ROMM
Revista de Osteoporosis
y Metabolismo Mineral

Association of early sports participation with bone mineral density and estimated fracture risk in older women

Association of early sports participation with bone mineral density and estimated fracture risk in older women

10.20960/RevOsteoporosMetabMiner.00109

04/08/2026

AR 00109

Association of early sports participation with bone mineral density and estimated fracture risk in older women

Wlaldemir Roberto dos Santos[1], Auan Alves dos Santos[1], Kláudia Emanuela Ramos Tenório[2], Yara Lucy Fidelix[3], Walmir Romário dos Santos[4], Keyla Brandão Costa[1], Paulo Thiago Gomes da Silva[5], Tainá Maria de Souza Vidal[1]

[1]School of Physical Education. University of Pernambuco. Recife, Pernambuco. Brazil. [2]Department of Genetics. Federal University of Pernambuco. Recife, Pernambuco. Brazil. [3]Graduate Program in Physical Education. Federal University of Vale do São Francisco. Petrolina, Pernambuco. Brazil. [4]School of Physical Education of Ribeirão Preto. University of São Paulo. Ribeirão Preto, São Paulo. Brazil. [5]Department of Biomedical Engineering. Federal University of Pernambuco. Recife, Pernambuco. Brazil

Received: 03/11/2025
Accepted: 22/03/2025

Correspondence: Wlaldemir Roberto dos Santos. School of Physical Education. University of Pernambuco. 310 Arnóbio Marques St. Santo Amaro. 50100-130 Recife, Pernambuco. Brazil
e-mail: wlaldemir.santos@upe.br

Funding: This work was supported by the National Council for Scientific and Technological Development (CNPq) under Grant 170036/2024-3 and 170099/2024-5. Financial sponsor was not involved in the design or execution of the study.

Conflict of interest: The authors declare no conflict of interest.

Artificial intelligence: The authors declare that no generative artificial intelligence (AI) or AI-assisted technologies were used in the writing or preparation of this manuscript.

ABSTRACT

Background: achieving high peak bone mass during youth is a key protective factor against fractures and osteoporosis in later life. Early sports participation has been associated with lasting benefits for bone health.

Objective: to examine the association between early sports participation, bone mineral density (BMD), and 10-year fracture risk in older women.

Methods: this cross-sectional and retrospective study included 52 older women (≥ 60 years; mean age 70.90 ± 7.17 years), all sedentary or insufficiently active. Participants were divided into two groups: without (G0; *n* = 29) and with (G1; *n* = 23) a history of sports participation during childhood and/or adolescence. G1 was further subdivided into G1a (childhood), G1b (adolescence), and G1c (both). BMD was assessed by DXA at the total body, lumbar spine, forearm, and femoral neck. Fracture risk was estimated using FRAX. Parametric and non-parametric tests were applied ($p < 0.05$).

Results: women with early sports participation presented significantly higher BMD at the total body ($p = 0.002$), lumbar spine ($p = 0.043$), and femoral neck ($p = 0.001$), as well as a lower estimated risk of major fractures ($p = 0.009$) and femoral neck fractures ($p = 0.034$). The strongest effects were observed among those who practiced sports during adolescence or both developmental periods.

Conclusion: early sports participation is associated with higher BMD and lower fracture risk in inactive older women. Encouraging organized physical activity from early life may be an effective preventive strategy for maintaining bone health throughout aging.

Keywords: Bone mineral density. Osteoporosis. Fracture. Exercise. Aging.

INTRODUCTION

Peak bone mass, which corresponds to the maximum accumulation of bone mineral density (BMD) achieved mainly during childhood and adolescence, is a crucial stage of human development and determines bone strength throughout life. Evidence indicates that higher BMD levels attained during youth are strongly associated with a reduced risk of fractures and delayed onset of conditions such as osteoporosis in subsequent decades (1). This association is partly explained by the high sensitivity of the skeleton to mechanical stimuli during pre-puberty and early puberty. During this period, impact activities such as jumping and running not only promote more significant structural gains in bone mass but also increase formation markers and reduce bone resorption markers (2).

