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Latent Hypertension and Dysautonomia Among Athletes With Office Prehypertension During One Year Training Macrocycle

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Abstract: *The research topicality is needed to diagnose in time and correct properly athletes' autonomic dysfunction (especially among sportspeople with pre-pathological states). The study of latent hemodynamic changes and detection of dysautonomia among prehypertension athletes (particularly those who train heavily) is a promising way to raise sportsmen's health and achievements.*
The research purpose is a hemodynamic profile study of athletes with office prehypertension during different training macrocycle periods.
Methods. *The research comprised 30 athletes of acyclic activity. Their average age was 23.1 (2.71) years. Females were nine individuals (30%). We monitored arterial blood pressure and heart rate in each macrocycle period, carried out the dysautonomia test and established anamnesis and complaints.*
Results. *For prehypertension athletes, the most challenging moment was the competition period. Therefore, the systolic arterial hypertension rate within preparation, competitive and transition training periods was 17%, 47% and 7% ($\chi 2=14.53$; $p<0.001$) while the diastolic one was 17%, 37% and 7% respectively ($\chi 2=8.75$; $p=0.012$). Significantly, we observed an increasing possibility of arterial blood pressure rise over normal values among dysautonomia athletes during the competition period (RR=3.27 ($p=0.01$); OR=8.33 ($p=0.006$)). However, during the preparation and recovery periods, arterial hypertension possibility was not significant ($p>0.05$).*
Conclusions. *In the competition period of training macrocycle is highly expectable development of arterial hypertension of latent course in athletes with office prehypertension. Besides, the relative risk of latent arterial hypertension in extra-training time increases if there are other symptoms of dysautonomia, but these changes are not persistent. However, their proper diagnosing and correcting may lead to athletes' better health and achievements*
Key words: *arterial blood pressure, office prehypertension, dysautonomia, arterial hypertension in athletes.*

Introduction

According to the latest review of the European Guidelines for Management of Arterial Hypertension (Williams, B., et al. (2018), systolic pressure of 130-140 mm Hg and a diastolic pressure of 85-90 mm Hg are regarded as high average values of arterial pressure (prehypertension). In such a pre-pathological state, there is an increasing rate of undesirable cardiovascular problems, e.g., persistent hypertension (Kokubo, Y., & Kamide, K. (2009). In terms of sports activities, there are currently no data on system differences in approaches to predicting and assessing probable risks during arterial blood pressure rise among sportspeople and other persons (Berge, H. M., Isern, C. B., & Berge, E. (2015), Pescatello, L. S., et al. (2019). Athletes' arterial blood pressure increase is noted to depend on physical load (prevalence of cyclic or acyclic exercises). It is the most typical problem within examinations: usually, there are over two-thirds of prehypertension sportspeople among all examined people. Besides, high arterial pressure is considered to influence myocardium change (Hedman, K., et al. (2019). According to our research Brizhatyi, A., et al. (2020), prehypertension athletes are more sensitive to repolarization disorders detected in people with athletic heart syndrome.

The main reasons for arterial blood pressure rise are chronic stress (caused by overtraining) and subsequent autonomic regulation disorders (occurring as inhibited parasympathetic reactions and hyper-activated sympathoadrenal system) (Baumert, M., et al. (2006). Although prehypertension is not regarded as a pathological state, hypertension progress can bring serious consequences. Nevertheless, one should base the hypertension diagnosis on the persistence of detected hypotension changes (Williams, B., et al. (2018). Our works note that top athletes need thorough screening to search for latent pathologies (particularly, to assess the cardiovascular state) Ataman, Y., Korzh, V., et al. (2019), Ataman, Y., Brizhata, I., et al. (2020). In the case of arterial hypertension, the ambulatory blood pressure checks among football players with average values defined latent hypertension when the rate was 30-50% (Berge, H., Andersen, T., Solberg, E., Steine, K. (2013).

