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Kinetics of oxygen uptake during high intensity exercise: comparison 11,12 and 13 years old trained boy

Analiza porównawcza kinetyki poboru tlenu podczas wysiłków fizycznych o dużej intensywności u 11,12 i 13 letnich trenujących chłopców

INTRODUCTION

Children's performance in anaerobic exercise is distinctly lower than in adolescents and adults. (Armon at al., 1991) Anaerobic performance continuously increases throughout the various growth and maturation stage reaching peak levels in the second or third decade of life.

Anaerobic performance during growth is strongly correlated with lean body mass, peak power and mean power increased during adolescence. The exact qualitative characteristics that are responsible for the relatively low anaerobic performance of the prepubescent child are not clear. It is known that anaerobic glycolysis is limited in children because of the low concentration of the phosphofructokinase in their muscles (Erikson and Saltin, 1974; Fournier et al.,1992)

One of the major factors influencing on lower anaerobic performance in children is small activity of muscle glycolitic enzymes proportional to ages. It is suggest that children can quickly adapt their oxidative metabolism meet the higher energy requirements and hence, have a lower need for nonoxidative metabolism in the short-term, high-intensity exercise.

Due to this our purpose was to examine:

- oxygen uptake kinetics during 30s Wingate Test
- heart rate in response to 30s Wingate Test

MATERIALS

Ten healthy boys trained soccer volunteered for this study. Each subject performed high intensity cycloergometer test three times. First one was when they are 11-yr old, the second 12-yr old and the third was when they are 13-yr old. Tables 1 and 2 illustrate the anthropological and physiological characterisation of the examined groups.

Table 1. Anthropological characteristics of the examined groups.

	Age [year]	Height [cm]	Weight [kg]	BSA [m 2]	BMI [kg.m2 -1]
11-yr boys n=10	11,2 ± 0,2*	153,8 ± 3,5*	43,1 ± 6,3*	1,4 ± 0,1	18,1 ± 0,7
12-yr boys n=10	12,1 ± 0,2*	155 ± 4,8*	43,6 ± 5,2*	1,4 ± 0,1	18,2 ± 1,2
13-yr boys n=10	13,1± 0,2	161,9 ± 5,9	48,6 ± 5,0	1,5 ± 0,1	18,5 ± 1,5
	P< 0,005	P< 0,01	P< 0,05		

Values are means ± SD, n - no. of subject,
* Difference from 13-yr old boys (as determined by paired t-test)
BMI – body mass index, BSA – body surface area

Table 2. Physiological characteristics of the examined groups in rest and during 30s Wingate Test.

	Resting phase			30s Wingate Test		
	VO2 [L.min-1]	VO2 [ml.kg.-1.min-1]	HR [bpm]	VO2 peak [L.min-1]	VO2 peak [ml.kg.-1.min-1]	HR peak [bpm]
11-yr old boys n=10	0,33± 0,1	7,2 ± 1,2	84± 10*	2,7± 0,3	60,9 ± 5,2*	186 ± 8*
12-yr old boys n=10	0,36± 0,1	7,7 ± 1,5	82 ± 9*	2,5± 0,4	56,8 ± 7,5*	185 ± 7*
13-yr old boys n=10	0,36± 0,5	7,1 ± 0,7	72 ± 7	2,4± 0,3	49,6 ± 4,3	178 ± 7
			P<0,02		P<0,02	P<0,05

Values are means ± SD, n- no. of subject,
* Difference from 13-yr old boys (as determined by paired t-test)
HR-heart rate, peak -peak of parameters during 30s Wingate Test

METHODS

We used Bar-Or's 30s Wingate Test in which the exercise is performed at a maximal rate from the onset of exercise (Bar-Or, 1987). During this test we measured VO2, VCO2 and HR in every 5sec. period using the expiratory gas analyser K4 b2 of Cosmed. The Ethical Committee of Scientific Researches at the Medical University of Gdansk approved this study.

RESULTS

The obtained data showed that in high-intensity exercise the VO2 on-kinetics was significantly faster in younger then in older boys. We also showed the VO2 responses at the onset of maximal exercise with tendency for younger boys to have faster VO2 peak and the greater initial increase in VO2.