School-based interventions with impact exercises, applied over several months, have demonstrated significant increases in BMD, especially in vulnerable regions such as the lumbar spine and femur (3). Besides increasing BMD, physical exercise stimuli promote changes in bone geometry and cortical thickening. An eight-year longitudinal study indicated that vigorous physical activity during childhood is associated with continuous gains in cortical thickness, maintained into adulthood (4).

Engaging in moderate to vigorous exercise during adolescence is also associated with greater hip bone strength in adulthood, even among currently inactive individuals (5). The combination of physical activity and an adequate diet, with balanced intake of calcium, protein, and vitamin D, enhances bone development. However, further studies are needed to investigate the isolated effects of each factor (6). In this context, the present study stands out for its originality by specifically examining the association between physical activity during adolescence and bone health in adulthood, highlighting the innovative nature of the investigation.

Considering the importance of BMD, skeletal sensitivity during growth, and the lasting effects of early physical activity, it is necessary to deepen the understanding of this association. In this context, the primary objective of the present study is to verify the association between sports participation during childhood and adolescence and BMD in older women. As a secondary objective, the study aimed to estimate the 10-year fracture risk according to sports participation in childhood/adolescence. This study seeks to contribute to the understanding of how these early physical experiences can influence bone health decades later, assisting healthcare professionals in developing preventive strategies from childhood focused on promoting bone health and reducing the risk of osteoporotic fractures in old age.

METHODS

Study type and sample selection

This cross-sectional, retrospective, quantitative study (7) was conducted at a university in Recife, Pernambuco, Brazil. The protocol was approved by the Research Ethics Committee (HUOC/UPE; opinion no. 6.855.902), and data were collected between January and June 2025 in accordance with the Declaration of Helsinki.

Eligible participants were postmenopausal women aged ≥ 60 years who were sedentary or insufficiently active (categories A and B) (8), were not receiving pharmacological or vitamin supplementation for osteoporosis, and had no diagnosis of dementia or cognitive impairment. Women classified as active or very active according to established criteria (8), those with difficulties understanding the interview, or those with physical limitations preventing BMD assessment were excluded.

Participants were recruited through a public invitation disseminated on social media. Interested individuals underwent an initial pre-screening to verify eligibility based on inclusion and exclusion criteria, followed by scheduling of the assessments.

Sample size was calculated according to World Health Organization guidelines for cross-sectional studies (9), adopting a 95 % confidence level, an absolute margin of error of 11 %, and an expected prevalence of 20 % for organized sports participation during childhood or adolescence, based on previous Brazilian data (10). The minimum estimated sample size was 50 participants. As the sample size calculation was based on exposure prevalence, the analyses involving BMD outcomes should be interpreted as exploratory.

Study design

After the initial selection and pre-screening, 67 older women were recruited and had their evaluations scheduled at a university laboratory. On the day of the evaluation, participants underwent a sociodemographic interview, which included the assessment of current and past health conditions, as well as the administration of the International Physical Activity Questionnaire (IPAQ) (8), both aimed at identifying characteristics, health status, and verifying compliance with the previously established inclusion and exclusion criteria.

Of the 67 older women recruited, 15 were excluded for being classified as active or very active, resulting in a final sample of 52 participants. The exclusion of these individuals aimed to ensure the study's focus on women with low or insufficient levels of physical activity. This measure was intended to avoid bias resulting from physiological adaptations associated with regular and intense sports practice, which could affect the parameters evaluated, such as BMD.

Participants who met the eligibility criteria answered an interview about early sports participation during childhood and adolescence, as proposed by Fernandes and Zanesco (11). Based on their responses, they were organized into the following groups:

- G0: Group with no sports participation during childhood or adolescence (*n* = 29).
- G1: Group that practiced sports in childhood and/or adolescence (*n* = 23):
  - G1a: Group that practiced sports only in childhood (*n* = 5).
  - G1b: Group that practiced sports only in adolescence (*n* = 9).
  - G1c: Group that practiced sports in both childhood and adolescence (*n* = 9).

Finally, participants underwent BMD assessment using Dual-Energy X-ray Absorptiometry (DXA) at the following sites: whole body, lumbar spine (L1 to L4), forearm, and femoral neck (12). Each evaluation session was always conducted by the same examiner, ensuring standardization of procedures. BMD assessment was performed by a trained examiner who was blinded to participants' group allocation.

