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Original Article

Physiological and subjective indicators of reaction to physical load of female basketball players with different game roles

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Abstract:
Purpose: determination of physiological and subjective parameters of reaction to physical load of female basketball players with different anthropometrical parameters. Material: in the research qualifies female basketball players of age 20-22 years (n=58) participated: 17 center players (body length 188±3.2 cm); 19 wingers (body length 178±4.3 cm); 22 fullbacks (body length 169±6.5 cm). Sportswomen fulfilled work on ergo-meter with step-by-step increading load up to individual maximum. Results: the highest indicators of load power during work on ergo-meter were registered in wingers and center players. The highest correlatioon coefficients were found between the perceived tension and relative power of work. This is one of the best indicators of sportswomen's workability. We determined reduction of workability and increase of fatigue with increase of sportswomen's weight-height indicators. Conclusions: it is necessary to individually control and dose load in basketball. One of such control methods is subjective assessment of load's heaviness.
Key words: basketball, game role, load, heart beats rate, subjective assessment, scale.

Introduction

The relevance of the present research is conditioned by demand in individual approach to planning female basketball players' trainings [Kozina, Jagiello, & Jagiello, 2015; Kozina, Repko, Ionova, Boychuk, & Korobeinik, 2016]. It is known [Ulmer, 1979; Najafi, Shakerian, Habibi, Shabani, & Fatemi, 2015], that anthropometrical characteristics are closely connected with physiological processes in organism and features of temper. These characteristics influence on bio-mechanical structure of movements. It would be logical to assume that anthropometrical indicators determine specific physiological and psychological responses to external impact. Understanding of these laws is an important task in respect to sportsmen's individual distinctions.

Modern basketball is unique by its combining players with quite different anthropometrical characteristics in one team [Ablov, 1982; Zhanneta et al., 2015]. However there are certain difficulties in training tall players. It is especially noticeable in training their workability [Makuts, & Vysochina, 2015; Zhanneta et al., 2015]. To large extent these difficulties are connected with bio-mechanical laws of reduction of power relative indicators, strength, maximal oxygen consumption and lung ventilation. Results of researches show that with increasing of body height all relative indicators of vitally important functions reduce. It is noticeable in tests, results of visual-motor reaction and in general endurance of tall players [Zhanneta et al., 2015].

Nevertheless all players are trained by single program, which does not stipulate individual approach to loads' dosing [Ablov, 1982]. However, the future of basketball is in individualization of training process [Zhanneta et al., 2015] and choosing of adequate tests for physical loads' control [Ivashchenko et al., 2016; Pryimakov, Iermakov, Kolenkov, Samokish, & Juchno, 2016]. In women basketball special attention is attracted by tall girls. In a number of cases such tall sportswomen often finish their career because of excessive individually admissible loads. Consideration of individually admissible loads is a characteristic feature of sports [Liu, 2015; Rovniy, & Lastochkin, 2015].

The purpose of the work is to find physiological and subjective parameters of reaction to physical load of female basketball players with different anthropometrical parameters.

Material and methods

Participants

In the research qualifies female basketball players of age 20-22 years (n=58) participated: 17 center players (body length 188±3.2 cm); 19 wingers (body length 178±4.3 cm); 22 fullbacks (body length 169±6.5 cm). Qualification of different game roles' sportswomen was equal (see table 1). The samples were formed

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according to indicators of body length, which corresponded to basketball players' game roles. All materials were collected under rules of bio-ethic and after signing of consent protocols.

Table 1. Body length indicators of different game roles' female basketball players

Game role	n	Body length, cm $\bar{x}$	S	Confidence of distinctions p	
Center players	17	188	3,2	Center players - Wingers	<0.001
Wingers	19	178	4,3	Center players - Fullbacks	<0.001
Fullbacks	22	169	6,5	Wingers - Fullbacks	<0.001

Organization of the research: Sportswomen fulfilled work on ergo-meter with step-by-step increading load up to individual maximum. Load was increased every 4 minutes by 40 W. At the end of every step we registered heart beats rate (HBR) and subjectively perceived tension by Borg's scale [Borg, 1982, 1998].

The following methods of determination of reaction to physical loads were used as the main:

– Heart beats rate was measured with the help of monitor of heart beats rate continuous registration«Polar RS300X». Simultaneously subjective perception of load's heaviness was registered.

– Borg's method [Borg, 1982, 1998] was applied as method of physical loads' pedagogic control by subjective feelings. It implies usage of special scale for quantitative assessment of work's heaviness subjective perception.

G. Borg [Borg, 1982, 1998] created special verbal-numerical scales for quantitative expressing of subjectively perceived physical load's tension. In our work we used one of them, which is a line of verbal (qualitative) characteristics of load tension's subjective perception (very, very light; very light; light; average; heavy; very heavy; very, very heavy). Quantitative characteristics from 6 to 20 correspond to these indicators. Qualitative verbal characteristics correspond to odd numbers (see table 2).