Latent hypertension rises among young and physically active people because of stress and exercise (especially those with high normal arterial blood values (Williams, B., et al. (2018), while cardiovascular risk may occur more often than persistent hypertension. The above-mentioned European guidelines offer the use of the ambulatory or home arterial blood pressure check to detect latent hypertension. However, the ambulatory check has many drawbacks that affect athletes' training significantly. They mainly are training discomfort, daytime activity changes and hemomanometer sleep use. The home arterial blood pressure check does not have such drawbacks. It is more suitable to apply in unusual training circumstances and measure the pressure regularly for the whole day (Vischer, A. S., & Burkard, T. (2016). Since hemodynamic changes occur among athletes (especially those who often practise strength exercise (Kreher, J., & Schwartz, J. (2012), we decided to study arterial blood pressure profiles during three-period in a year training macrocycle. It consists of the preparation, competition and recovery periods (Platonov, V. N. (1997), Garrett, W., Kirkendall, J., & Kirkendall, D. (2000). They differ in physical and emotional loads, flight adaptation challenges, circadian disorders, diets, etc. Such factors may significantly affect athletes' overall health state and arterial blood pressure values.

The research purpose was to study hemodynamic profile of acyclic athletes with office prehypertension during different year macrocycle periods.

MATERIALS AND METHODOLOGY

We conducted our research within a group of 30 athletes (jumping, throwing, hurdling, shot put) at the Sumy State University Sports Medicine Centre in 2017-2021. Weekly training activity of all examined people had been over 8 hours within the last three months until the research began. Athletes accepted the research proposal after an advanced examination during the first ten days of the preparation period. The average age was 23.1 (2.71) years. Females were six individuals 9 (30%). Sports anamnesis duration was 10.1 (2.95) years. Although six persons (23.3%) revealed chronic locomotive problems, they might train and compete. All participants consented to conducting the research and processing their data. The Sumy State University Medical Institute Bioethical Commission considered and approved the issue of bioethical standards compliance within the research.

We measured the office arterial blood pressure via the oscillometric method (with a proper cuff size as to upper arm features, according to standardized principles of office blood pressure measurement) Vischer, A. S., & Burkard, T. (2016), James, G. D., & Gerber, L. M. (2018). Athletes measured their blood pressure twice a day: after waking up and in over 2 hours since the end of evening training. They performed such a procedure for 3-7 days (M=5.9 (1.2) days) as to the principles of home blood pressure check (Vischer, A. S., & Burkard, T. (2016), Stergiou, G., Kario, K., Kollias, A., McManus, R., & Ohkubo, T. (2018). Besides, all athletes provided their anthropometric measures and complaints. They also completed the Vein test (Vein, A. (1998), and general examination. The principle mentioned above occurred every four months in the year macrocycle's preparation, competition, and recovery periods. The year preparation period lasted for 228.1 (16.2) days. The competition period was 63.4 (6.1) days. The recovery period (including unplanned ones) comprised 72.0 (6.6) days.

We carried out the statistical analysis via the open web resource *socscistatistics.com* keeping medical statistics rules. The average values are indicated as M (SD), where M is means, SD is standard deviations. Discrete variables are shown as a percentage. We compared them by calculating the $\chi 2$ criterion and the Yates correction (Haviland, M. G. (1990). Besides, we contrasted the means of different macrocycle periods via the ANOVA methodology for regular measurements. Rate values were contrasted to determine the $\chi 2$ criterion. We measured the relative risk value (RR) to compute the symptom progress probability. To relate these factors to the arterial blood pressure levels, the odds ratio (OR) was used. The value of $p<0.05$ was regarded as statistically significant.

RESULTS

We established that typical symptoms of athletes' prehypertension were chronic stress and vegetative dysfunction (table 1). Notably, weakness, sleep and exercise tolerance disorders occurred most often. The competition period was the hardest: the rate of practically all symptoms was the highest (p<0.05). On the other hand, in case of recovery and no need to keep fit, the symptoms softened (even compared to the preparation period). Remarkably, only two individuals (8%) revealed sleep disorders within the recovery period against five persons (20%) of the preparation period. The Vein index confirmed the obtained data (the vegetative dysfunction integrative index). We found its highest values of 9.44 (6.62) points among athletes of the competition period.

