



INVITED REVIEW

# Fatness and fitness related to exercise in normal and obese children and adolescents



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## KEYWORDS

Body fat;  
Physical fitness;  
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**Abstract** The main aim of this article is the review of selected longitudinal studies (lasting from several months up to 14 years in the same groups) investigating body fat indicators in relationship to physical activity, exercise and fitness levels in normal weight and obese children and adolescents from preschool age. Special attention was focused on complex simultaneous observations which included body composition, cardiorespiratory efficiency, motor abilities, and dietary intake in their mutual relationships, also with regard to secular changes along the last 50 years up to the present. Musculoskeletal problems related to excess fatness were also considered.

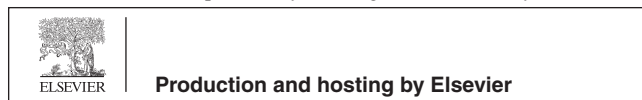
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## Contents

1. Introduction . . . . .	246
2. The role of exercise in morphological and functional development. . . . .	246
3. Secular effect of reduced physical activity . . . . .	246
4. Causes of increased adiposity and reduced physical fitness . . . . .	247
5. Secular changes of adiposity and the effect of exercise in preschool age. . . . .	247
6. The effect of adaptation to exercise in schoolchildren and adolescents. . . . .	247
7. Body composition and functional capacity in growing obese . . . . .	248
8. Food intake in the growing obese . . . . .	248
9. Effect of reduction treatment and prevention in the obese by exercise . . . . .	249
10. Inpatient treatment of obese children. . . . .	249
11. Effects of the interruption of exercise . . . . .	249
12. Musculoskeletal problems due to excess body fat and reduced fitness . . . . .	250
13. Conclusions and perspectives . . . . .	250
References . . . . .	251

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## 1. Introduction

The increasing standard of economic conditions during the last decades enabling the full availability of food and allowing for changes in the composition of dietary intake has been contributing not only to an accelerated growth in height and weight, but also to a disproportional development of body composition, resulting in overweight and obesity. In 2011, more than 40 million children under the age of five were overweight globally, including developing countries (WHO, 2013). Nutritional intake, from the point of view of energy content and density has not been collocated to real dietary needs of the growing organism (WHO, 2010a,b,c, 2011, 2013; Vignerová et al., 2007; ENHIS, 2009; Cali and Caprio, 2009; Maffei et al., 1998; Tucker et al. 1997; Centers for Disease Control and Prevention, 2008; Cattaneo et al., 2009; Flegal et al., 2010), as well also due to the prevalence of reduced energy output from sedentarism (Rizzo et al., 2007; Tremblay et al., 2011; Rauner et al., 2013, and others).

This situation predisposes the child for increased obesity prevalence, along with accompanying health problems later in life and can be harmful especially in children and adolescents. Metabolic syndrome, cardiovascular diseases, diabetes, orthopedic and psychological problems resulting from obesity have been manifesting during recent decades not only in adults, but also in children during their growth and development (WHO, 2010a,b,c, 2013; Lisková et al., 1998; Livingstone, 2000; Lobstein and Frelut, 2003; Rizzo et al., 2007; Rolland-Cachera, 2012; Rolland-Cachera et al., 2006; Berghöfer et al., 2008; Pařízková and Hills, 2001; Pařízková and Hills, 2005; De Niet and Naiman, 2011). However, up to the present, an exact evaluation of childhood obesity prevalence on the world scale, comparing identically defined representative samples from individual countries and using the same methods and criteria has not been reported. Even when childhood obesity prevalence has been stabilizing in some countries (Cali and Caprio, 2009; Salanave et al., 2009; Kunešová et al., 2011; Townsend et al., 2012 and others), in many other countries obesity has been increasing. This includes transitional ones, as well as the social strata in developing countries which have full availability of food (WHO, 2011).

Various studies followed the mentioned health problems from the point of view of individual aspects (e.g. BMI, nutritional, biochemical, and/or functional ones, etc.), but mainly *not with regard to their mutual interrelationships*, and only during *limited periods of time*. The aim of this review was to focus attention especially on complex studies which have followed up not only morphological parameters such as body composition, but simultaneously also the functional ones (i.e. cardiorespiratory efficiency, aerobic power, motor testing, and others), and also dietary intake and musculoskeletal problems. Main concern was on longitudinal studies of the same groups lasting up to 4, 5, 8 and 14 years of both normal weight and obese individuals, starting with preschool age.

Special attention was focused on the *early development of fitness* – which has been shown to decrease secularly along with increasing fatness since preschool age. Early development of fitness has been shown to be a *predisposition for the preservation of an adequate physical activity regime resulting in desirable good health also later in life*.

## 2. The role of exercise in morphological and functional development

Participation in adequate exercise has been an essential part of the care of the child for optimal development, and also for education. A positive effect has been correlated not only with health and physical performance, but also on the development of personal will and discipline, adaptability, overcoming personal discomfort, achievement of set aims, fair play, teamwork, and so forth. This applies as well up to the present where great attention to physical education and sports occurs in the best schools, Scout organizations and the like.

Early adaptation to optimally increased physical activity and exercise has always prevented excessive adiposity and contributed to the optimal development of vital organs, muscle and skeletal tissue, etc. (Pařízková, 1963, 1977, 1989, 1993 etc.). In addition, when experienced in an optimal way, it contributes to a desirable body posture, the prevention of orthopedic problems, and positively influences psychological development. This applies not only with regard to the present status of the growing organism, but also has significant *delayed consequences* for later life. As shown by the results of experimental models using laboratory animals, significant positive delayed consequences of an adequately increased physical activity during fetal and early growth period on later status of the adult offspring were found (e.g. microstructure of the heart, lipid metabolism; Pařízková, 1978, 1979, 2010; Pařízková and Petrásek, 1978).

## 3. Secular effect of reduced physical activity

The reduction of physical activity and physical work load due to present lifestyle (WHO, 2013) has an essential negative impact on body composition (absolute and relative amounts of fat and fat-free, lean body mass), physical fitness and the level of the functional capacity of the organism especially during growth and development (Pařízková, 1977, 1989; Cali and Caprio, 2009; WHO, 2013; Rauner et al., 2013, and others). This impact is especially marked during preschool age when the need and the level of spontaneous physical activity are significantly highest as compared with following growth periods and adulthood (Pařízková and Hainer, 1995; Sigmund et al., 2009, 2012).

Secular comparison of the results ascertained in children and adolescents in the sixties of the last century, and those at the beginning of this millennium concerning body composition and level of physical fitness – i.e. cardiorespiratory efficiency, motor development, muscle strength, and other functional ones, showed negative changes (Olds, 2009; Tomkinson and Olds, 2007). Reduction of the level of cardiorespiratory fitness (aerobic and anaerobic power) and a worsening of motor development were revealed. Later, the reduction of muscle force also appeared (Tomkinson and Olds, 2007).

Along with the acceleration of growth in the general population during recent decades (i.e. a continual increase of height and weight), fat content in the organism has been increasing relatively more and disproportionately as compared to the other body tissues. Increased fatness has been manifesting even when the body mass index (BMI = weight kg/height m<sup>2</sup>) has not changed more markedly: i.e. changes in body composition

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