This variant of scale was worked out by Borg [Borg, 1982, 1998] on the base of linear interconnection between heart beats rate value and subjective assessment of the perceived tension. For healthy people of 20-25 yrs age subjective assessment from 6 to 20 points correspond to heart beats rate from 60 to 200 bpm^{-1}. However, there are large individual distinctions in subjective assessment of tension's perception under equal heart beats rate values.

The scale of load tension's subjective assessment is used in the following way: when fulfilling physical work, sportsman calls the number of the scale, which corresponds to his subjective perception of this load's tension. For example, sportsman perceives load as "average". According to the scale number 13 corresponds to it. Sportsman calls number 13. Sometimes, it is difficult for sportsman to exactly characterize the felt tension. Then he calls number, which is between two verbal characteristics (in the supplied example it is 16). Answers (numbers) called by sportsman are entered in record of test. If load is not felt as physical tension at all, number 6 is called. If load is perceived as higher than "very, very heavy" number 20 is called.

Table 2. Scale of subjective assessment of load's heaviness (by Borg) [Borg, 1982, 1998]

Numerical values of scale	Verbal characteristics of scale
6	
7	Very, very light
8	
9	Very light
10	
11	Light
12	
13	Average
14	
15	Heavy
16	
17	Very heavy
18	
19	Very, very heavy
20	

In this scale quantitative values of subjective perception approximately correspond to HBR $\cdot 10^{-1}$. When using this scale sportswomen call numbers, which correspond their subjective perception of load's heaviness.

All sportswomen gave consent for participation in experiment. The procedure of experiment was approved by university's ethic committee.

Statistical analysis

For every indicator we found mean arithmetic value M, mean square deviation S (standard deviation), variation coefficient (V). Sample's testing for normal distribution was fulfilled with test – Chi square. Besides, Pearson's correlation analysis was used for determination of correlation between physiological and subjective indicators of load's tension (intensity). Correlations were considered to be confident at significance level of $p<0.050$; 01 and 0.001.

Statistical processing of the data was carried out with the help of SPSS program.

Results

It was found that heart beats rate grows in direct proportion to load's increasing. HBR does not depend on game role of female basketball players (see fig. 1). With it, the highest indicators of power of work during work on ergo-meter up to individual maximum (up to refusal) were found in wingers and center players. The least heart beats rate indicators were found in center players and the highest in fullbacks.

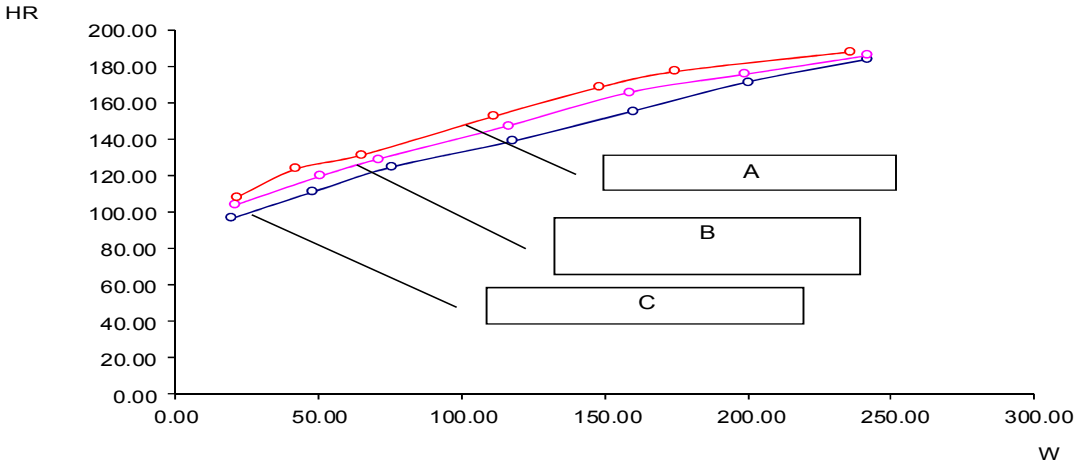

Fig. 1. Dependence of heart beats rate on absolute power of load (W) in female basketball players of different games role: HR – heart beats rate in work, i.e. heart beats rate, registered under loads, beats per minute; A – fullbacks, 169±6.5 cm; B – wingers, 178±4.3 cm; C – center players, 183±3.2 cm.

However, on the base of this fact it is impossible to conclude about higher workability of center players, comparing with wingers and fullbacks (see fig. 2). With equal relative power of load, heart beats rate is the highest in center players. Then wingers and fullbacks go. It shows that basketball players' workability reduces with increase of weight-height indicators.

