HOMO - Journal of Comparative Human Biology xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

HOMO - Journal of Comparative Human Biology

journal homepage: www.elsevier.com/locate/jchb

Bone mineral density, hand grip strength, smoking status and physical activity in Polish young men

Anna Kopiczko[a], Karol Gryko[b,*], Monika Łopuszańska-Dawid[a]

[a] *Department of Anthropology and Health Promotion, Józef Piłsudski University of Physical Education in Warsaw, Warsaw, Poland*
[b] *Department of Athletics and Sports Games, Józef Piłsudski University of Physical Education in Warsaw, Warsaw, Poland*

ARTICLE INFO

Keywords:
Densitometry
Bone mineral content
Tobacco
IPAQ
Dynamometer

ABSTRACT

The human skeleton undergoes constant changes encompassing the phases of growth, consolidation and involution of the bone tissue. The aim of the research was to assess the relationship between bone mineral density (BMD) and such factors as hand grip strength, somatic structure or attitudes to tobacco smoking in men with different levels of physical activity.

The study included 172 males aged 20–30 years. Mineral density and forearm bone mass were measured using the dual-energy X-ray absorptiometry method. Physical activity levels were assessed with the use of the International Physical Activity Questionnaire. Hand grip strength was measured with Jamar hand dynamometer. Attitudes towards smoking were assessed using the Global Adult Tobacco Survey.

The correlation between a high level of physical activity among men and higher BMD and bone mass both in the distal and proximal parts of the forearm was statistically significantly greater compared to individuals with an insufficient level of physical activity. A better state of BMD and higher bone mass in both forearm bones was noted among non-smoking men. A high level of physical activity was the most significant predictor of BMD in the distal part of the forearm. The regression analysis in the proximal part revealed that body mass and a high level of physical activity were the most important predictors of BMD.

The lack of physical activity was associated with more frequent occurrence of low bone mass in men. Tobacco smoking may be one of the most important risk factors of poor bone mineralization in young men.

Introduction

The human skeleton serves as the body support framework, provides the basis for muscle attachments, protects internal organs and stores calcium, phosphorus and magnesium. Skeleton is formed by two types of bone tissue, i.e., the cortical bone (cortex), which forms the outer shell of the bone and is present predominantly in the shafts of long bones as well as the trabecular bone, which makes up the interior of short and flat bones but can also be found in long bones (Martin and Seeman, 2008).

The human skeleton undergoes constant changes including the consolidation phase of bone growth and involution of bone tissue. The periods of childhood and adolescence experience a significant influence of bone mineralization. Peak bone mass is reached around the age of 20 years. Until this time, approximately 90–95% of the skeleton bone mass is formed (Parfitt et al., 2000).

* Corresponding author at: Józef Piłsudski University of Physical Education in Warsaw, Faculty of Physical Education, Department of Sport, 34 Marymoncka Street, 00-968 Warsaw, Poland.
E-mail addresses: anna.kopiczko@awf.edu.pl (A. Kopiczko), k.gryko@awf.edu.pl (K. Gryko).

https://doi.org/10.1016/j.jchb.2018.08.003
Received 22 April 2018; Accepted 4 August 2018
0018-442X/

At further stages of ontogeny, constant bone loss associated with the loss of the trabecular bone and resorption of bone from the marrow cavity is observed. The rate of bone loss depends on sex (Gracia-Lorda et al., 2007). Women lose 35–50% of the cancellous bone and 25–30% of the cortical bone, while in the case of men bone loss is at the level of 15–45% and 5–15%, respectively. In men, the loss of the trabecular bone begins after reaching peak bone mass, and the loss of the cortical bone starts later and is associated with a decrease in physical activity, sexual hormones and bioavailability, leading to an increased bone turnover (Compston, 2002; Gracia-Lorda et al., 2007; Riggs et al., 2008).

An adequate calcium intake, regular physical activity, proper physical development and muscle mass growth are of particular importance for proper bone mineralization. The value of peak bone mass is affected both by intrinsic factors (i.e., genetics including population of origin, sex, body composition) and exogenous factors (i.e., diet, physical activity, nutritional status, medication use, chronic diseases), (Cadarette et al., 2001; Hawker et al., 2002).

