7%), and from the MED students, 25 were female and 18 were male (58.1% versus 41.9%).

Table 1 shows the results of the variables: age; body weight; height; BMI; time of physical exercises expressed in minutes; calcium intake in milligrams in adulthood, childhood and adolescence. These variables were stratified first by course and then by gender. Time spent in the weekly practice of physical activities was higher in PE students of both sexes. Height was higher in MED male students and BMI was higher in PE female students.

Table 2 shows the results of the body composition. MED male students have shown higher amounts of body fat and lower amounts of lean body mass. MED female students, however, showed lower amounts of lean body mass, with no significant differences for body fat.

Table 3 presents BMD in Z-score in the evaluated parts of the body, which were higher in PH students both in the proximal femur (neck of femur and total femur) and in the total body for both genders. The BMD of the lumbar spine was statistically different only in male students.

Regarding the densitometric diagnosis, a higher prevalence of LBM was observed in MED students (34.9% versus 4.7%; p = 0.001). In the stratification by gender, LBM remained more prevalent for females in the MED program (36.0% versus 3.7%; p < 0.01), nonetheless for males, there was no significant difference between the courses, although the frequency of LBM was approximately five times higher for MED students (33.3% versus 6.6%; p = 0.08).

There was no significant difference regarding the history of previous fractures between the courses (32.6% versus 26.1%; p = 0.68). Also, there was no association of drugs with bone mass between the courses. Among the most used drugs (currently or previously) in the PH students group were oral contraceptive (24.9%), satiety agents (4.9%), and L-thyroxine (4.9%). In the group of MED students, the most used drugs were oral contraceptive (27.9%), the association of inhaled corticosteroid/ β_2-adrenergic (4.6%), satiety agents (4.6%), and oral corticosteroid (4.6%). 7.3% of PE students and 6.9% of MED students used vitamin supplement. No student mentioned the use of a calcium supplement or cigarettes. One female MED student reported previous smoking habits (2 packs/ year), but she did not meet the criteria for LBM.

Among the set of independent variables considered for each logistic regression model, the only ones that provided a significant contribution were: for lumbar spine, "program" and "BMI"; for neck of femur, "program"; for total femur "program" and "family history of osteoporosis"; and for total body, "program" and "BMI". The odds ratio (OR) and the respective 95% confidence intervals for the independent variables of each model were estimated. The possible probabilities obtained from the models that presented a maximum percentage of accuracy were also estimated: 83.3% for lumbar spine, 100% for neck of femur, 85.9% for total femur, and 70.6% for total body. A significant model (p < 0.05) for each of the diagnoses presented was obtained. A probability matrix was elaborated for all models, with all possible combinations of the categories of predictor variables. In the lumbar spine, the highest estimated probability was 80.1% for the diagnosis of LBM in the cases of MED students with a low BMI. The model showed a nine times higher probability of a MED student to be diagnosed with LBM in comparison with a PE student. In the neck of femur, the highest estimated probability was 20.9% for the diagnosis of LBM in the cases of a MED student. The model showed a five times higher probability of a MED student to be diagnosed with LBM in comparison with a PE student. In the total femur, the highest estimated probability was 32.5% for the diagnosis of LBM in the cases of MED students with no family history of osteoporosis. The model showed an eight times higher probability of a MED student to be diagnosed with LBM in comparison with a PE student. In the total body, the highest estimated probability was 91.9% for the diagnosis of LBM in the cases of MED students with a low BMI.

Table 1 – Anthropometric and lifestyle variables stratified by program and gender