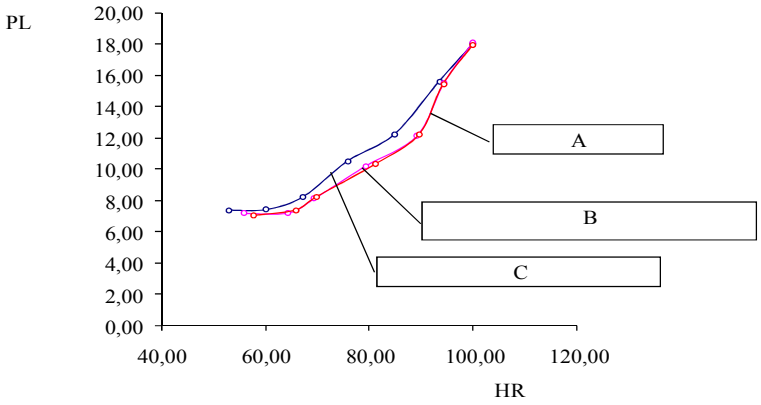

Fig. 2. Dependence of subjectively perceived load's tension (PL, points) on relative heart beats rate HR (expressed in percents from HRmax) in female basketball players of different game roles: HRmax – maximal heart beats rate: heart beats rate, registered at the end of the last step of work; A – fullbacks; B – wingers; C – center players.

Subjectively perceived load's intensity is the highest in center players (see fig. 2). It also points at increase of fatigue with increasing weight-height indicators.

The biggest distinctions in location of correlation lines between subjective and objective indicators of physical load were found in dependences between relative power of work and subjectively perceived load's intensity. With equal relative power, subjectively perceived intensity of center players is by 0.5-4 points higher. These distinctions grow with progress of work relative power. It points at need in consideration of subjective parameters of reaction to load, when training female basketball players (see fig. 2).

It was found that between subjective and objective indicators of load's tension there exists high positive confident correlation. Correlation coefficients were from 0.74 to 0.96 ($p<0.01$). The highest correlation coefficients were found between the following:

- Perceived intensity and work relative power. It is one of the best indicators of workability;
- Between perceived intensity and relative heart beats rate. It is one of the best indicators of physiological load.

Such results point at high informational potential of subjective assessment of the perceived load's intensity.

Discussion

In the fulfilled research we received results, which witness about individual characteristics of physiological and subjective parameters of sportswomen's with different body length reaction to load. From the received data it follows that heart beats rate can not be interpreted equally for sportswomen with different body length and mass. At the same time the received data witness that for more adequate assessment of functional tension sportsmen's subjective feelings of the fulfilled physical work can be used. It complies with results of many other authors [Iermakov et al., 2016; Ilnytska et al., 2016].

Borg G. [Borg, 1998] found dependence between heart beats rate and perceived tension. The same dependence was obtained in our research as well. Though there were some individual distinctions in correlation between heart beats rate and perceived tension. It shows that with equal heart beats rate values different sportswomen had different subjective perception of tension. It also confirms results of other studies [Kovářová, Nováková, Kovář, & Pánek, 2013; Kovářová, Pánek, Kovář, & Hlinčík, 2015]. In this connection we assumed that heart beats rate was the main factor of load tension's perception [Thirer, Knowlton, Sawka, & Chang, 1978]. However, in further works it was found that dependence between perceived tension and heart beats rate is not linear, if environmental conditions vary. It brings to conclusion that heart beats rate is not the main factor of functional tension. We assumed that blood circulation indicators influence more on subjective assessment of perceived tension: cardiac output, systolic volume, blood pressure [Clingman, & Hillard, 1988; Akimov, & Alekseev, 2008]. When building training programs for endurance it is recommended to control physical load level by pulse. However, such method of control is not always acceptable. That is why it is recommended to supplement heart beats rate indicators by indicators of load tension's subjective assessment [Borg, 1982; Kozina et al., 2016a, 2016b]. That is why it is not good to underestimate human potentials to regulate load's intensity, basing on subjective feelings. In our research we found reduction of workability and increase of fatigue with increasing weight-height indicators of female basketball players. For individualization dosing loads' process it is purposeful to use subjective assessment of work's tension. This method is rather informative owing to high correlation coefficients between physiological and subjective parameters of load. Besides, this method is integral: multifaceted reflection of physiological changes by subjective feelings. Alongside with it, this method is sufficiently acceptable for sportswomen and coaches. Such approach is especially important for load's dosing for the tallest players of basketball teams.

Conclusions

1. Female basketball players of different game roles have different reaction to physical load. With equal power of work the highest heart beats rate was registered in fullbacks; the lowest – in center players. Players' workability is reducing with increasing their body length.
2. With equal heart beats rate values and relative power of load (power, divided by body weight) tall center players perceive load in the heaviest way. It shall be considered, when determining volume and intensity of load for players of different game roles and in control of female basketball players' physical loads.
3. Between heart beats rate indicators and subjectively perceived load's tension we found high confident positive correlation ($r=0.7$-$0,9$, $p<0.01$). It witnesses about high informational potential of subjective assessment of the perceived tension. Besides, it proves purposefulness of this indicator's usage for control of loads of different game roles' basketball players. It is especially important for tall center players.
4. In connection with reduced workability of tall players it is necessary to pay more attention to control over their training and competition loads. For this purpose method of load's control by sportswomen's subjective feelings (Borg's method) can be used.

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