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The impact on children's bone health of a school-based physical education program and participation in leisure time sports
The Childhood Health, Activity and Motor Performance School (the CHAMPS) study, Denmark

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ABSTRACT

Objective. To evaluate the effect of a school based physical education (PE) program and the amount of leisure time sport (LTS) on children's bone health and to examine if LTS influences the impact of school type on children's bone health.

Methods. Children attending "sports" schools (6 × 45 min PE lessons per week) were compared to children at "traditional" schools (2 × 45 min of PE lessons per week) in Svendborg, Denmark. Whole-body DXA scans were performed at baseline (2008) and at a two-year follow-up (2010). Bone mineral content (BMC), bone mineral density (BMD), and bone area (BA) were measured. Multilevel regression analyses examined the impact of school type and LTS participation on bone.

Results. 742/800 (93%) invited children accepted to participate. 682/742 (92%) participated at two-year follow-up. Mean (SD) age was 9.5 years (0.9) at baseline. A positive association between LTS and BMC, BMD ($p < 0.001$) and for BA ($p < 0.05$) (total body less head (TBLH) and lower limb (LL)) was found. All effects regarding school type were insignificant.

Conclusion. A positive impact of attending LTS on bone traits was found. There was no effect on BMC, BMD and BA (TBLH, and LL) for children attending sports schools compared to traditional schools.

Introduction

The peak bone mass (PBM) is the maximum attained bone mass in a lifetime. A low PBM is a predisposing factor to later development of osteoporosis (Bachrach, 2001). Several factors affect the magnitude of the PBM such as genetics, and lifestyle including nutrition and physical activity (PA) (Berger et al., 2010; Fewtrell et al., 2009). It is important to optimize the modifiable factors during childhood and adolescence when bone growth occurs in order to achieve the highest possible PBM according to our genetic potential, since low bone mass in elderly people is associated with a high fracture risk (Johnston and Slemenda, 1994). The optimal time for bone mineral accrual is prepuberty and early puberty (Bass et al., 2002).

Adiposity and inactivity in childhood is an increasing problem in high-income countries (Brisbois et al., 2012). The impact of adiposity on bone health in childhood and adulthood is contradictory (Dimitri et al., 2012). However, as commonly known inactivity is highly correlated to adiposity and has a negative impact on bone health and may cause a lower PBM and a later increased risk of osteoporosis. The behavior of inactivity tracks from early childhood into adulthood (Janz et al., 2005) and it is important to influence children's behavior of physical activity at an early stage in life to ensure future health and good habits of PA.

The objective of the study was to evaluate the effect of a generalized school based PE program on children's bone health, and to examine if participation in leisure time sport (LTS) influences the impact of

Abbreviations: BA, bone area; BMC, bone mineral content; BMD, bone mineral density; BMI, body mass index; DXA, dual energy X-ray absorptiometry; TBLH, total body less head; LTS, leisure time sport; LL, lower limb; PBM, peak bone mass; SMT-TQ, Short Messaging Service-Track-Questionnaire.

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school type on children's bone health or has an independent impact on bone health in childhood.

Methods

Study design

The study was a part of the CHAMPS study, DK an on-going prospective observational cohort study (Wedderkopp et al., 2012). The CHAMPS-study, is a natural experiment, in which the variations in exposure (i.e. the sports schools versus the traditional schools) and outcomes are analyzed with the intent of making causal inferences (Craig et al., 2012) on the effect of the intervention.

Nineteen primary schools in the municipality of Svendborg, Denmark, were invited to participate in the project, six schools agreed to participate. The final concept for the six sports schools included a minimum of 4.5 h of PE, divided into at least 3 sessions per week, at 60 min each. Parents and children were unaware of the initiation of this project until two months before the following school year. Four traditional schools were matched on size and geographic location (rural or urban) (Wedderkopp et al., 2012).

Children attending 2nd to 4th grade (7.7–12 years) were invited at baseline in year 2008. No child was excluded since none of the children received medication with an influence on bone metabolism. Children were examined at baseline (2008) and at two-year follow-up (2010). Examinations of the children took place at the Hans Christian Andersen Children's Hospital, Odense, Denmark (Fig. 1).

Ethical considerations

All children and parents from the participating schools received information about the study through school meetings and written information. Parents signed informed consent forms. Permission to conduct the CHAMPS study — DK was granted by the Regional Scientific Ethical Committee of Southern Denmark (project number: S-20080047).