Instruments

Current physical activity level was assessed using the short version of the IPAQ, validated for the Brazilian population (8). The instrument evaluates the frequency and duration of physical activities performed in the previous seven days and classifies individuals as sedentary, insufficiently active, active, or very active.

Sports participation during childhood (7-10 years) and adolescence (11-17 years) was retrospectively assessed using two dichotomous (yes/no) questions regarding engagement in organized and supervised sports activities outside school for at least one year (11). This instrument was selected due to its ease of understanding and high reproducibility (Kappa = 1.00; p = 0.001) and has been used in epidemiological studies (10,12,13). To facilitate recall, examples of common sports and school-stage temporal references were provided during the interview.

BMD was assessed by DXA using a Hologic® device (Discovery CI/WI; software QDR4500W, version 11.2). Total body BMD and regional BMD at the lumbar spine (L1-L4), femoral neck, and forearm were evaluated following standardized positioning protocols (14). All DXA scans were performed by a single trained examiner blinded to group allocation.

Fracture risk was estimated using FRAX adapted for the Brazilian population (15), incorporating femoral neck BMD and clinical risk factors, including age, sex, history of fractures, family history of fractures, corticosteroid use, smoking, alcohol consumption, rheumatoid arthritis, and secondary osteoporosis. The model estimated the 10-year probability of major osteoporotic and hip fractures (16).

Statistical analysis

Numerical variables were described using mean and standard deviation. Data normality was assessed using the Shapiro-Wilk test, and homogeneity of variances between groups was evaluated using Levene's test, both considered prerequisites for applying parametric tests. Data entry was performed blindly, without prior knowledge of the group to which each participant belonged, and was subsequently verified by a second person to ensure data accuracy.

For comparisons between groups G0 (no sports participation during childhood and/or adolescence) and G1 (with sports participation during this period), the independent samples Student's *t*-test was applied to variables with normal distribution and homogeneity of variances. For variables that did not meet these assumptions ($p < 0.05$ in the Shapiro-Wilk or Levene tests), the Mann-Whitney U test was used. In both cases, a significance level of $p < 0.05$ was adopted. Effect size was calculated based on Cohen's d formula and interpreted as follows: negligible (≥ -0.15 and < 0.15), small (≥ 0.15 and < 0.40), medium (≥ 0.40 and < 0.75), large (≥ 0.75 and < 1.10), and very large (≥ 1.10 and < 1.45).

For comparisons among groups G0 (no sports participation), G1a (participation only in childhood), G1b (participation only in adolescence), and G1c (participation in both childhood and adolescence), one-way ANOVA was used for variables that met normality and homogeneity of variance assumptions. When these assumptions were not met, the non-parametric Kruskal-Wallis test was applied as an alternative. All statistical analyses were performed using IBM SPSS Statistics software, version 28.0.

RESULTS

The sample consisted of 52 older women, with a mean age of 70.9 ± 7.2 years. Participants were allocated into groups according to early sports participation. Detailed anthropometric and clinical characteristics of the total sample and of each group are presented in table I.

Table I

When comparing bone conditions between groups G0 and G1, it was observed that group G1 presented significantly higher values. Total bone tissue was 21.31 % greater in G1 (p = 0.038), with a medium effect size (ES = 0.53); total body BMD was 8.11 % higher (p = 0.002), with a large effect size (ES = 0.89); lumbar spine BMD showed a 10.10 % increase (p = 0.043), with a medium effect size (ES = 0.57); and femoral neck BMD was 15.14 % higher (p = 0.001), with a large effect size (ES = 1.06). Furthermore, the estimated 10-year fracture risk was lower in group G1: major fractures had a 38.90 % lower chance of occurring compared to G0 (p = 0.009), with a large effect size (ES = 0.75); and hip fractures were 47.79 % less likely (p = 0.034), with a medium effect size (ES = 0.50) (Table II).

Table II

When comparing bone conditions between group G0 and the subgroups that practiced sports in childhood and/or adolescence (G1a, G1b, and G1c), significant differences were observed in total body BMD (p = 0.047), with group G1b showing the highest values (1.013 ± 0.09 kg/cm²), which was 17.93 % above G0. Regarding femoral neck BMD (p = 0.018), the best results were found in group G1c (0.794 ± 0.14 kg/cm²), with a value 19.04 % higher than that of G0.

