

PECULIARITIES OF ATHLETES' ADAPTATION AND PREPARATION FOR 24TH WORLD UNIVERSITY GAMES IN BANGKOK

Jonas Poderys, Aleksas Stanislovaitis, Česlovas Garbaliuskas, Mindaugas Ežerskis

Lithuanian Academy of Physical Education, Kaunas, Lithuania

Jonas Poderys. PhD, Habilitated Doctor in Biomedical Sciences, Professor at the Department of Track and Field Athletics, Research Supervisor at the Laboratory of Kinesiology, Lithuanian Academy of Physical Education. Research interests: complex evaluation of athletes' physical fitness and functional condition.

ABSTRACT

Travelling across several time zones exposes the sportsman to a shift of his internal biological clock and the result is a transient desynchronization of the circadian rhythm lasting for several days until the body adapts to new environmental conditions. The subjects of this study were 12 Lithuanian Track and Field athletes participating in the 24th University Games in Bangkok. We used the model of integral evaluation of the body functioning during exercise which integrates changes of three functional elements: P — periphery system (muscles), R — regulatory system (brain), S — supplying system (heart, blood-vessel system). A Finger Taping Test, where the time intervals were recorded in milliseconds between separate motions, and a nonlinear dimensional reduction by grouping them to various components were used for analysis.

We observed a lot of changes in various indices but the main attention was paid to the assessment of indices providing information about the mobilization and recovery of the cardiovascular system and the complexity of body functioning. After the arrival the characteristic feature was a slower mobilization of the body functions at the onset of exercise for the first 4—5 days, though the level of mobilization during the exercise remained the same. Another characteristic feature was the slower recovery of cardiovascular indices after exercise for the first 6—7 days. There were some phases in the process of adaptation after sudden change of geographical and environmental conditions before competition. The first phase of activation of regulatory systems occurred, and the phase of increased energy demands appeared after 48 hours and lasted for the next five days. A wide range of individual variations characteristic of adaptive changes in the body depended on training and competitive experience of athletes, their personality, sleep and behaviour habits and training loads performed before departure to the venue of competitions as well. The behaviour of athletes and training strategies during the first days were important and could help accelerate the adaptation. And on the contrary, heavy training loads could decrease the speed of adaptive changes.

Keywords: cardiovascular system, complexity, recovery, adaptation.

INTRODUCTION

The Olympic Games is the most important competition for elite athletes, and for this reason there is an increased attention to studies designed to assess adaptation of the body to sudden changes in time and environmental conditions. There are a lot of studies meant to analyze the transient desynchronization of circadian rhythm, called jet lag (Buxton et al., 2003; Atkinson et al., 2007; Lagarde, 2007). Additional decrement for

physical performance at the venue of the Olympics Games in Beijing will be hot and wet environmental conditions. All of them require analysis and understanding of the problems of adaptation and peak performance. During the last three years many scientists from different countries have tried to assess the peculiarities of functional changes of elite athletes during such adaptation. The assessment of adaptation and preparation for the

competitions of athletes participating in the 24th University Games in Bangkok presents equally important information.

It is well known that human health, harmonic development of the human body and peak performance strongly depend on the relations between the systems and on the complexity of the whole body. The complexity of human beings has been emphasized over the last century with the appearance of new scientific theories that have influenced biological and social sciences. The human body can be evaluated as a complex system (Biggiero, 2001) which consists of, at least, three holistic systems, and they were mentioned even in 1548 by Vesalius. The decrease of the complexity of the human body leads to disintegration of its functions. We used the model of integral evaluation of the body functioning during exercise (Vainoras, 2002), which integrates changes of three functional elements: P — periphery system (muscles), R — regulatory system (brain), S — supplying system (heart, blood-vessel system). The relation between these systems can be specified by several parameters, but we used the simplest and easier calculated ECG and arterial blood pressure parameters handling with the problems of adaptation and sports performance.