The oxygen consumption in the first 10sec of test was 29,4 ± 7,1; 29,5 ± 6,8 and 23,6 ± 6,4 [ml.kg.-1.min-1] in 11yr, 12yr and 13yr old boys respectively. The VO2 peak [ml.kg.-1.min-1] in last 5"-10" of exercise was 59,7± 3,6 in younger boys, whereas in older 48,1± 4,7 (values are means ± SD). This data supported hypothesis that younger boys can quickly adapt their oxidative metabolism even in such a short lasting exercise. Data from other studies (Williams at al. 2001, Hebestreit at al. 1998, Cooper 1996) also supported our results.

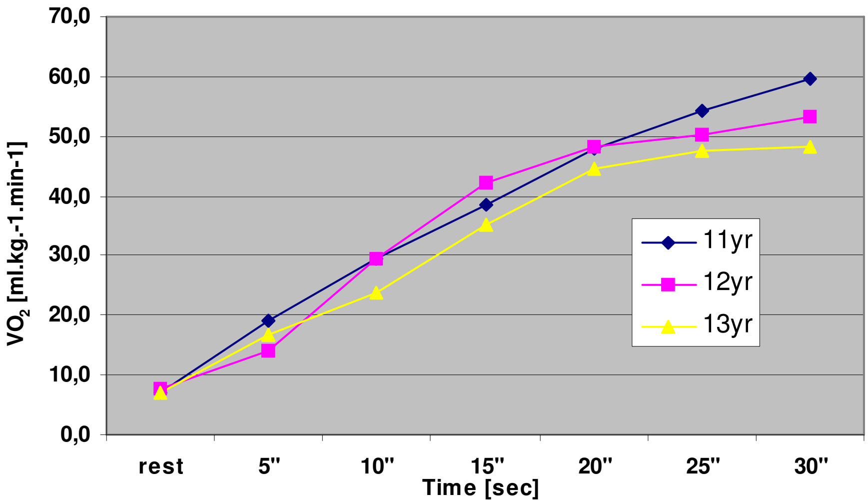

Fig 1. Kinetics of VO2 uptake during 30s Wingate Test.
Significantly different between groups in 10";15"; 25" (p<0,05) and 30" (p<0,001) as determined by paired t-test

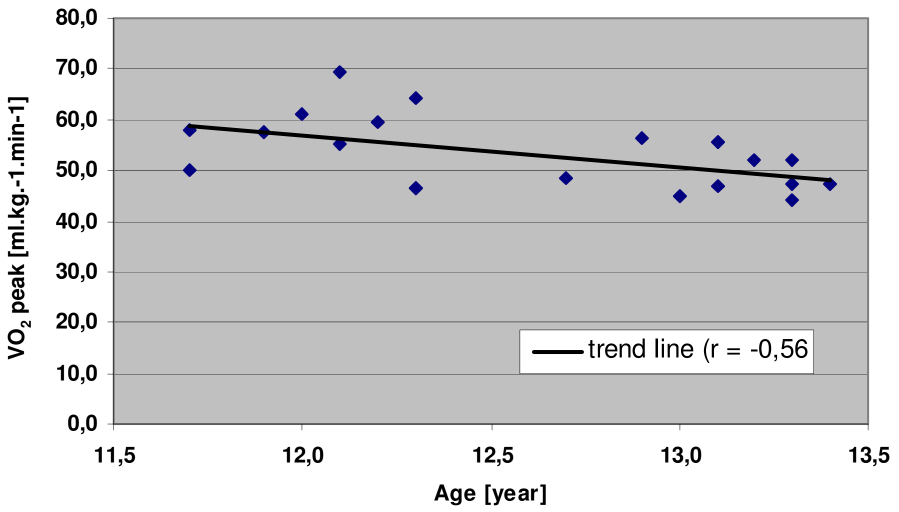

Fig.2 Relationship between age of subject and VO2 peak in 30s Wingate Test

We showed negative correlation (r = -0,56) between age of examined subject and VO2 peak expressed in [ml.kg.-1.min-1]. Figure 2 presented this correlation. There is no similar correlation in heart rate contrary to what has been expected.

We also showed significantly difference in heart rate kinetics in response to exercise. In the first 5-10" of Wingate Test younger boys have higher HR value than older ones.

