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Physical activity from adolescence to young adulthood and bone mineral density in young adults from the 1982 Pelotas (Brazil) Birth Cohort

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ABSTRACT

Objective. To evaluate a prospective association between physical activity (PA) and bone mineral density (BMD) in young adults.

Method. Total body (TB), lumbar spine (LS) and femoral neck (FN) BMD were measured in participants from the 1982 Pelotas Birth Cohort by dual-energy X-ray absorptiometry at 30 y. PA was evaluated at 15, 18 (males) and 23 y.

Results. 3454 young adults were scanned (DXA) at least at one anatomical site. In males, PA at 15 y was associated with LS density ($\beta = 0.061$ g/cm^2; 95% confidence interval (CI): 0.015; 0.108). A positive dose–response effect was found for the association between PA at 18 y and BMD. Males in the two highest quartiles of PA at 23 y had significantly greater BMD at all anatomical sites than males in the lowest quartile. We observed greater BMD at 30 y in boys who were active at least in one of the assessments (18 or 23 y) compared to inactive boys at both ages. Females in the highest quartile of PA at 23 y showed greater FN density at 30 y ($\beta = 0.020$; 95%CI: 0.001; 0.039).

Conclusions. A physically active pattern is important to BMD across the first three decades of life. Potential beneficial effects of PA were not entirely lost with advancing age in male young adults.

Introduction

Bone health is critically important to the overall health and quality of life throughout the human's lifespan. Bones play a major role as a "storehouse" for minerals that are vital to the functioning of many other life-sustaining systems in the body. Unhealthy bones lead to an increase in fracture risk caused by low bone mass and deterioration of bone structure mainly characterized as osteoporosis (U.S. Department of Health and Human Services, 2004). This reduction in bone mass is an important health problem with social and financial impacts on society since each year about 2 million individuals suffer an osteoporotic-related fracture worldwide (WHO Scientific Group on the Prevention and Management of Osteoporosis, 2000).

The development of the skeleton can be influenced by early life factors (birth weight, maternal nutrition, etc.) (Cooper et al., 2009; Jones, 2011; Martinez-Mesa et al., 2013) and bone mass is determined by the factors that influence the gain, maintenance or bone loss across the lifespan, including modifiable and lifestyle factors, such as physical activity (Heaney et al., 2000). Although the benefits of physical activity to bone health are shown in the literature, there is controversy if the role of physical activity on bone mass has important benefits not only during growth, where the peak of accrual BMD was not reached, but also during adulthood, though in the maintenance phase of bone mass (Bielemann et al., 2013). In addition, evidences of the effect of physical activity during early ages on bone density in youth and later ages are scarce, mainly in middle or low-income countries where ethnicities and physical activity patterns are distinct from high-income countries (Bielemann et al., 2013).

Benefits of physical activity during adolescence and adulthood on bone mass are more consistent in males (Baxter-Jones et al., 2008; Delvaux et al., 2001; Kemper et al., 2000; Neville et al., 2002; Valimaki et al., 1994; Van Langendonck et al., 2003; Welten et al., 1994) whereas absence of association is found in some studies with females especially with a prospective effect of physical activity during adulthood (Barnekow-Bergkvist et al., 2006; Kemper et al., 2000; Neville et al., 2002; Uusi-Rasi et al., 2002).

This study was aimed at assessing the effect of physical activity during adolescence and young adulthood on bone mineral density in subjects belonging to the 1982 Pelotas (Brazil) Birth Cohort Study.

Methods

The study was carried out in Pelotas, a medium-sized city in southern Brazil that currently has 330,000 inhabitants. In 1982, all maternity hospitals in the city were visited daily and the 5914 liveborns whose families lived in the

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urban area of the city were examined and their mothers interviewed. These subjects have been followed-up many times.

In 1997, all households in a 27% systematic sample of the 259 census tracts in the urban area of the city were visited in search of individuals born in 1982. All existing households in these 70 census tracts were visited to locate the participants and 1076 adolescents were located. From July to September 2000, we followed the male subjects during the compulsory enlistment Army medical examination and 2250 of the 3037 males of the cohort were interviewed (follow-up rate: 79%, 143 known deaths). Between October 2004 and August 2005, the entire cohort was sought and 4297 cohort members were interviewed (follow-up rate 77%). From June 2012 to February 2013 another follow-up was carried out with the entire cohort and subjects were invited to visit the Epidemiologic Research Center. All procedures were approved by the Ethics Committee in Research of the Faculty of Medicine at Federal University of Pelotas and a written informed consent was obtained from all subjects.

Physical activity was measured at 15, 18 and 23 years of age. In 1997, the subjects were asked about their frequency in dance, sports and games, besides school or work-related activities. The options included: every day; at least once a week; at least once per month; and never. Subjects were considered as active if they responded "at least once a week". In 2000, boys were asked about frequency and duration spent in exercises in a usual week (e.g. gym, sports club, household, school, and commuting to work). In the 2004–5 follow-up, the long form of the International Physical Activity Questionnaire (IPAQ) was administered (Craig et al., 2003). In this study we analyzed the weekly time spent in physical activity only during leisure-time. The time spent in vigorous-intensity physical activity was multiplied by two (Craig et al., 2003).