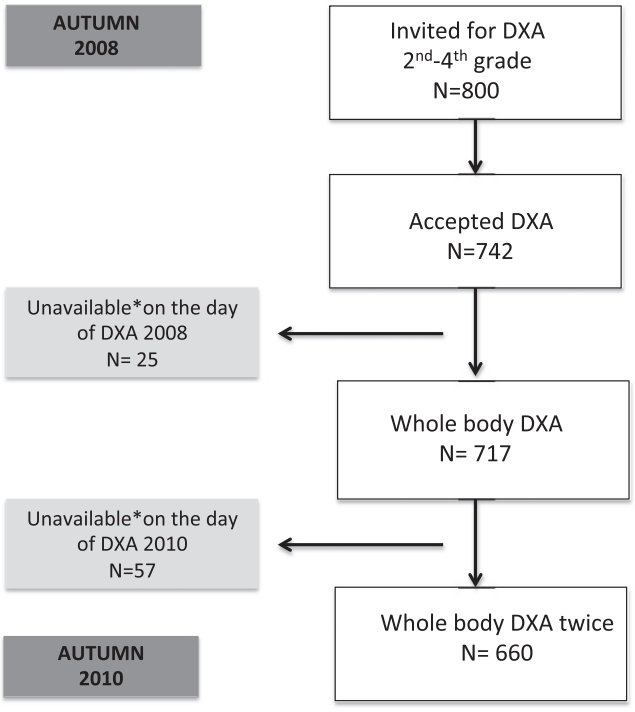

Fig. 1. Flowchart of the participants.

Data collection

Anthropometrical data

Anthropometric measures were measured with children required to go barefoot, wearing only a thin T-shirt, underwear and stockings. Body weight was measured to the nearest 0.1 kg on an electronic scale, SECA 861, and height was measured to the nearest 0.5 cm using a portable stadiometer, SECA 214 (both from Seca Corporation, Hannover, MD).

Dual energy X-ray absorptiometry

Dual energy X-ray absorptiometry (DXA), GE Lunar Prodigy (GE Medical Systems, Madison, WI), equipped with ENCORE software (version 12.3, Prodigy; Lunar Corp, Madison, WI), was used to measure BMC, BMD and BA. The total body less head (TBLH) and lower limb (LL) values were used (Lewiecki et al., 2008). The children were scanned in a supine position wearing underwear, a thin T-shirt, stockings and a blanket for the duration of the DXA scan. The GE Lunar Prodigy has reproducibility with precision errors (1 SD) of approximately 0.75% CV (coefficient of variation) for BMC in children and adolescents with mean age 11.4 years (5–17 years) (Margulies et al., 2005).

Pubertal self-assessment

Tanner pubertal stages self-assessment questionnaire (SAQ) which consists of drawings of the 5 Tanner stages for pubic hair (boys, and girls) and breast development (girls), respectively (Tanner, 1962) with explanatory text in Danish was used to evaluate sexual maturation. Children were presented with standard pictures showing the pubertal Tanner stages and asked to indicate which stage best referred to their own pubertal stage (Duke et al., 1980).

Short Messaging Service-Track-Questionnaire

Sports participation was measured weekly by "Short Messaging Service-Track-Questionnaire" (SMS-T-Q) version 2.1 (New Agenda Solutions, SMS-Track ApS, Esbjerg). SMS-Track is a web based IT-system (SMS survey) developed as a tool for frequent surveillance (Shiffman et al., 2008). The method is a "follow-up" procedure and was used in this study to investigate LTS participation over time (Johansen and Wedderkopp, 2010). The questionnaire was automatically sent to the parent's mobile phone once a week including a question about LTS: "How many times did [NAME OF CHILD] engage in sports during the last week?" The parents were instructed to answer with a relevant number between 0 and 8. The answers 0 to 7 represent the unique number of times engaging in sports, whereas 8 indicated "more than 7 times". The returned answers were automatically recorded and inserted into a database.

Statistical analyses

An initial analysis found mean (±SD) of key physical characteristics at baseline and at two-year follow-up. Explorative plots assessed linearity between the outcome variables (BMC, BMD and BA) and non-linear covariates were transformed to achieve linearity. Model assumptions of normality of the residuals were checked by Shapiro–Wilk's test and q–q plots. There was no indication of deviation from normality.

The effect of variables of interest upon the accrual of BMC, BMD and BA between baseline and follow-up was analyzed in a multilevel linear regression model (using xtmixed command from STATA 12.1). Backward elimination was used to reduce the initial model, containing all the explanatory variables including baseline bone traits and height, log(weight), gender, puberty, all at follow-up, school type, the amount