Endurance ability characteristics of professional sportsmen

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ABSTRACT

Rozenstoka S. Endurance ability characteristics of professional sportsmen. *J. Hum. Sport Exerc.* Vol. 7, No. Proc1, pp. S166-S172, 2012. Cycling and kettlebell sport are cyclic kinds of sport. For sport achievement is important the development of endurance ability. In kettlebell sport high performance is based on the strength endurance. One of the conditions for success in competition is sportsman's high aerobic and anaerobic capacity. Complex cardiopulmonary exercise testing allows for simultaneous study of the responses of the cardiovascular and pulmonary systems to a stated physical load stress. There is direct correlation between physical work capacity and functional ability of the body. Determining aerobic and anaerobic ability is equally important for estimating functional abilities of the body. The performance of muscular work requires physiological responses of the body systems to be coupled in order to increase metabolic rate. The aim of the study is to assess the difference of basic parameters of physical work capacity during physical load between professional cyclists and kettlebell lifters. Physiological testing of sportsmen as an integral part of professional sport now can show the physical work capacity and the functional ability of the body. Regular endurance load causes one of the adaptation changes of cardiovascular system with decreasing of heart rate during the rest and load. Relative maximal physical work capacity is relevantly higher for professional cyclists for about 27% than it is for kettlebell lifters. Aerobic and anaerobic thresholds increase in regular endurance trainings. The body clearly has an upper limit for oxygen uptake at present state of condition, physical training of the body and person's practice regime. Maximal oxygen uptake is relevantly higher about 24% for professional cyclists than it is for the kettlebell lifters. **Key words**: ENDURANCE, CARDIOPULMONARY TEST, HEART RATE, OXYGEN UPTAKE.

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E-mail: info@sportlab.lv
6th INSHS International Christmas Sport Scientific Conference, 11-14 December 2011. International Network of Sport and Health Science. Szombathely, Hungary
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202

doi:10.4100/jhse.2012.7.Proc1.18

INTRODUCTION

Cycling and kettlebell sport are cyclic kinds of sport. For sport achievement in cyclic kinds of sport is important to develop endurance ability, which allows muscles to work intensive and resist muscle fatigue. High performance is based on the strength endurance in kettlebell sport, this physical ability is composed from strength and endurance (Rudnev, 2010). Endurance of the sportsmen has been described by aerobic capacity indicators: physical work capacity at aerobic and anaerobic threshold load, heart rate changes during the load and oxygen uptake. For success in competitions of mentioned kind of sports is high aerobic and anaerobic capacity (Lescinskis, 2010). In cycling and kettlebell sport are possible to get excellent result by another factors: movement economy, ability to develop high speed with less oxygen consumption (Shave, 2006).

Complex cardiopulmonary exercise testing is now the standardised method for the evaluation of the functions of cardiovascular and breathing systems and physical work capacity of the body. It is well suited for prophylactic screening of healthy people. Complex cardiopulmonary exercise testing is quantitative which also allows gauging the severity of dysfunction (Wasserman, 2005).

The aim of the study is to assess the difference of basic parameters of physical work capacity during physical load between professional cyclists and kettlebell lifters.

Physical load tolerance and sports achievements depend on 3 major body systems which limit possibilities to do or continue any severe physical activity (Rozenstoka, 2011). These systems have to work together simultaneously and effectively:

1. The cardiovascular system – provides blood supply and oxygen transport;
2. The breathing system – provides oxygen uptake and carbon dioxide elimination out of the body;
3. The body muscle groups (legs muscle) which are involved in physical work with muscle weakness, pain, energy reserve and the activity of ferment systems.

MATERIAL AND METHODS

In study voluntary participated 39 professional sportsmen, 19 of which were cyclists and 20 were kettlebell lifters (Table 1). Professional cyclists average age was 21 ± 1 year, mean height 185.4 ± 1.5 cm, mean weight 76.2 ± 1.7 kg, mean Body mass index 22.1 ± 0.2 and they have regular training regime: 6 days per week, 2-3 hours 1-2 times per day. But professional kettlebell lifters average age was 23 ± 1 year, mean height 181.4 ± 2 cm, mean weight 76.9 ± 3.0 kg, mean Body mass index 23.4 ± 0.4 and they have regular training regime: 5-6 days per week 2-3 hours once a day.

Table 1. *Material used to conduct the research*

Names of the groups	Cyclists	Kettlebell lifters
Description of group	Professional sportmen	Professional sportsmen
Number of participants	19	20
Gender	Men	Men
Age	21 ± 1 year	23 ± 1 year
Weight	76.2 ± 1.7 kg	76.9 ± 3.0 kg
Height	185.4 ± 1.5 cm	181.4 ± 2 cm
Body mass index	22.1 ± 0.2	23.4 ± 0,4
Training regime	Regularly, 6 days per week, 2-3 hours 1-2 times per day	Regularly, 5-6 days per week 2-3 hours once a day

Methods
Analysis of special literature;
Anthropometric methods: weight, height, BMI (Body Mass Index);
Complex load test on Cardiopulmonary system Master screen CPX, ISO certified (Test protocol: relaxation – 2 minutes, reference – 2 minutes, load phase with load increase – 10W/minute, recovery – 6 minutes);

Statistical analysis
Complex cardiopulmonary exercise testing was carried out in sports doctor supervision and is composed of several parts, duration of them has been established by sports doctor, taking into account the state of health and fitness level.