METHODS

The subjects of this study were 12 Lithuanian Track and Field athletes participating in the 24th University Games in Bangkok. Before the arrival and each day after the arrival to the training camp in Bangkok the participants of the study underwent testing procedures, i.e. one or two tests were performed: a) 40 s Finger Taping Test, where the time intervals were recorded in milliseconds between separate motions and a nonlinear dimensional reduction by grouping them to various components were used for analysis; b) Roufier Test (30 squats per 45 s) during which the 12-lead ECG was recorded. The analysis of the results obtained during the study was performed using the model of integral evaluation of the body functioning during exercise (16). A computerized ECG analysis system "Kaunas-load", developed by the Institute of Cardiology of Kaunas University of Medicine, was applied for ECG recording and analysis. The changes in RR interval or heart rate (HR), JT interval, ST-segment depression and changes in the ratio of intervals JT/RR were analyzed. The index of velocity of adaptation to exercise load was defined $V_{Ad} = (JT_1 / JT_0) 100\% - (RR_1 / RR_0) \times 100\%$.

The peculiarities of recovery after workloads was assessed first by evaluating the time of half period of recovery ($t_{1/2} T$) of registered indices and second by Liapunov exponent ($LE_x = 1 / N \sum \ln |\Delta X_i / X_i|$). The sign and value of LE_x was accepted as an indicator of stability in the whole process of recovery (Suetani et al., 2004).

RESULTS

We observed a lot of changes in various indices but the main attention was paid to the assessment of indices providing information about the mobilization and recovery of the cardiovascular system and the complexity of body functioning. The Table presents the dynamics of some cardiovascular indices obtained during the study. The results confirmed the proposition by other outstanding physiologists (Buxton et al., 2003; Atkinson et al., 2007; Lagarde, 2007) that travel across several time zones, exposing the sportsmen to a shift of their internal biological clock and the result are transient desynchronizations of the circadian rhythm lasting for several days until the body adapts to new environmental conditions.

The change in the ratio of JR / RR intervals of ECG allowed to assess the dynamics of the mobilization of the cardiovascular system, i.e. outlining at what extent the cardiovascular function was mobilised during the exercise (Poderys et al., 2006). The results provided in the Table showed that the level of mobilization during the exercise remained the same. However the characteristic feature was slower mobilization of the body functions at the onset of exercise for the first 4—5 days after the arrival. The dynamics of index of V_{Ad} was an evidence of this.

The next characteristic feature was the slower recovery of various indices of the cardiovascular system after exercise for the first 6—7 days and increase in the number of LE_x . One of the reasons of slower recovery after exercising may be the increase of vascular tonus and slowdown in the repolarisation processes, disturbances in balance of electrolytes and changes in dynamic balance between the processes of capillary filtration and reabsorption.

DISCUSSION

Complex dynamic system approach provides the possibility to keep a close watch on individual adaptive changes of athletes and helps them to

Table. Dynamics of cardiovascular indices during the study

Indices		In Lithuania	One day after arrival								
			2	3	4	5	6	7	8	9	10
Mobilization during the Roufier Test (JT / RR)	Before	0.343 ± 0.001	0.352 ± 0.001	0.344 ± 0.001	0.347 ± 0.001	0.352 ± 0.002	0.350 ± 0.001	0.349 ± 0.001	0.342 ± 0.002	0.347 ± 0.001	0.351 ± 0.001
	At the end of Test	0.445 ± 0.001	0.442 ± 0.001	0.446 ± 0.002	0.447 ± 0.001	0.443 ± 0.001	0.446 ± 0.002	0.439 ± 0.001	0.438 ± 0.002	0.444 ± 0.001	0.443 ± 0.001
Velocity of adaptation (V_{Ad} , %)		18.9 ± 0.31	20.6 ± 0.32	26.3 ± 0.37	27.5 ± 0.36	23.8 ± 0.32	20.2 ± 0.30	19.8 ± 0.31	20.1 ± 0.32	20.4 ± 0.31	19.9 ± 0.33
Total number of LEX having a positive effect		4	15	15	12	10	5	3	4	3	3
Sequence in recovery of ECG indices JT / RR — RR — JT (number of accidents)	Optimal	12	11	9	6	6	7	9	11	10	11
	Chan- ged in sequen- ce	0	1	4	6	6	5	3	1	2	1