	Physical Education			Medicine			
Variables	n	Average ± SD	CI (95%)	n	Average ± SD	CI (95%)	*t*-test
Age	42	22.9 ± 4	(21.6-24.1)	43	23.4 ± 2.5	(22.6-24.2)	t = 0.73 p = 0.46
Female students	27	22.8 ± 4.2	(21.1-24.4)	25	24 ± 2.7	(22.9-25.1)	t = 1.28 p = 0.20
Male students	15	23 ± 3.8	(20.9-25.1)	18	22.5 ± 2.1	(21.4-23.6)	t = 0.47 p = 0.63
Weight	42	66.9 ± 11.7	(63.3-70.4)	43	67.4 ± 16.1	(62.5-72.2)	t = 0.16 p = 0.87
Female students	27	61.8 ± 9.1	(58.2-65.4)	25	57.7 ± 9.9	(53.6-61.7)	t = 1.58 p = 0.12
Male students	15	76 ± 10.3	(70.2-81.7)	18	80.9 ± 13.2	(74.3-87.4)	t = 1.16 p = 0.25
Height	42	1.7 ± 0.1	(1.7-1.7)	43	1.7 ± 0.1	(1.7-1.7)	t = 1.61 p = 0.11
Female students	27	1.6 ± 0.1	(1.6-1.7)	25	1.7 ± 0.1	(1.6-1.7)	t = 0.14 p = 0.88
Male students	15	1.7 ± 0.1	(1.7 1.8)	18	1.8 ± 0.1	(1.8-1.8)	t = 2.36 p = 0.02
BMI	42	23.5 ± 2.8	(22.6-24.3)	43	22.6 ± 3.4	(21.6-23.6)	t = 1.30 p = 0.19
Female students	27	22.7 ± 2.7	(21.6-23.7)	25	21 ± 2.5	(20-22.1)	t = 2.27 p = 0.02
Male students	15	24.9 ± 2.6	(23.4-26.3)	18	24.7 ± 3.3	(23.1-26.3)	t = 0.14 p = 0.88
PE (t in min.)*	42	570.2 ± 500	(418.9-721.4)	43	152.8 ± 135.6	(112.3-193.3)	t = 5.27 p < 0.01
Female students	27	438.6 ± 303.2	(318.7-558.5)	25	152.4 ± 150.5	(90.3-214.5)	t = 4.25 p < 0.01
Male students	15	807 ± 684.1	(428.2-1185.8)	18	153.3 ± 115.9	(95.7-211)	t = 3.99 p < 0.01
Adulthood Ca (mg/day)	42	860.8 ± 358	(752.5-969)	43	883.7 ± 368.7	(773.5-993.9)	t = 0.29 p = 0.77
Female students	27	799.8 ± 294	(683.5-916.1)	25	922.4 ± 425.1	(746.9-1097.8)	t = 1.21 p = 0.22
Male students	15	970.5 ± 441.4	(726-1214.9)	18	830 ± 274.7	(693.3-966.6)	t = 1.11 p = 0.27
Childhood and adolescence Ca (mg/day)	42	900.3 ± 274.6	817.3-983.4	43	939 ± 274.7	(856.9-1021.1)	t = 0.64 p = 0.51
Female students	27	906.4 ± 237.3	812.5-1000.3	25	938.1 ± 275.9	(824.2-1052)	t = 0.44 p = 0.65
Male students	15	889.4 ± 340.6	(700.8-1078.1)	18	940.4 ± 280.9	(800.7-1080)	t = 0.47 p = 0.64

SD, standart deviation; BMI, body mass index; PE, physical education. *Weekly physical exercises (time in minutes).

The model showed a seven times higher probability of a MED student to be diagnosed with LBM in comparison with a PE student. In the four logistic regression models presented, with respect to the OR, a significantly greater probability for a MED student to be diagnosed with LBM in comparison with a PE student was observed.

Table 2 – Body composition parameters stratified by program and gender

	Physical Education			Medicine			
Variables	n	Average ± SD	CI (95%)	n	Average ± SD	CI (95%)	*t*-test
Body fat %	42	24.2 ± 8	(21.7-26.6)	43	27.1 ± 7.3	(24.9-29.3)	t = 1.77 p = 0.07
Female students	27	28.3 ± 5.6	(26.1-30.5)	25	31.1 ± 5.6	(28.8-33.4)	t = 1.79 p = 0.07
Male students	15	16.7 ± 6.1	(13.3-20.1)	18	21.6 ± 5.6	(18.8-24.3)	t = 2.38 p = 0.02
Lean body mass %	42	72.2 ± 7.8	(69.9-74.6)	43	69.4 ± 7.3	(67.2-71.6)	t = 1.74 p = 0.08
Female students	27	68.2 ± 5.5	(66-70.4)	25	65.3 ± 5.5	(63-67.5)	t = 1.92 p = 0.05
Male students	15	79.5 ± 5.9	(76.2-82.8)	18	75.1 ± 5.3	(72.5-77.8)	t = 2.23 p = 0.03
Bone mass %	42	3.6 ± 0.4	(3.5-3.7)	43	3.5 ± 0.8	(3.3-3.8)	t = 0.74 p = 0.45
Female students	27	3.5 ± 0.3	(3.4-3.6)	25	3.7 ± 1	(3.2-4.1)	t = 0.66 p = 0.51
Male students	15	3.8 ± 0.4	(3.6-4)	18	3.3 ± 0.4	(3.1-3.5)	t = 3.18 p < 0.01