RESULTS

Physical work capacity
The functional abilities of the body, sports achievement and endurance directly depend on physical work capacity and the level of body adaptation processes to physical load. Regular physical load increases functional ability of the body and physical work capacity. There is a direct correlation between physical work capacity and functional ability of the body. During different testing phases the index of Physical work capacity (W/kg) reveals great differences between the groups (Table 2).

Table 2. *Physical work capacity during different testing phases.*

Group	Rest	Aerobic threshold		Anaerobic threshold		Relative maximal load
		W/kg	%	W/kg	%	
Cyclists	0	3.1 ± 0.1	61	4.4 ± 0.1	86	5.1 ± 0.1
Kettlebell lifters	0	1.4 ± 0.1	38	3.2 ± 0.1	86	3.7 ± 0.1

The difference of average values is statistically confident (p>0.95).

Relative maximal physical work capacity for professional cyclists are 5.1 ± 0.1 W/kg and for professional kettlebell lifters are 3.7 ± 0.1 W/kg. It is relevantly higher for professional cyclists for about 27% than it is for kettlebell lifters. During the aerobic threshold cyclists reach 3.1 ± 0.1 W/kg or 61%, but during the anaerobic threshold - 4.4 ± 0.1 W/kg or 86% from relative maximal load compared with kettlebell lifters who have reached only 1.4 ± 0.1 W/kg or 38% during the aerobic threshold, but during the anaerobic threshold the same as cyclists – 3.2 ± 0.1 W/kg or 86% from relative maximal load (p>0.95). Aerobic threshold relative load capacity is relevantly higher for professional cyclists for about 55% than it is for kettlebell lifters but anaerobic threshold relative load capacity is relevantly higher for professional cyclists for about 27%. The excellent aerobic threshold and anaerobic threshold load capacity is a good indicator of physical work capacity of cyclists (Impellizzeri, 2005). It means that professional cyclists have significantly better aerobic abilities.

Heart rate changes during relaxation, increased physical load and recovery

Regular endurance load causes one of the adaptation changes of cardiovascular system with decreasing of heart rate during the rest and load (Wasserman, 2005). Changes in heart rate during physical load and recovery from the load are mediated by the balance between sympathetic and parasympathetic nervous system. It depends on increased tonus of parasympathetic nervous system during relaxation, decreased request of arterial blood flow of engaged muscles, higher oxygen supply for muscles and improvement of biochemical processes in the muscle.

Professional cyclists have lower heart rate during relaxation than kettlebell lifters, but the difference of average values is not statistically confident (Table 3). Heart rate increases linearly to quantity of physical load. During physical load reduced increase of heart rate for professional endurance sportsmen compensates with the increase of cardiac output. Aerobic and anaerobic thresholds increase in regular endurance trainings. There is a statistical difference between the groups in the heart rate of aerobic threshold and maximal heart rate, but they reach those at different maximal loads. Heart rate of aerobic threshold for professional cyclists is 139 ± 2 beats/min and for professional kettlebell lifters is 129 ± 3 beats/min (p>0.95). There is not statistical difference in the heart rate of anaerobic thresholds (Table 3).

Table 3. *Heart rate during different testing phases.*

Group	Rest		Aerobic threshold		Anaerobic threshold		Maximal load	Recovery 6 min
	beats/min	%	beats/min	%	beats/min	%	beats/min	beats/min
Cyclists	69 ± 2	37	139 ± 2	75	173 ± 2	93	186 ± 2	110 ± 2
Kettlebell lifters	74 ± 2	42	129 ± 3	72	167 ± 3	94	178 ± 1	109 ± 2
The difference of average values is statistically (p>0.95)	not confident		confident		not confident		confident	not confident

The duration of testing load and the appearance of complaints depend on the state of health, functional ability and physical training of a person's body (Wasserman, 2005). For healthy people the reasons of interruption of Complex load testing are reached maximal heart rate, local fatigue of engaged muscles because of lactic acidosis, general fatigue of the body and shortness of breath. During the recovery the decrease of heart rate is connected with the activation of depend on reactivation of parasympathetic nervous system (Mintale, 2008). The difference is not great in changes of heart rate during the recovery after physical load between the groups (Table 3). It could be explain by the difference in reaching maximal load between the groups.