Time spent in physical activity at 18 and 23 years was divided into quartiles. We also estimated the variation in physical activity recommendation (150 min/week) from 18 to 23 years. Subjects were classified into one of the following categories: inactive at both ages; active only at the youngest age; active only at the oldest age; and active at both ages.

Bone mineral density (g/cm^2) in the 30 year follow-up was measured in total body, lumbar spine (L1–L4) and right femoral neck using the method of dual-energy X-ray absorptiometry (Lunar Prodigy Advance — GE®, Germany). DXA scans were not done in pregnant women and subjects weighing more than 120 kg or taller than 1.92 m. Subjects with metal plates or screws, implants and metal items were excluded from examination. Subjects that could not fit in the DXA scan area were submitted to half-body scans of their right side to estimate total body BMD.

At 30 years, height was measured to the nearest 1 mm with barefooted subjects using a wooden stadiometer. With respect to potential confounders, birth weight measured with pediatric scales (Filizola) soon after birth, monthly family income, household assets index at 2 years, maternal smoking during pregnancy and breastfeeding duration were collected in the perinatal or during the follow-ups in childhood. Calcium intake (mg/day) and phosphorus intake (mg/day) were measured in 2004–5 by a food-frequency questionnaire based on a list of food included in another instrument created by Sichieri and Everhart (1998). Current smoke was asked in 2000 and 2004–5 visits. Age at menarche was asked in 1997 (subsample) and in 2004–5, as well as the use of oral contraceptives. Skin color was evaluated by self-report in 2004–5. Data on lean mass (g) was obtained from total body DXA scans at 30 years.

The analyses were stratified by sex since potential effect modification was considered when the p-value for the interaction term was 0.2. Analysis of variance or Kruskal–Wallis test, depending on the heterogeneity of variance, was used to compare the mean time spent in physical activity at 18 and 23 years according to tertiles of BMD. Crude and adjusted analyses were performed using linear regressions. Covariates were included in the analyses according to the model presented in Fig. 1. The significance level was set at 5%. The analyses were performed with Stata 12 software (StataCorp, College Station, TX, USA).

Results

In the 2012–13 visit we interviewed 3701 subjects (follow-up rate: 68.1% — considering 325 known deaths), and 3454 young adults were scanned with DXA. In this study 3338, 3433 and 3450 participants met the inclusion criteria for total body, lumbar spine and femoral neck BMD, respectively. Table 1 shows the distribution of potential confounders as well as means and standard deviations of BMD at 30 years and physical activity evaluation at 15, 18 and 23 years. BMD at all anatomical sites was lower in females than in males. Almost 90% of males performed physical activity at least once a week at 15 years, whereas for females this proportion was 60%. Around 30% of males and 65% of females did not practice any leisure-time physical activity at 23 years.

The description of min/week spent in physical activity at 18 and 23 years in males according to BMD at 30 years is shown in Fig. 2. Differences on mean values of physical activity were observed between

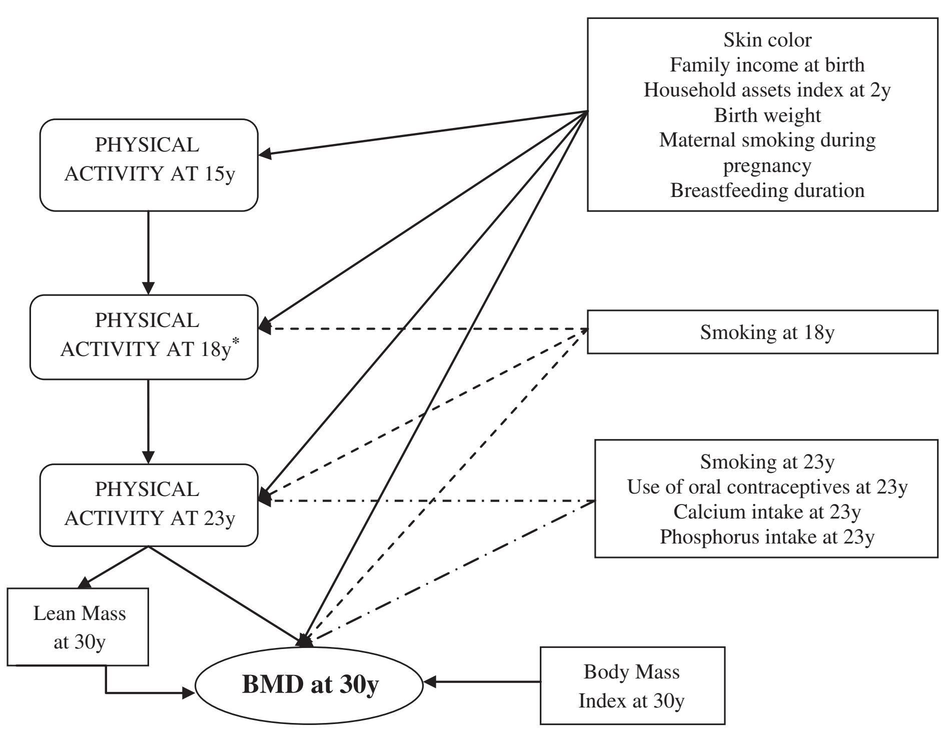

Fig. 1. Flow chart illustrating the three physical activity assessments and covariates used in the linear regression models between bone mineral density (BMD) and physical activity at different ages. *Information only available for males.