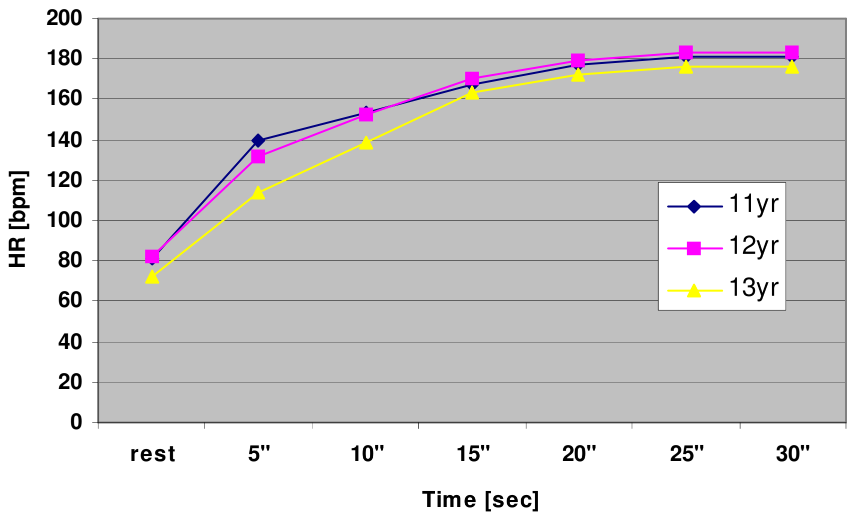

Fig 3. Kinetics of heart rate (HR) during 30s Wingate Test

Significantly different between groups in 5" (p<0,02) and 10"(p<0,05) .

DISCUSSION

The obtained data showed that in high-intensity exercise the VO2 on-kinetics was significantly faster in younger then in older boys. We also showed the VO2 responses at the onset of maximal exercise with tendency for younger boys to have faster VO2 peak and the greater initial increase in VO2. Data from other studies (Williams at al. 2001, Armon at al.1991, Hebestreit at al.1998) supported our results.

This supported hypothesis that in children during supramaximal exercise major source of energy is yielding from aerobic metabolism.

We want to still perform longitudinal examination of continuously changes in the anaerobic power and capacity in boys and the effect of training on anaerobic metabolism

Our results using cycloergometer 30s Wingate Test add to the limited number of studies defining children's VO2 kinetic responses to supramaximal exercise. More studies are required using a wider range of exercise-intensity domains, different test modalities, and assessment of maturity differences to define children's VO2 kinetic responses to exercise more fully.

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ABSTRACT

The purpose of this work was to examine oxygen uptake (VO2) kinetics in young boys during short-term, high-intensity exercise. Ten healthy boys trained soccer volunteered for this study. We performed longitudinal examination. Each subject performed 30s Wingate Test. three times (in age of 11,12 and 13) During this test we measured VO2, VCO2 and HR in every 5sec period using the expiratory gas analyser K4 b2 of Cosmed.

The obtained data showed that in high-intensity exercise the VO2 on-kinetics was significantly faster in younger then in older boys. We also showed the VO2 responses at the onset of maximal exercise with tendency for younger boys to have faster VO2 peak and the greater initial increase in VO2.

STRESZCZENIE

Wielu autorów sugerowało w swoich pracach ograniczone możliwości dzieci do wykonywania wysiłków fizycznych o dużej intensywności. Główną przyczyną takich ograniczeń jest mniejsza aktywność kluczowych enzymów glikolitycznych. Celem niniejszych badań było określenie kinetyki poboru tlenu w krótkich wysiłkach fizycznych o dużej intensywności., a tym samym określenie na ile może być wykorzystany do pokrywania zapotrzebowania energetycznego pracujących mięśni. W tym celu wykorzystano 30s Wingate Test , który powtórzono trzykrotnie w odstępach 1 roku między kolejnymi testami. Podczas trwania testu mierzono pobór tlenu , wydalanie dwutlenku węgla, parametry wentylacyjne płuc i częstość skurczów serca. Wykazano istotne różnice w poborze tlenu u młodszych chłopców w stosunku do ich poboru tlenu w latach kolejnych. Uzyskane wyniki potwierdzają hipotezę o większych możliwościach aktywacji tlenowych szlaków metabolicznych u młodszych dzieci nawet w bardzo intensywnych wysiłkach krótkotrwałych.