Bone mass depends, *inter alia*, on the somatic structure, particularly on a few significant somatic features such as body mass. In numerous studies, a positive correlation between body mass index (BMI) and BMD was noted due to the effects of proper or slightly increased relative body mass on an appropriate course of bone tissue remodelling (Mussolino and Gillum, 2008; Porthouse et al., 2004; Reid, 2002). Body weight has also been identified in several reports as a factor affecting peak bone mass (Cadarette et al., 2001; Hawker et al., 2002).

In the study on the predictor variables of normal bone tissue development, differences in bone density and bone size related to sex were pointed out. Larger periosteal circumference in male individuals may result from an increased mechanical load caused by higher mass and greater body surface area in men (Havill et al., 2007).

However, osteoporosis in men is now considered a major public health problem and has become a very interesting field of research. Densitometry makes it possible to measure bone mass and simultaneously provides an image of bone structure and afterwards, the data are processed by computer software. It is included in the canon of diagnostic tests for osteopenia and osteoporosis (Kanis and Johnell, 2005). Bone resilience depends mainly on bone mass and quality. The variable most widely used for measuring bone mass is mineral bone density, which is responsible for approximately 70% of its strength. It is most often expressed in grams per unit of the area (cm^2) or the volume is perceived as the function of peak bone mass and progressive bone mass loss with age (Lewiecki et al., 2008; NIH, 2001).

Physical activity is an important element of human lifestyle. It brings positive changes in various systems of the body. In the skeletal system it improves bone mineralization and optimal bone mass, strengthens and stabilizes joints, increases their range of motion and strengthens the insertions, tendons and ligaments (Cardadeiro et al., 2014; Slemenda et al., 2009). In the muscular system, it increases the cross-section and volume of muscle fibers and increases the tension, strength and elasticity of the muscles (by stabilizing the bone structure and strengthening the muscle corset). Biochemical changes in the body lead to an increased resistance to fatigue and faster recovery. Bone and skeletal muscles involved in locomotion are both derived from somatic mesoderm and accumulate peak tissue mass synchronously, according to genetic information and environmental stimuli (Brotto and Bonewald, 2015). Hypokinesia increases the risk of developing many chronic diseases, such as cancer and cardiovascular, metabolic or musculoskeletal diseases, and is the cause of 6% of deaths worldwide (World Health Organization, 2010b).

Moreover, the correlation between smoking tobacco and BMD was assessed. It was assumed that toxins included in tobacco smoke bring about the weakness of bones and lead to osteoporosis by affecting the activity of osteoblasts and osteoclasts. A group of scientists from Creighton University Medical Center in the USA proved that cigarette smoke stimulates the body to produce excessive amounts of two proteins, i.e., S100A8 and S100A9, which are responsible for the processes of bone mass loss that are constantly occurring in a body. Smoking induces bone loss; however, there is a scarcity of data on the relationship between smoking history and BMD. Long-term smoking may be a risk factor for bone loss in middle-aged men regardless of, height, weight and pulmonary function (Lee et al., 2018).

The aim of this research was to assess the relationship between BMD and such factors as hand grip strength, somatic structure and attitudes to tobacco smoking in men with different levels of physical activity. Our interest in this research area stemmed from activities that pointed to the need for early diagnostic intervention targeting decreased bone mineralization in young adults.

Material and methods

The study included 172 randomly selected men from Warsaw aged 20–30 years with different levels of physical activity. All examined men were students of Warsaw universities.

The study was carried out from 26 September to 2 December 2016 on working days from Monday to Friday. It was conducted in the Department of Anthropology and Health Promotion, Józef Piłsudski University of Physical Education in Warsaw, Poland, in the laboratory of densitometry and anthropometric tests. The team with necessary qualifications and experience in research performed the measurements on the entire study group.

Bone mineral density (BMD), bone mass content (BMC) and T-scores of non-dominant forearm were measured by means of dual-energy X-ray absorptiometry (pDEXA) method using Norland instrument. The effective dose (μSv) for this densitometer is 0.05. The length of the forearm was measured using large anthropometry calipers at the radiale-stylion points (r-sty). There were two measurement points: at the proximal and the distal parts of bone according to the adopted method of densitometry. The Norland pDEXA has a general distal site (radius + ulna), general ⅓ proximal site (radius + ulna), and a ⅓ proximal radius site. Regression statistics were reported for all similar regions of interest (ROIs). The distal ROIs span 10 mm of the lowest BMD region in the distal forearm and are found using an automated search routine. The proximal site spans 10 mm starting at the ⅓ forearm length and continuing proximally (Norland Medical System pDEXA). The choice to investigate the forearm can give information on the possibility to have a