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LUMBAR BONE MASS OF ADULT MALES AND FEMALES IS POSITIVELY RELATED TO PHYSICAL ACTIVITY PATTERNS IN ADOLESCENCE AND YOUNG ADULTHOOD

HAN C.G. KEMPER, INGRID BAKKER, WILLEM VAN MECHELEN, G. BERTHEKE POST, JOS W.R. TWISK

Institute Research in Extramural Medicine (EMGO), The Netherlands

ABSTRACT

The purpose of this study was to investigate the relation of daily physical activity during adolescence (age 13-17) and young adulthood (age 21-27) on the lumbar bone mass (LBM) at age 32.

LMB was measured with dual X-ray absorptiometry (DXA) in the lumbar region in 163 males and 139 females at age 32.

Physical activity was measured longitudinally from age 13 till age 27 by an interviewer administered activity questionnaire. From this a metabolic (METPA) and a mechanic physical activity score (MECHPA) were derived. Regression analyses were performed with gender, height, weight, body fatness and calcium intake as covariates.

Both aspects of physical activity (METPA and MECHPA) during adolescence and young adulthood are positively related to the LBM at age 32 in both sexes.

This longitudinal study shows that physical activity during youth can increase peak bone mass.

Keywords: peak bone mass, physical activity, longitudinal study, lumbar bone mineral density

Introduction

The purpose of this study is to investigate the relations of daily physical activity of males and females in adolescence (ages 13-17) and young adulthood (ages 21-27) with the bone mass in the lumbar spine at age 32. If physical activity during growth and development in adolescence can increase the peak bone mass at adult age, this can be an important preventive measure for osteoporosis later in life (1).

The data are from the Amsterdam Growth and Health Longitudinal Study (AGAHLS). This is an observational study, following a group of 500 boys and girls with eight repeated measurements between the age of 13 and 32 (2,3).

Methods

For the purpose of this publication six physical activity measurements (at age 13, 14, 15, 16, 21 and 27) are used and a measurement of lumbar bone mass (LBM) at age 32. The total number of subjects that could be included was between 163 and 139 males and females. The design of this study is illustrated with Fig. 1a and 1b.

Bone mass was measured in the lumbar spine with dual X-ray absorptiometry (DXA, Norland XR-26) and from that the bone mineral density (BMD in grams per cm^2) was calculated.

The amount of physical activity was measured with an interviewer administered activity questionnaire developed for the

AGAHLS (4). This questionnaire administered the total time per week spent on all physical activities in relation to school, work, sports, transportation, stair climbing and other leisure time activities, during the 3 months prior to the measurement. From this interview two indicators of physical activity were derived: the metabolic and the mechanic component of physical activity.

The metabolic component was assessed by multiplying the time and the metabolic equivalent (estimated from the literature) of the different physical activities (METPA) (4). The mechanic component was assessed as the sum of the ground reaction forces (estimated from the literature) of the different physical activities (MECHPA) (5).

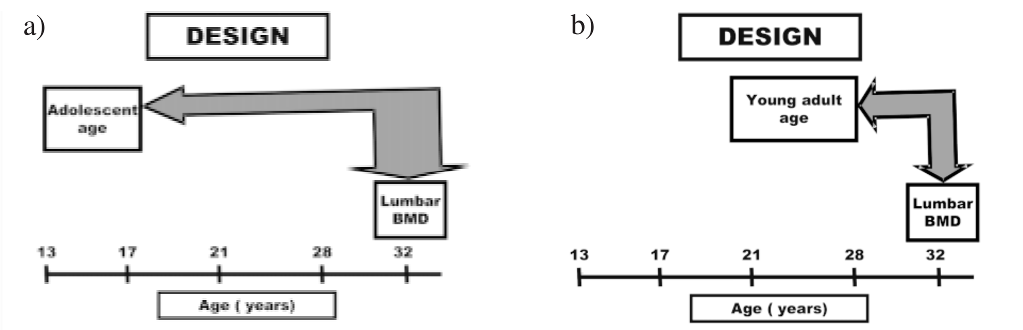

Fig. 1a & 1b. *Diagram illustrating the design of the study, with bone density measurement at age 32 and longitudinal measurements of physical patterns in two periods (during adolescence, 1a and during young adulthood, 1b) in the same subjects between age 13 and 27 years*

Statistical analysis

It is hypothesized that the prediction of BMD at adult age not only depends on physical activity during youth but is also highly related to gender, body composition (body mass, fat mass) and dietary intake (calcium) during youth. Therefore gender, body height, body weight, body fatness (sum of four skinfolds) and calcium intake (calculated from a cross-check dietary history interview) (6) were included as covariates in the linear regression analysis.

For each indicator the relationships with lumbar bone mass (LBM) were analysed in a multiple analysis correcting for gender, body height, body weight, fatmass and calcium intake.

Results

Table 1 shows the results of the multiple linear regression analyses relating physical activity in adolescence and the young adult period to BMD of lumbar bone mass (LBM) at age 32. The adjusted standardized regression coefficients and p-values regarding the relationships with METPA and MECHPA indicate the following: For both the metabolic and mechanic components of physical activity in adolescence and young adulthood strong relationships are demonstrated with adult LBMD. During adolescence (age 13-16) only the METPA was significantly ($p< 0.05$) and positively related with LBMD at age 32. In the young adulthood (21-27 years) only the MECHPA was significantly ($p< 0.01$) and positively related to LBMD at age 32.