Regarding the 10-year fracture risks, the lowest values were observed in group G1b. For major fractures (p = 0.022), this group had a risk of 2.53 ± 1.02 %, representing an 48.73 % lower risk compared to G0. For hip fractures (p = 0.019), the risk in G1b was 0.36 ± 0.25 %, corresponding to a 74.10 % lower risk of femoral neck fracture compared to G0 (Table III).

Table III

DISCUSSION

The results of this study show that older women with a history of sports participation during childhood and/or adolescence have better bone conditions and a lower estimated risk of fractures compared to those who did not practice sports during these periods ($p < 0.05$). The group that reported early sports participation (G1) showed significantly higher BMD values in total body, lumbar spine, and femoral neck compared to the group without this history (G0), in addition to a lower estimated risk of major fractures and femoral neck fractures over the next 10 years. These findings indicate that early exposure to structured physical activity may contribute to long-term bone benefits, even in the absence of regular physical activity in old age.

The association between sports participation during youth and better bone health in old age reinforces the role of physical activity during growth as a key factor for achieving a higher peak bone mass (1,2), which may exert a protective effect even in the presence of low levels of physical activity during senescence. Previous studies suggest that combined interventions involving proper diet and physical activity during childhood and adolescence promote BMD accumulation, although evidence on the long-term durability of these effects remains limited (6). Although the present study focused on childhood and adolescence, it is worth emphasizing that regular physical exercise in old age –particularly resistance training– can also positively influence BMD in postmenopausal women. High-intensity training (≥ 70 % 1RM), performed three times per week for at least 40 minutes per session, appears to be ideal (17).

These findings reinforce the importance of understanding the impact of different life stages on bone health, suggesting that the benefits of early physical activity may be long-lasting, even in the absence of continuous stimuli over the decades.

The magnitude of the differences observed between the groups analyzed in this study reinforces the clinical relevance of the findings. Femoral neck BMD, a region highly vulnerable to osteoporotic fractures, was 15.14 % higher in the G1 group, with a large effect size (ES = 1.06). Furthermore, the 47.79 % difference in femoral neck fracture risk estimated by FRAX suggests a potential protective effect of early physical activity, even among sedentary or insufficiently active older women. Reducing the risk of fracture is a noteworthy finding, especially considering that falls (a common precursor to fractures) are the leading cause of death from unintentional injury in adults aged 65 and older (18). In this context, a recent systematic review indicated that physical exercise interventions are associated with a reduction in falls across several high-quality trials and bring significant benefits to various health outcomes (19).

Thus, the results presented may have relevant implications for public policies aimed at preventing falls and fractures, by highlighting the importance of building a solid bone foundation during youth.

Subgroup analysis revealed that the benefits varied according to the period of sports participation. Group G1c, which practiced sports during both childhood and adolescence, showed the highest femoral neck BMD values, while group G1b, with exclusive participation during adolescence, exhibited the lowest fracture risks, especially for major fractures. These results suggest that adolescence may represent a critical window for consolidating bone adaptations induced by mechanical stimuli, which aligns with the literature indicating puberty as the period of greatest bone mass accumulation velocity, influenced by hormonal and biological maturation changes (3). Considering that currently most Brazilian adolescents do not engage in sports activities and fail to meet the minimum physical activity recommendations (20), it is necessary to plan and implement strategies that enable physical exercise in various contexts, such as at school and during youths' leisure time.

Prioritizing physical activity during adolescence should, therefore, be seen as a long-term investment in musculoskeletal health, with the potential to reduce the burden of osteometabolic diseases in the elderly population.

Despite its cross-sectional and retrospective design, the present study employed a validated self-report instrument to assess sports participation during childhood and adolescence, which has been widely used in adult populations and has demonstrated high reproducibility in previous studies (11,12). In addition, the exclusion of participants who were currently active or very active helped to isolate the potential long-term effects of early sports participation, reducing confounding related to current physical activity levels.

Nevertheless, some limitations should be acknowledged. Due to the cross-sectional and retrospective nature of the study, causal relationships cannot be established, and the findings should be interpreted as associations. The assessment of early sports participation relied on a dichotomous self-report measure (yes/no) covering broad developmental periods, which limits exposure precision by not capturing information on intensity, duration, type of sport, or mechanical loading characteristics, and may be subject to recall bias, despite the instrument's high reproducibility.