Table 3 – Bone mass in Z-score stratified by program and gender

	Physical Education			Medicine			
Z-score	n	Average ± SD	CI (95%)	n	Average ± SD	CI (95%)	*t*-test
Lumbar spine	42	0.3 ± 1.1	(0-0.6)	43	-0.4 ± 1.2	(0 - -0.1)	t = 3.18 p < 0.01
Female students	27	0.1 ± 0.9	(0-0.5)	25	-0.4 ± 1.3	(0 - 0.1)	t = 1.85 p = 0.07
Male students	15	0.7 ± 1.2	(0-1.3)	18	-0.5 ± 1	(0 - 0.1)	t = 2.85 p < 0.01
Neck of femur	42	1.1 ± 1.1	(0.7-1.4)	43	0.1 ± 1.2	(0 - 0.5)	t = 3.80 p < 0.01
Female students	27	0.8 ± 0.9	(0.5-1.2)	25	-0.1 ± 1.1	(0 - 0.4)	t = 3.16 p < 0.01
Male students	15	1.5 ± 1.3	(0.8-2.3)	18	0.4 ± 1.4	(0 - 1)	t = 2.50 p = 0.01
Total femur	42	0.7 ± 1	(0.4-1)	43	-0.1 ± 1.1	(0 - 0.2)	t = 3.43 p < 0.01
Female students	27	0.3 ± 0.9	(0-0.7)	25	-0.4 ± 1	(0 - 0)	t = 2.83 p < 0.01
Male students	15	1.3 ± 1	(0.7-1.8)	18	0.2 ± 1.2	(0 - 0.8)	t = 2.58 p = 0.01
Total body	42	-0.1 ± 0.9	(0-0.1)	43	-0.9 ± 1	(0 - -0.6)	t = 3.57 p < 0.01
Female students	27	-0.1 ± 0.9	(0-0.2)	25	-0.8 ± 0.9	(0 - -0.5)	t = 2.83 p < 0.01
Male students	15	-0.2 ± 0.9	(0-0.4)	18	-0.9 ± 1.1	(0 - -0.4)	t = 2.09 p = 0.04

Discussion

The results of this study evidenced that there was a difference in the BMD and in the BC among MED and PE college students, especially regarding male students. There are studies that have attributed the differences in bone mass to intrinsic and extrinsic factors[5]. The former group derives from genetic constitution, gender, race and hormonal factors, which determine roughly 80% of the bone mass peak. The latter group is related to the use of medications, presence of chronic diseases, and lifestyle habits that mainly include dietary patterns, alcohol intake, smoking, and physical activities[5].

This study highlights the impact of lifestyle on bone mass in young adults, especially with respect to physical activity. According to the literature, there are no studies that assess bone mass and BC in college students with different life habits. Nevertheless, there have been some studies that have measured bone mass in college students in medical school. In Brazil, a study conducted in the Faculdade de Medicina da Universidade de São Paulo with 100 students of both genders and similar ages, demonstrated a frequency of LBM of about 50%[11]. Students' lifestyles were analyzed, as well as their associated diseases and use of medication[11]. The authors found that a difference between students with normal BMD and students with reduced BMD was the amount of physical activity performed, evidencing a higher frequency of LBM in students who engaged in physical activity for less than five hours a week[11].

All male participants from the MED program showed lower BMD in all four measured parts in comparison to the participants from the PE program. As for females, this standard was maintained, with exception of the lumbar spine. A Swedish study with MED students found gender differences in the association of physical activity and BC with BMD[12]. In the male gender, the BMD in the total body, neck of femur, and lumbar spine, as well as weight and lean body mass, was positively associated with the amount of weekly physical activity. In women, the BMD was associated with weight, lean body mass, and fat body mass. These results suggest that the effect of physical activity on bone mass varies according to gender and skeletal segment studied, which may explain the differences of BMD between the genders observed in this study.