Discussion

The results indicate that physical activity (METPA and MECHPA) in youth is positively related to the amount of bone mass in the lumbar spine of males and females at the adult age of 32 years. These

Table 1. *Adjusted standardized regression coefficients (ß) and explained variance (r^2) of the lumbar bone mineral density (LBMD) at age 32, regarding the multiple linear relationships with mechanic (MECHPA) and metabolic (METPA) physical activity during adolescence (13-17 years) and young adulthood (21-27 years)*

		ADOLESCENCE (13-16 years)	YOUNG ADULTHOOD (21-27 years)
		LBMD	LBMD
Metabolic Physical Activity (METPA)	n	163	139
	ß	0.18	0.04
	r^2	2.7%	1.2%
	p	<0.05	NS
Mechanic Physical Activity (MECHPA)	n	162	139
	ß	0.08	0.20
	r^2	0.7%	4.0%
	p	NS	p<0.01

relations remain significant also when they are corrected for possible other influences like gender, height, weight, fat mass and calcium intake. The variance explained by physical activity alone on adult LBM varies from 2 % by METPA in adolescence to 7% by MECHPA in young adulthood. The relations with MECHPA are stronger for the young adult period. This can be explained by the fact that the young adult activity period (21-27 years) is closer to the age of 32 years at which LBM was measured. De Ridder et al (7) demonstrated in a cross-sectional study that weight bearing activity in Dutch prepubertal girls is the best measure for physical activity in relation to bone mass. During the adolescent period the metabolic component seems more important than the mechanic component of physical activity for the prediction of LBM at age 32 but thereafter, in the young adult period, the mechanical component is significantly related to adult LBM. During the adolescent period the average total amount of metabolic physical activity is in boys 4500 and in girls 3500 MET's per week. After age 16 the average total amount of physical activity is only 3000 MET's per week in both males and females (Fig. 2). This decrease in metabolic activity has probably led to a metabolic activity level below a certain threshold where it is no longer effective in bone mass.

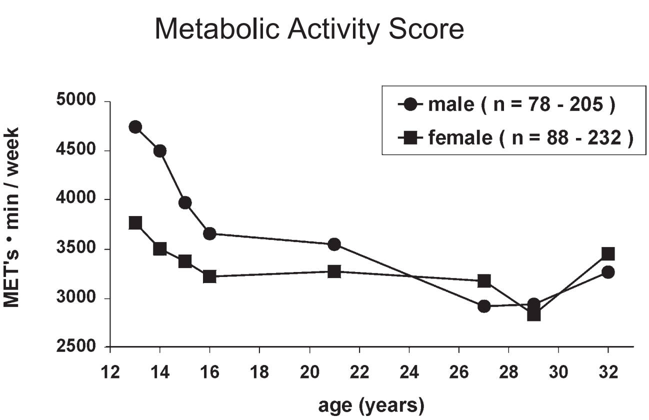

Fig. 2. *Age trends in males and females of metabolic activity between age 13 and 32 years*

From animal experiments it is shown (8) that the duration and frequency of exercise is of less importance than the mechanical stress of the exercise on the bone. During young adulthood the duration, intensity and frequency of physical activity (important components of the METPA) are reduced with respect to the adolescent period with 15-35 % (3), but the mechanic component is reduced only 9% (5): adult subjects run and walk less and take less stairs than in their youth, but they do not totally stop doing it. These short activities are only registrated by the MECHPA (fig. 3).

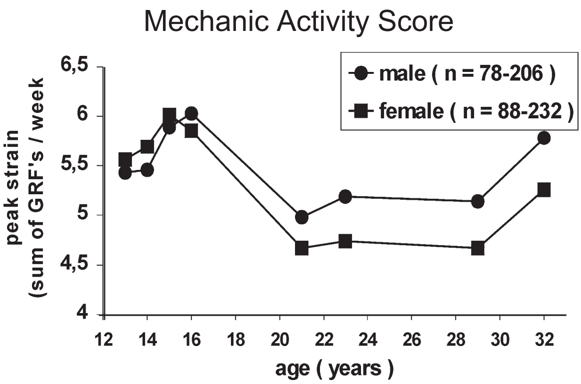

Fig. 3. *Age trends in males and females of mechanic activity between age 13 and 32 years*

The positive and statistical significant relationships of adult LBM at age 32 with the physical activity level during youth (age 13-27) suggest that physical activity can influence an optimal increase in bone mass at age 32. However, the results are from an observational longitudinal study, which can never prove a causal relationship because the subjects were not randomly assigned to different physical activity levels. Therefore, self-selection can also be involved in the occurrence of the positive relationships between LMB and physical activity levels. Randomized controlled trials in young boys and girls with longterm exercise programs as intervention (as performed in pre- and postmenopausal women (9)) can give pertinent answers to this problem.

Conclusion

It can be concluded that physical activity in youth and young adulthood is significant related to LBM at age 32. It seems that in young boys and girls (age 13-16) a lifestyle with physical activities with a high metabolic component and in young adults (age 21-17) with a high mechanic component increases the accrual of LBM leading to a higher LBM at adult age (32 years). This result shows that physical activity is of outmost importance in the early prevention of osteoporosis.

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Address of correspondence:
Prof.dr. Han C.G. Kemper
Institute for Research in Extramural Medicine (EMGO)
Faculty of Medicine
Vrije Universiteit
Van der Boechorststraat 7
1081 BT Amsterdam
The Netherlands
e-mail: HCG.Kemper.EMGO@med.vu.nl