The sample size was relatively small, and subgroup analyses resulted in small group numbers, which may reduce statistical power and lead to instability in some estimates. In addition, recruitment via social media may have introduced selection bias, with a possible overrepresentation of individuals with higher digital literacy and healthier profiles, which may limit the generalizability of the findings. Important factors that may influence bone mineral density across the lifespan –such as nutritional intake (e.g., calcium and vitamin D), sun exposure, medication use, hormonal status, reproductive history, and menstrual characteristics– were not controlled for and should be addressed in future studies.

Despite these limitations, the results support the hypothesis that regular sports participation during growth is associated with better bone health indicators in older age, reinforcing the relevance of early-life physical activity as a potential contributor to long-term skeletal integrity.

CONCLUSION

This study aimed to investigate whether participation in organized sports during childhood and adolescence is associated with bone health and fracture risk in older women. The findings indicate that women who reported early engagement in sports activities presented higher BMD values in the total body, lumbar spine, and femoral neck, as well as a lower estimated 10-year risk of major osteoporotic and femoral neck fractures, compared to those without such history. These results point to a positive association between early exposure to mechanical loading and skeletal parameters later in life.

Although the cross-sectional and retrospective nature of the study does not allow causal inferences, and potential recall bias should be considered, the findings suggest that participation in organized sports during youth may be related to more favorable bone health outcomes in older age. Promoting structured physical activity in childhood and adolescence may therefore be an important strategy within broader public health approaches aimed at supporting skeletal health across the lifespan. Future longitudinal and controlled studies with larger and more diverse samples are necessary to confirm these associations and to better elucidate the long-term relationship between early sports participation and bone health.

REFERENCES

1. Sagelv EH, Emaus N, Evensen E, Christoffersen T, Dennison E, Furberg AS, et al. Acquisition of peak bone mass in a Norwegian youth cohort: longitudinal findings from the Fit Futures study 2010-2022. Arch Osteoporos 2024;19:58. DOI: 10.1007/s11657-024-01414-2
2. Rempe J, Rosengren BE, Jehpsson L, Swärd P, Dencker M, Karlsson MK. Physical activity in late prepuberty and early puberty is associated with high bone formation and low bone resorption. Front Physiol 2022;13:828508. DOI: 10.3389/fphys.2022.828508
3. Zhang W, Wang X, Liu Y, He Q, Ding Q, Mei J, et al. Effects of exercise on bone mass and bone metabolism in adolescents: a systematic review and meta-analysis. Front Physiol 2024;15:1512822. DOI: 10.3389/fphys.2024.1512822
4. Metcalf KM, Letuchy EM, Levy SM, Janz KF. An 8-year longitudinal analysis of physical activity and bone strength from adolescence to emerging adulthood: the Iowa Bone Development Study. Pediatr Exerc Sci 2020;32:58-64. DOI: 10.1123/pes.2019-0090

5. Elhakeem A, Heron J, Tobias JH, Lawlor DA. Physical activity throughout adolescence and peak hip strength in young adults. JAMA Netw Open 2020;3:e2013463. DOI: 10.1001/jamanetworkopen.2020.13463
6. Proia P, Amato A, Drid P, Korovljev D, Vasto S, Baldassano S. The impact of diet and physical activity on bone health in children and adolescents. Front Endocrinol (Lausanne) 2021;12:704647. DOI: 10.3389/fendo.2021.704647
7. Thomas JR, Nelson JK, Silverman SJ. Métodos de pesquisa em atividade física. 6th ed. Petersen RDS, translator. Porto Alegre: Artmed; 2012.
8. Benedetti TRB, Antunes PC, Rodriguez-Añez CR, Mazo GZ, Petroski ÉL. Reproducibility and validity of the International Physical Activity Questionnaire (IPAQ) in elderly men. Rev Bras Med Esporte 2007;13:1116. DOI: 10.1590/S1517-86922007000100004
9. Lwanga SK, Lemeshow S. Sample size determination in health studies: a practical manual. World Health Organization; 1991. Available from: https://iris.who.int/handle/10665/40062. [Accessed: 1 July 2025].
10. Tebar WR, Borges LO, Delfino LD, Mota J, Ritti-Dias RM, Christofaro DGD. Association of early sports participation with sedentary behavior in community-dwelling adults: the role of sociodemographic factors in a retrospective epidemiological study. J Phys Act Health 2023;20:374-84. DOI: 10.1123/jpah.2022-0540
11. Fernandes RA, Zanesco A. Early physical activity promotes lower prevalence of chronic diseases in adulthood. Hypertens Res 2010;33:926-31. DOI: 10.1038/hr.2010.106
12. Silva GC, Tebar WR, Lemes IR, Sasaki JE, Mota J, Ritti-Dias RM, et al. Can sports practice in childhood and adolescence be associated with higher intensities of physical activity in adult life? A retrospective study in community-dwelling adults. Int J Environ Res Public Health 2022;19:14753. DOI: 10.3390/ijerph192214753
13. Christofaro DGD, Tebar WR, Mota J, Delfino LD, Santos AB, Ritti-Dias RM, et al. Association of sports practice in childhood and adolescence with cardiac autonomic modulation in adulthood: a retrospective