Table 1. *Dynamics of anthropometric measures, training activity peculiarities and symptom presence during the year training macrocycle*

Measure	Preparation period	Competition period	Recovery period	p
Body weight index (kg/m^2)	24.6 (5.25)	22.92 (4.32)	24.41 (4.37)	<0.001
Adipose tissue percentage	15,88 (3.14)	15,05 (3.71)	19.62 (5.1)	0.002
Average weekly training activity (hours)	18,45 (2.66)	15.35 (3.2)	12.17 (3.80)	<0.001
Weakness for at least 2 weeks	3 (10%)	12 (40%)	4 (13%)	0.008
Sleep disorders	5 (17%)	11 (37%)	2 (7%)	0.013
Higher efforts for standard exercise loads	9 (30%)	15 (50%)	3 (10%)	0.003
Higher sensitivity to cold and heat	6 (20%)	8 (27%)	3 (10%)	0.252
Other vegetative dysfunction symptoms	6 (20%)	9 (30%)	3 (10%)	0.221
Vein index (points)	4.48 (5.16)	9.5 (6.58)	3.22 (3.46)	<0.001
Rest heart rate during office control (beats/minute)	56.7 (10,23)	57.7 (8,72)	60.4 (8,59)	0.023

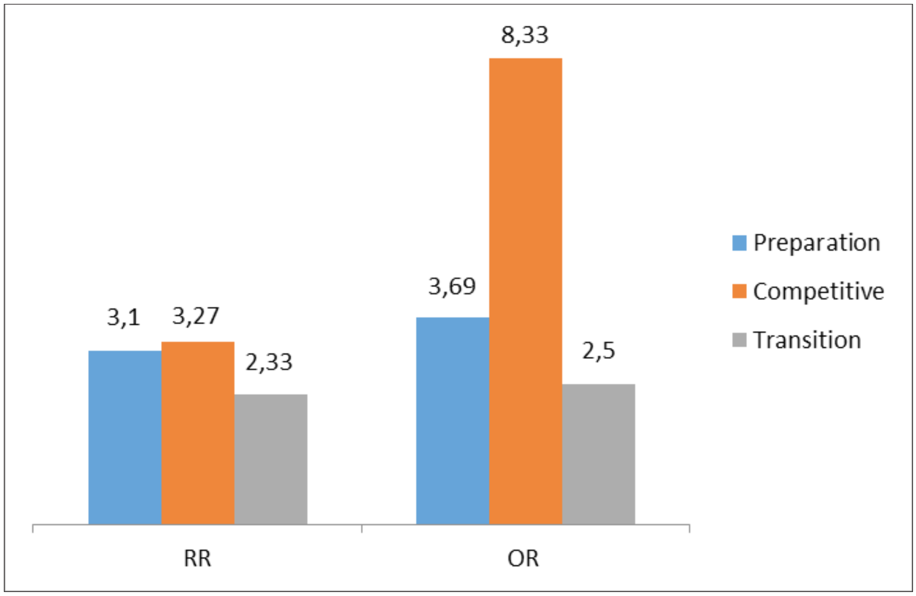
Comparing average office arterial blood pressure values with those of maximal home ones, we established a considerable prevalence of systolic and diastolic pressure for the competition period (p<0.001). Meanwhile, the preparation period showed lower blood pressure values (table 2).

Table 2. *Mean office and home arterial blood pressure on different stages of athletes' training*

	Preparation period	Competition period	Recovery period	p
Office systolic arterial blood pressure	134.65 (3.36)	136.29 (3.1)	129.58 (7.28)	<0.001
Home systolic arterial blood pressure	136.41 (7.02)	141.91 (10.22)	131.2 (8.51)	<0.001
Office diastolic arterial blood pressure	83.77 (4.57)	85.55 (3.1)	79.45 (4.79)	<0.001
Home diastolic arterial blood pressure	85.2 (6.17)	91.57 (5.25)	80.33 (6.75)	<0.001

Comparing the rate values, we defined that latent arterial hypertension had prevailed in the competition period as well (detected only via home measurement). Therefore, the systolic arterial hypertension rate within three subsequent periods was 17%, 47% and 7% ($\chi 2$=14.53; p<0.001) while the diastolic one was 17%, 37% and 7% respectively ($\chi 2$=8.75; p=0.012). In three cases (10%), hypertension had an isolated systolic character possibly caused by measurement problems. We also calculated the relative risk (RR) and the odds ratio (OR) of latent arterial hypertension among prehypertension acyclic athletes depending on vegetative dysfunctions (figure 1).