In Japan, the evaluation of BMD in college students from several courses evidenced a positive effect of physical exercise on BMD, especially impact exercises[17], while in New York a study with 50 ultra-Orthodox Jewish adolescents, whose habits encourage academic and intellectual activity to the detriment of physical activity, showed that a sedentary lifestyle can be detrimental to BMD[14]. The BMD of these adolescents with ages from 15 to 19 years showed lumbar spine BMD values below reference values with an average Z-score of - 1.2 ± 1.2 SD, -1.7 ± 1.1 in males and -0.6 ± 1.0 in females.

Calcium intake is another extrinsic factor that interferes with bone mass. Calcium is essential to healthy bone development. Its proper consumption during childhood and adolescence contributes to bone growth and acquisition of bone mass[4]. This study has not verified differences in the calcium intake between PE and MED students. Nevertheless, the daily average consumption is below the 1,000 mg/day recommended for the age group from 19 to 30 years[17], evidencing the inadequacy of these young adults concerning calcium consumption. This finding occurs in other national and international studies[7,18-20]. In Brazil, the study on calcium consumption by teenagers attending public schools in Osasco (SP) showed that the daily average consumption is approximately half of the amount recommended for both males and females[20]. The daily average verified was 628.8 ± 353.8 mg/day for boys and 565.6 ± 295.4 mg/day for girls, which are below the recommended amount for this age group. The reduction in calcium daily intake seems to be a trend of the modern society. The substitution of milk and milk products by non-dairy products such as juices and soft drinks has contributed to that, in addition to the increase of alcohol, caffeine, oxalate, phytate, and protein consumption, which reduces calcium retention in the body[7,21,22]. Inadequate calcium consumption is a risk factor that makes it reaching the bone mass peak more difficult, which, associated with a sedentary lifestyle, can have an even worse negative impact.

As for BC, male PE students showed higher amounts of bone mass and lean body mass and lower amounts of body fat compared to MED students of the same gender, possibly a reflection of the higher physical activity. The literature describes a positive association between lean body mass and bone mass[23-25]. Lean body mass plays an important role in bone deposition and bone health in the long term, as it maintains mechanical pressure on the bone. Some clinical tests already confirmed that it is a key predictor of increased bone mineral content[26]. In this research, results of greater lean body mass and greater bone mass found in PE students reinforce the hypothesis that bone performance is driven by muscle development, a principle based on the mechanostat theory. With respect to body fat, literature is controversial. Although the traditional paradigm suggests that adiposity benefits the skeleton and protects against osteoporosis, there are scientific papers which challenge this widely disseminated view and present evidences that, despite the increase of mechanical load, the adipose tissue is not beneficial to the bone structure in young men and women[24]. Two studies with women from childhood until adult life showed that body fat is negatively associated with bone mass[26,27]. These findings, therefore, reinforce the previous idea that bone resistance is mainly determined by dynamic loads of muscular strength instead of static loads, such as fat body mass.

LBM prevalence was greater in MED students, especially in females. Despite the quantitative difference in bone mass and frequency of LBM observed between the two groups, the occurrence of bone fractures was not different up to the moment of this study. A higher probability of MED students to be diagnosed with LBM in the four bone parts studied (lumbar spine, total body, neck of femur and total femur) was identified. Thus, it can be assumed that MED students may not reach a proper bone mass peak, which can be a risk factor to osteoporosis and fractures in the adult age.

Conclusion

MED students from FURB have shown lower bone mass, different BC and higher risk of having LBM than PE students. These differences may be attributed to lifestyle, especially to the quantitative variations in physical activities. Interventions intended to change lifestyle habits, particularly stimulation of regular physical activities, as well as orientations on proper calcium daily intake, could contribute to optimize these young adults' bone health. Studies to evaluate the occurrence of fractures in these young adults during their adult life could be useful to clarify whether the quantitative differences in bone mass verified in this research affect or not the incidence of fractures in later ages.

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