The changes of oxygen uptake during relaxation and increased physical load

Determining aerobic and anaerobic ability is equally important for estimating functional abilities of the body (Wasserman, 2005). During all testing phases for professional cyclists oxygen uptake is higher than kettlebell lifters (Table 4). During physical load the oxygen uptake increases gradually and linearly. The increase of oxygen uptake has direct correlation with increased physical load. The body clearly has an upper limit for oxygen uptake at present state of condition, physical training of the body and person's practice regime. Relative oxygen uptake is used to compare individuals of different body size and to better quantify aerobic physical training. During physical load slow increase of oxygen uptake contributes to reduced muscular efficiency during heavy physical load by recruiting more low-efficiency fast-twitch muscle fibers. It also increases oxygen uptake to satisfy the increased work load of respiration muscles, the heart at high ventilatory and cardiac output responses, involves work of additional muscles, progressive vasodilatation to the local muscle units by metabolic vasodilators, thereby increasing oxygen flow and oxygen consumption at the oxygen deficient sites; additionally contributing to progressive stock up of metabolism and products (Wasserman, 2005).

Table 4. *Relative oxygen uptake during different testing phases*

Groups	Rest		Aerobic threshold		Anaerobic threshold		Maximal load
	ml/kg/min	%	ml/kg/min	%	ml/kg/min	%	ml/kg/min
Cyclists	4.5 ± 0.1 1.3 MET	8	37.7 ± 1.3 10.8 MET	65	51.9 ± 1.3 14.8 MET	92	56.7 ± 1.0 16.2 MET
Kettlebell lifters	4.0 ± 0.1 1.1 MET	9	18.6 ± 0.1 5.3 MET	43	35.9 ± 1.0 10.3 MET	83	43.1 ± 1.4 12.3 MET
The difference of average values is statistically confident (p>0.95)							

Oxygen uptake during the aerobic ATP resynthesis is adequate to supply oxygen needed of engaged muscles (Whipp, 2000). There is statistical difference between oxygen uptake of aerobic and anaerobic threshold in each group. During the aerobic threshold professional cyclists reach 37.7 ± 1.3 ml/kg/min or 10.8 metabolic units but kettlebell lifters – 18.6 ± 0.1 ml/kg/min or 5.3 metabolic units. If oxygen uptake is not adequate, processes of anaerobic ATP resynthesis start and metabolic lactic acidosis is gradually developed. During the anaerobic threshold professional cyclists reach 51.9 ± 1.3 ml/kg/min or 14.8 metabolic units but kettlebell lifters reach - 35.9 ± 1.0 ml/kg/min or 10.3 metabolic units. The difference of average values is statistically confident (p>0.95). Aerobic threshold and anaerobic threshold increase in regular endurance trainings. Professional sportsmen with high aerobic work capacity often do not reached anaerobic zone of ATP resynthesis because kinetic processes of oxygen are more intensive and fatigue takes place in local engaged muscles (Ainsworth, 2000).

One of the best determinants for success in cycling is maximal oxygen uptake (Smith, 1999). The body clearly has an upper limit for oxygen uptake at present state of health, physical training of the body and person's practice regime. It is limited by maximal cardiac output, oxygen saturation of arterial blood, cardiac output factional distribution of engaged muscles and oxygen utilization of muscle cells (Wasserman, 2005). Maximal oxygen uptake is relevantly higher about 24% for professional cyclists than it is for the kettlebell lifters. Maximal oxygen uptake is limited by maximal cardiac output, oxygen saturation of arterial blood, cardiac output factional distribution of engaged muscles and oxygen utilization of muscle cells. Research results show that professional cyclists reach 92% of maximal oxygen uptake but kettlebell lifters reach 83% of maximal oxygen uptake during anaerobic threshold.

DISCUSSION

The performance of muscular work requires physiological responses of cardiovascular and breathing systems to be coupled to increase metabolic rate. The way and proportion of utilization of carbohydrates and fats depend on physical training, intensity of physical load and intensity of metabolism during the load (Wasserman, 2005). Muscle glycogen stores are important in work tolerance. When muscle glycogen becomes depleted, exercising subject senses exhaustion. It would be valuable to make simultaneously Cardiopulmonary and Calorimetry research for endurance kind of sports.

CONCLUSIONS

1.Physiological testing of sportsmen as an integral part of professional sport now can show the physical work capacity and the functional ability of the body.

2.Physical work capacity is relevantly higher for professional cyclists for about 27% than it is for kettlebell lifters. Aerobic threshold relative load capacity is about 55% but anaerobic threshold relative load capacity is about 27% relevantly higher for professional cyclists than it is for kettlebell lifter.

3.There is a statistical difference between professional cyclists and kettlebell lifters groups in the heart rate of aerobic threshold and maximal heart rate reachec at different capacity.

4.Maximal oxygen uptake is relevantly higher for professional cyclists for about 24% than it is for the kettlebell lifters.

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