Figure 1. Comparing the relative risk (RR) with the odds ratio (OR) of latent arterial hypertension depending on dysautonomia and training year macrocycle periods



Significantly, we observed an increasing possibility of arterial blood pressure rise over normal values among dysautonomia athletes during the competition period (RR=3.27 (p=0.01); OR=8.33 (p=0.006)). However, during the preparation and recovery periods, arterial hypertension possibility was not significant (p>0.05).

Discussion

Acyclic activity requires exercising variably: one should alternate strength loads with anaerobic energy supply for the highest ones. Such sportspeople usually tend to non-functional overtraining, which is an important reason for athletes' vegetative dysfunction (dysautonomia) (Kreher, J., & Schwartz, J. (2012). Apart from constant overtraining, emotional stress, climate change, current recovery problems before essential competitions, and post-infection consequences can often affect athletes' organisms. These factors influence sportspeople's bodies within a year peculiarly: each macrocycle period differs in medical and biological challenges (Platonov, V. N. (1997). Obviously, athletes have the most substantial effect during intensive training and starts. In this respect, an individual approach to each athlete and study of early vegetative dysautonomia complaints are relevant. However, sometimes it is difficult to differentiate between the complaints themselves (e. g. weakness, exercise tolerance disorders) and chronic fatigue syndrome, lack of psychological support or motivation, etc.

Sports medicine doctors try to detect dysautonomia signs. Remarkably, among examined athletes, they progress as sympathoadrenal system hyperactivation with corresponding clinical implications (Grandou, C., Wallace, L., Impellizzeri, F., Allen, N., & Coutts, A. (2020). The latter can be latent and predict severe physiological dysfunctions. Thus, an ambulatory check of high normal arterial blood pressure (prehypertension) may regard the case as a personal physiological feature. On the other hand, it may imply dysadaptation or vegetative dysfunction. As mentioned in the introduction, prehypertension indicates a pre-pathological state and leads to the risk of persistent arterial blood pressure rise over normal values. A home blood pressure check can define latent hypertension in time (otherwise, one cannot detect it beforehand).

Our research showed that different year macrocycle periods have specific rates and signs of vegetative dysfunction. That concerns such symptoms as weakness, sleep and exercise tolerance disorders. We observed their increasing progress within the competition period. It is this period when a complex of chronic stress factors influences athletes. They may produce significant hemodynamic changes caused by sympathicotonia. The competition period registered the highest systolic and diastolic arterial blood pressure (both by the doctor and at home). Besides, the competition period revealed high rates of detecting arterial hypertension at home (almost every second prehypertension athlete). Additionally, the average home systolic arterial blood pressure exceeded normal values within the competition period and was 141.91 (10.22) mm Hg.

Competition hemodynamic changes tightly concern dysautonomia: we established an almost threefold rise in hypertension relative risk in the case of dysautonomia (p=0.027). However, such changes are temporary: during the recovery period, the arterial blood pressure of most athletes normalized (decrease by 10%). Meanwhile, hypertension lowered significantly (systolic pressure drop from 47 to 7%; diastolic pressure drops from 37 to 7%). There was a considerable reduction of heart rate values (p=0.023). All these phenomena resulted in a deep vegetative dysfunction recession. Thus, irrespective of no persistent hemodynamic changes among prehypertension athletes, we regard proper dysautonomia detection (latent arterial hypertension) as a way to improve athlete's health and achievements.

Conclusions

In the competition period of training macrocycle is highly expectable development of arterial hypertension of latent course in athletes with office prehypertension. Besides, the relative risk of latent arterial hypertension in extra-training time increases if there are other symptoms of dysautonomia, but these changes are not persistent. However, their proper diagnosing and correcting may lead to athletes' better health and achievements.

Conflict of interests

The authors confirm the absence of any conflict of interests.

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