Science & Sports (2015) 30, 89—95

Disponible en ligne sur ScienceDirect www.sciencedirect.com

Elsevier Masson France EM|consulte www.em-consulte.com

ORIGINAL ARTICLE

Longitudinal changes of cycling peak power in overweight and normal weight boys

Évaluation du pic de puissance chez des enfants en surpoids

M. Maciejczyk[a,*], J. Szymura[b], J. Gradek[c], J. Cempla[a], M. Wiecek[a]

[a] *Institute of Biomedical Sciences, Department of Physiology and Biochemistry, University of Physical Education, Al. Jana Pawła II 78, 31-571 Kraków, Poland*
[b] *Department of Clinical Rehabilitation, University of Physical Education, Kraków, Poland*
[c] *Institute of Sport, University of Physical Education, Kraków, Poland*

Received 7 May 2014; accepted 29 September 2014
Available online 4 November 2014

KEYWORDS
Anaerobic;
Muscle power;
Force—velocity relationship;
Body composition;
Allometric scaling;
Obesity;
Body fat;
Puberty;
Maturation;
Boys

Summary
Objective. — The purpose of this study was to assign cycling peak power (CPP) in overweight boys, and to determine the longitudinal changes in CPP over the period of 10 to 14 years of age.
Methods. — Eleven overweight and fourteen normal weight boys took part in three exercise tests, which were conducted every two years. The force—velocity test was used to measure CPP. The workload in the force—velocity test was assigned in relation to fat-free mass (FFM). Optimal braking force was defined as the workload used during the sprint in which the highest cycling power was reached.
Results. — The CPP (absolute, relative to free-fat mass, and to body mass raised to the 0.67 exponent) was comparable in overweight and normal weight boys. The relative to body mass CPP was significantly lower in the overweight boys. During growth, systematical increase in the difference in CPP between overweight and normal weight boys was noted. The cycling peak power was noted in both groups at a similar relative to the FFM optimal braking force.
Conclusion. — Longitudinal changes of CPP indicated the constant impairment of anaerobic performance in overweight boys. During growth, the gain of relative to body mass and to FFM cycling peak power is lower in overweight than in normal weight boys. Optimal braking force in pre-pubertal boys remained at a similar level but significantly increased at puberty. This finding should be taken into account for planning measurements of CPP in pre-pubertal and circumpubertal children.

* Corresponding author.
E-mail address: marcin.maciejczyk@awf.krakow.pl (M. Maciejczyk).

http://dx.doi.org/10.1016/j.scispo.2014.09.005
0765-1597/

MOTS CLÉS
Anaérobie ;
Puissance musculaire ;
Relation force—vitesse ;
Composition corporelle ;
Croissance allométrique ;
Obésité ;
Masse grasse ;
Puberté ;
Maturation

Résumé
Objectifs. — Il s'est agit dans cette étude, d'évaluer le pic de puissance (CPP) développé au cours d'exercices de sprint sur ergocycle chez des enfants de 10 à 14 ans en surcharge pondérale, et de déterminer l'évolution au fil du temps de leurs performances.
Méthodes. — Onze enfants en surcharge pondérale, et quatorze de poids corporel normal ont pris part à cette étude en réalisant trois évaluations sur ergocycle en deux ans. Le CPP a été évalué à la suite d'un test de force—vitesse en prenant en considération la masse maigre corporelle (FFM).
Résultats. — Le CPP (exprimé en valeur absolue, relatif à la masse maigre ou à la masse corporelle affectée de la puissance 0,67) est similaire pour les deux groupes d'enfants. Le CPP rapporté au poids corporel est significativement plus faible chez les enfants en surpoids ; au cours de la croissance, la différence de ces valeurs de CPP entre enfants en surpoids et de poids corporel normal s'accroît. La force de freinage optimale rapportée à la masse maigre est observée pour les mêmes niveaux au sein des deux groupes d'enfants.
Conclusions. — Cette étude longitudinale du CPP suggère une altération constante des performances anaérobies chez les enfants/adolescents en surpoids. Au cours de la croissance, le gain de CPP rapporté au poids corporel ou à la masse maigre est plus faible chez les enfants en surpoids que chez les enfants de poids corporel normal. La force optimale de freinage chez les enfants pré-pubères augmente au cours de la puberté, et ce dans les deux groupes expérimentaux. Ces résultats doivent être pris en compte pour la détermination de CPP chez les enfants pré-pubères et au cours de la puberté.

1. Introduction

Anaerobic performance is usually measured using the Wingate Anaerobic Test (WAnT), performed with constant braking force. Dotan and Bar-Or [1] reported a 0.69 N/kg braking force value in the WAnT for active 13—14 years old boys. Since power is the product of force and velocity, maximal power corresponds to optimal values of braking force (F_{opt}), and velocity (V_{opt}) [2,3]. Studies on the force—velocity relationship [4,5] showed the hyperbolic relationship between generated muscle power and velocity as well as the linear relationship between pedalling velocity and workload. Thus, eliciting the cycling peak power (CPP) requires optimal braking force to be individually determined for each participant, without assuming a fixed pattern.

Anaerobic fitness, during growth and development, has not received equal attention from researchers as aerobic fitness [2]. Although in almost daily tasks, games or sports events, the child is primarily involved in short-term supramaximal exercises, most of the scientific literature is devoted to the study of maximal aerobic power [2]. The aerobic performance in overweight children is well documented [6—9], but anaerobic performance is relatively less known in this age group.

During puberty, hormonal and neuromuscular factors are most often associated with the significant increase in muscle tissue. Several studies have described the effect of growth on anaerobic performance. Most of them were cross-sectional studies [10,11] with a smaller number of longitudinal studies reported [12,13]. Only few studies examined the impact of obesity/overweight on anaerobic performance. These studies evaluated the differences between sexes in the level of anaerobic power [14,15], or were only performed once to compare the anaerobic power between obese and normal weight children [16,17]. To our knowledge, no studies have been conducted to evaluate the longitudinal changes in maximal power output in overweight children. Previous attempts conducted in order to assign the braking force indispensable for generating the peak power were usually conducted on children with normal body composition, and the results of those studies showed different values for the braking force [1,18—20]. Determining the optimal braking force in children may be difficult because of changes in body composition with growth, and particularly because of developmental changes in the level of fat-free mass (FFM) [14]. It may be particularly difficult in obese or overweight children who, compared to normal weight children, have a different body composition (greater FFM and fat mass).

The objective of this study was to determine the cycling peak power and optimal braking force in overweight and normal weight boys, and to determine the longitudinal changes of these indicators over the period of 4 years (10 to 14 years of age).

2. Methods

This study obtained approval from Bioethical Commission of Regional Medical Chamber and Education Welfare Service. All participants and their parents/guardians gave informed consent for their children to participate in the study. In order to avoid the practice effect, one week before the main exercise test, participants were familiarized with the maximal cycling on the cycle-ergometer.

2.1. Participants

The exercise tests were conducted every two years. Altogether, three tests were conducted: the first at the age of