adapt to the environmental changes and the local conditions better and faster. Our results showed a wide range of individual variations in the character of adaptive changes. On the other hand the schedule of the day and the training loads must be planned with attention. There were cases when athletes performed exhorting training load soon after arrivals which led to worse adaptation, and exercises of low or moderate intensities could help to deal with some depression and were useful for faster adaptation.

There are quite many publications and reviews concerning the effects and the mechanism of acclimatization to heat (Coris et al., 2004). Summarizing the outcomes of these studies we can claim that the main effects of acclimatization to heat is an increase in blood volume, increase of sweat rate, onset at lower core temperature, greater distribution of fluids over the body surface, decrease of sodium and chloride content of sweat and urine; decreased perception of effort at the same amount of workload.

The analysis of the obtained results in the pre-competitive training camps using the complex dynamic system approach allowed us to distinguish a few phases of adaptation. The phase of activation of the regulatory system occurs first, and quite good performance could be achieved by athletes during these days. Dynamics of RR inter-

val changes and increased values of adaptation to exercise (V_{Ad}) are some of the significant indices. Besides, we observed an increase of LEX having a positive effect.

A significant change in values and dynamics of JT intervals of ECG was found starting from the third day after arrival. This and the dynamics of ratio JT / RR during exercise test is an index of the second phase — increased energy demand which is required for various body functions during adaptation. The next characteristic feature is the slower recovery of various indices (time of the half period of recovery — $_{1/2}T$) of the cardiovascular system after exercise. The duration of these changes (the duration of the second phase) was individual and lasted for 3—5 days. The training strategies of athletes were also influential.

Peak performance is one of the most complicated and important issues in coaching. Training strategy is directed towards the achievement of high performance level. However, there is only a limited number of days when an athlete can achieve his or her best result which is characterized as peak performance (Virus, 2004). The most desirable thing is to have the peak performance at the most important competition. The state ensuring the peak performance should be related to the special tuning of the regulatory mechanisms (Virus, 2004). The result of this “tuning” is an extreme mobilization of pos-

sibilities of neuromuscular apparatus and body resources. The tuning should involve the central nervous and endocrine systems (Viru, 2004). The period of extreme concentration and motivation may have a negative influence on peak performance as well, and that is why special attention must be given to the structure of the preparation and training design. How can we control this? Various methods could be used to evaluate of this process. Finger Taping Test, when the duration of each movement is registered and analyzed using nonlinear dimensional reduction by grouping them to various components seems to be one of the simple and sensitive methods for assessing the peculiarities of central commands CNS related to tuning regulatory systems when obtaining peak performance. The rational model of hormonal changes suggests the decline of testosterone level in the mid-season with subsequent increase prior to the competition and opposite dynamics for cortisol (Viru, 2004). The increased anxiety suppressed excretion of testosterone during post-exercise recovery, similarly to the cortisol level which is also subjected to psychological stressors (Mujika et al., 2004; Filaire et al., 2007). Training insufficiency leads to hormonal changes modifying metabolic responses, which shift towards anaerobic and catabolic prevalence in the athletes' loss of aerobic component of preparedness and the reduce of muscle mass (Isurin et al., 2005). The training loads with a high intensity of exercise helped to deal with this.

Peculiarities of body functioning during exercise after a sudden change of time and environmental conditions was studied by many of scientists but their application under other conditions remains ambiguous due to very limited sample sizes and the wide range of individual variations in the behavior of sportsmen. Nevertheless all

these studies provide a great amount of information and the implementation of the findings or observed phenomena should be individualized and creative.