epidemiological study. Sports Med Open 2024;10:41. DOI: 10.1186/s40798-024-00707-7
14. Santos WR, Santos WR, Paes PP, Ferreira-Silva IA, Santos AP, Vercese N, et al. Impact of strength training on bone mineral density in patients infected with HIV exhibiting lipodystrophy. J Strength Cond Res 2015;29:3466-71. DOI: 10.1519/JSC.0000000000001001
15. Associação Brasileira de Avaliação Óssea e Osteometabolismo (ABRASSO). Calculadora FRAX adaptada para a população brasileira. 2025. Available from: https://abrasso.org.br/frax-brasil/. [Accessed: 1 July 2025].
16. Albergaria BH, Zerbini CAF, Lazaretti-Castro M, Eis SR, Vilaca T, Johansson H, et al. A new FRAX model for Brazil. Arch Osteoporos 2023;18:1-8. DOI: 10.1007/s11657-023-01354-3
17. Zhao F, Su W, Sun Y, Wang J, Lu B, Yun H. Optimal resistance training parameters for improving bone mineral density in postmenopausal women: a systematic review and meta-analysis. J Orthop Surg Res 2025;20:1-15. DOI: 10.1186/S13018-025-05890-1
18. Web-based Injury Statistics Query and Reporting System (WISQARS). Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 2025. Available from: https://www.cdc.gov/injury/wisqars/index.html. [Accessed: 26 July 2025].
19. Guirguis-Blake JM, Perdue LA, Coppola EL, Bean SI. Interventions to prevent falls in older adults: updated evidence report and systematic review for the US Preventive Services Task Force. JAMA 2024;332:58-69. DOI: 10.1001/jama.2024.4166
20. Soares CAM, Leão OADA, Freitas MP, Hallal PC, Wagner MB. Tendência temporal de atividade física em adolescentes brasileiros: análise da Pesquisa Nacional de Saúde do Escolar de 2009 a 2019. Cad Saúde Pública 2023;39(10):e00063423. DOI: 10.1590/0102-311XPT063423

Table I. Sample characterization (n = 52)

Variables	Mean ± SD	Confidence Interval	p
Age (years)	70,90 ± 7,17	68.90-72.90	0.333
Body mass (kg)	66.50 ± 10.6	63.50-69.50	0.771
Height (cm)	155.00 ± 7.10	153.00-157.00	0.986
BMI (kg/m²)	27.70 ± 3.40	26.60-28.80	0.482
Bone tissue (kg)	2.00 ± 0.75	1.79-2.21	0.001*
BMD FB (kg/cm²)	0.958 ± 0.52	0.932-0.984	0.733
BMD LS (kg/cm²)	0.897 ± 0.59	0.854-0.940	0.001*
BMD forearm (kg/cm²)	0.419 ± 0.11	0.387-0.450	0.001*
BMD FN (kg/cm²)	0.711 ± 0.11	0.681-0.741	0.210
Large fractures (%)	4.05 ± 2.66	3.31-4.79	0.001*
Femoral neck fractures (%)	1.18 ± 1.44	0.77-1.58	0.001*

$p < 0.05$; BMI: body mass index; BMD: bone mineral density; FB: full body; LS: lumbar spine; FN: femoral neck.

Table II. Differences between the group with no sports participation during childhood or adolescence (G0) and the group with sports participation during childhood and/or adolescence (G1) in bone tissue, bone mineral density (full body, lumbar spine, forearm and femoral neck), and fracture risk (major fractures and femoral neck fractures)

Variable	G0 (*n* = 29) Mean ± SD	G1 (*n* = 23) Mean ± SD	Δ (%)	Confidence interval		*p* (ES)
				Bottom	Higher	
Bone tissue (kg)	1.83 ± 0.66	2.22 ± 0.82	0.39 (21.31)	-800	2.35	0.038* (0.53)
BMD FB (kg/cm^2)	0.925 ± 0.08	1.000 ± 0.08	0.075 (8.11)	-0.120	0.280	0.002* (0.89)
BMD LS (kg/cm^2)	0.859 ± 0.03	0.945 ± 0.10	0.086 (10.01)	-0.171	0.002	0.043* (0.57)
BMD forearm (kg/cm^2)	0.409 ± 0.07	0.431 ± 0.14	0.022 (5.38)	-0.085	0.041	0.486 (0.19)
BMD FN (kg/cm^2)	0.667 ± 0.08	0.768 ± 0.11	0.101 (15.14)	-0.154	0.047	0.001* (1.06)
Large fractures (%)	4.90 ± 2.80	2.99 ± 1.99	1.91 (38.90)	0.498	3.31	0.009* (0.75)
FM fractures (%)	1.49 ± 1.60	0.778 ± 1.12	0.712 (47.79)	-0.076	1.51	0.034* (0.50)

**$p < 0.05$; G0: group with no sports participation during childhood or adolescence; G1: group that participated in sports during childhood and/or adolescence; ES: effect size; BMD: bone mineral density; FB: full body; LS: lumbar spine; FN: femoral neck.*

Table III. Differences among the group with no sports participation during childhood or adolescence (G0), the group that participated in sports only during childhood (G1a), the group that participated in sports only during adolescence (G1b), and the group that participated in sports during both childhood and adolescence (G1c) in bone tissue, bone mineral density (full body, lumbar spine, forearm and femoral neck), and fracture risk (major fractures and femoral neck fractures)

Variable	**G0 (*n* = 29) Mean ± SD**	**G1a (*n* = 5) Mean ± SD**	**G1b (*n* = 9) Mean ± SD**	**G1c (*n* = 9) Mean ± SD**	**F (df_1, df_2)**	***p***
Bone tissue (kg)	1.83 ± 0.66	2.23 ± 1.00	2.28 ± 0.90	2.17 ± 0.72	0.974 (3, 12.1)	0.437
BMD FB (kg/cm²)	0.925 ± 0.08	0.972 ± 0.10	1.013 ± 0.09	1.005 ± 0.07	3.49 (3, 12.9)	0.047*
BMD LS (kg/cm²)	0.859 ± 0.03	0.993 ± 0.05	0.942 ± 0.03	0.923 ± 0.08	1.70 (3, 14.7)	0.211
BMD forearm (kg/cm²)	0.409 ± 0.07	0.440 ± 0.05	0.412 ± 0.16	0.445 ± 0.17	0.406 (3, 12.7)	0.752
BMD FN (kg/cm²)	0.667 ± 0.08	0.728 ± 0.06	0.763 ± 0.07	0.794 ± 0.14	4.71 (3,13.8)	0.018*
Large fractures (%)	4.90 ± 2.80	3.70 ± 1.59	2.53 ± 1.02	3.02 ± 2.79	4.42 (3, 14.1)	0.022*
FM fractures (%)	1.49 ± 1.60	1.42 ± 1.53	0.36 ± 0.25	0.83 ± 1.33	4.80 (3, 12.7)	0.019*

**p* < 0.05; G0: group with no sports participation during childhood or adolescence; G1a: group that participated in sports only during childhood; G1b: group that participated in sports only during adolescence; G1c: group that participated in sports during both childhood and adolescence; BMD: bone mineral density; FB: full body; LS: lumbar spine; FN: femoral neck.*