CONCLUSIONS

1. Travelling across several time zones exposes the sportsman to a shift in his internal biological clock and the result is a transient desynchronization of the circadian rhythm lasting for several days until the body adapts to new environmental conditions.
2. After the arrival the characteristic feature is the slower mobilization of body functions at the onset of exercise for the first 4—5 days, though the level of mobilization during the exercise remains the same. The next characteristic feature is the slower recovery of cardiovascular indices after exercise for the first 6—7 days.
3. There are some phases in the process of adaptation to sudden change of geographical and environmental conditions before competition. The phase of activation of the regulatory systems occurs first, and the phase of increased energy demands appears after 48 hours and lasts up to the next five days.
4. The wide range of individual variations characteristic to adaptive changes in the body depends on training and competitive experience of athletes, their personality, sleep and behaviour habits, and the training loads performed before departure to the venue of competition as well. The behaviour of athletes and training strategies during the first days are important and can help accelerate the adaptation. And on the contrary, heavy training loads can decrease the speed of adaptive changes.

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BANKOKO 24-OS STUDENTŲ UNIVERSIADOS LENGVAATLEČIŲ ADAPTACIJOS IR PASIRENGIMO VARŽYBOMS YPATYBĖS

Jonas Poderys, Aleksas Stanislovaitis, Česlovas Garbaliuskas, Mindaugas Ežerskis
Lietuvos kūno kultūros akademija, Kaunas, Lietuva

SANTRAUKA

Kelionės, kurių metu kertama daug laiko juostų, sutrikdo žmogaus cirkadinius ritmus ir prireikia atitinkamo laiko, kol organizmas prisitaiko prie naujos aplinkos. Šio tyrimo metu tirta 12 lengvaatlečių, dalyvavusių pasaulio studentų universiadoje Bankoke. Funkcinės būklės vertinimo modelis, integruojantis trijų organizmo holistinių sistemų — vykdančiosios (raumenų), aprūpinančiosios (širdies ir kraujagyslių) bei reguliavimo (centrinės nervų) funkcinius rodiklius, buvo panaudotas adaptacijos eigai vertinti. Tepingo testo rezultatai, kai piršto judesio ciklo trukmė matuojama milisekundėmis, buvo sugrupuoti į įvairaus dydžio duomenų grupes, apskaičiuojami koreliacinės dimencijos įverčiai ir panaudoti kaip papildomas rodiklis.

Tyrimo rezultatai parodė, kad atvykus į Bankoką dėl neįprastų sąlygų sportininkai kelias dienas patyrė adaptacinius pokyčius, t. y. pamažu grįžo į normalią būseną. Atliekant fizinius krūvius, organizmo mobilizacijos laipsnis iš esmės nesikeičia, tačiau ji vyksta lėčiau — sumažėja adaptacijos greitis. Pirmomis atvykimo dienomis reikšmingai sulėtėja atsigaivimo procesai. Atvykus pirmas dvi tris dienas pastebimi didesni organizmo reguliacinių sistemų pokyčiai, o aprūpinančiųjų sistemų didesnio laipsnio mobilizacija (antra adaptacijos fazė) pastebima 3—7 dieną. Didelė individualių pokyčių įvairovė susijusi su sportininkų treniruočių ir varžybine patirtimi, individualiomis ypatybėmis, miegu ir fiziniu aktyvumu per dieną, su treniruotės krūviais, atliktais prieš išvykstant į universiadą. Sportininkų dienvakare ir treniruotės krūviai pirmomis atvykimo dienomis yra labai reikšmingi veiksniai, galintys pagreitinoti adaptaciją. Priešingai, per dideli ir sunkūs fiziniai krūviai lėtina adaptaciją.

Raktažodžiai: širdies ir kraujagyslių sistema, kompleksiskumas, atsigaivimas, adaptacija.

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Jonas Poderys
Lithuanian Academy of Physical Education
(Lietuvos kūno kultūros akademija)
Sporto str. 6, LT-44221 Kaunas
Lithuania (Lietuva)
Tel +370 37 302650
E-mail j.poderys@lkka.lt