LOAD INTENSITY IN VOLLEYBALL GAME LIKE DRILLS

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The key problem of training in sports games is rightfully considered the relation between match performance and training load (Argaj, 2005; Bloomfield, Fricker, & Fitch, 1992; Dobrý & Semiginovský, 1988; Laurenčík, 2006; Reilly & Bangsbo, 1998; Tomajko, 2000). The training process in volleyball must result from the typical demands of match load, the specificities of players' specializations and their roles in the game system of a team, athletes' individual specificities and, at the same time, respect the trends of modern volleyball and the training process. Changing an intensive movement activity focused on performing specific tasks for particular game specializations during a relay lasting only a few seconds with relatively long time outs is regarded as a significant volleyball match load parameter (Aartrijk, 2000; Alberda, 1995; Baacke, 1994; Papageorgiou, 1999; Papegeorgiou & Timmer, 1990; Polglaze & Davson, 1992; Přidal & Zapletalová, 2003; Ureña, 2000; Zhang, 2000; Zimmermann, 1999).

Keywords: Heart rate, sports games, training control, training process.

In the current training process, complex game like drills and preparatory games requiring participation and the close cooperation of more players or the whole team respectively are preferred. Drills drawn in this way represent adaptation stimuli of complex character, which lead to an increase in effectiveness and game like situations' solution stability and which can also contribute to fitness development and maintenance. Effective load manipulation requires a perfect understanding of the used training means, which primarily holds for "key" drills of particular training periods. As one of the most approachable and reliable physiological indicators of inner load, the heart rate is considered (Bouchard, Shephard, & Stephens, 1994; De Van, Lacy, Cortez-Cooper, & Tanaka, 2005; Jeukendrup & Van Diemen, 1998; Neumann, Pfücner, & Hottenrott, 2005; Pate, 1991; Süss, 2006).

We proceeded based on the above mentioned facts found as a result of our research, whose aim was to find out the level of load represented by verified preparatory games' versions and if the load in two repetitions of the same type of a preparatory game is similar.

METHODS

During the 2 one week competition microcycles, we observed 6 players of the SKUP Olomouc men's volleyball team (age 21.2 ± 1.6 years). Their resting heart rate ($\bar{x}$ = 49.0 ± 3.0 bpm) was measured by means of heart rate monitors before they entered their training session. Using the Leger test (Multiple progressive shuttle run test) (Kovář, 1990; Novosad, Lehnert, & Frömel, 1994) we determined the players' maximum heart rate ($\bar{x}$ = 192.0 ± 6.5 bpm) one week before the preparatory games were included. During the observed training cycles the players took part in four training sessions with the content of the preparatory competitive game being 6 v. 6 – in the first week with rule modifications and in the second week it was done without the modifications. The games were recorded with a camera.

A preparatory competitive game, the relay, was started with a serve by one of two specified players, who regularly took turns in serving and did not participate in the game further. After the relay was finished, the coach threw another ball to the passing side. After four relays were played, the front line players exchanged their positions with the back row players. The passing team thus attacked in the same position four times after the serve pass and four times after passing the tossed ball. The passing team is given the advantage of the first attack, therefore the opponent is awarded by 2 points for each relay won. The game was played according to the rules of volleyball – the set was won by the team which first scores 25 points, the intervals between sets lasted for 2 minutes. During the training sessions, 9 sets were played (the actual time, i. e. without intervals of rest between sets, was 50 : 20 min. in the first measurement and 51 : 45 min. in the second measurement). The B preparatory game was played without rule modifications. The fifth one of 5 sets was played up to 15 points (the actual times were 66 : 45 min. and 62 : 30 min.). The tactics of

the attack combinations were the same and prearranged in both types of preparatory games.

The intensity of the inner load during the preparatory games was assessed by measuring the heart rate using "Polar Vantage" heart rate monitors (Terbizan, Dolezal, & Albano, 2002). To assess the load intensity, the actual playing time (the sum of the length of single sets and rest intervals between them) was measured. To formulate the intensity, we determined, by means of "Polar" software and video record the necessary. Information, which we entered into a set form onto which we recorded the number of attacks performed by particular players during a set. Before the training session the players recorded every movement activity longer than 15 minutes (any high intensity movement activity was forbidden during the period under consideration). They expressed themselves as to their currently felt fatigue and about sleeping as well (Pivnička, 2002).

RESULTS AND DISCUSSION

The inner load during the first and second repetition of the A preparatory game (TABLE 1) was evaluated through the use of average heart rate in the game (AHR) and maximal heart rate (HRmax) during the game. The average circulation load expressed in the percentage of a maximal heart rate determined by the Leger test (% HRmax) was calculated as well. The values of AHR found in this way represented 83.1% or 81.1% of a maximal heart rate as determined by the Leger test. From the results it is clear that the differences in values of controlled parameters were neither logically nor statistically significant. We can presume that typical volleyball game patterns express the considerable stability of the team game load. Comparison of particular average and maximal heart rate values during exercises in particular players enabled us to get data about differences in load caused by the realized exercises (TABLE 1). In this respect we can state that there were considerable differences. Significant differences of AHR in the case of the first training session were found in players number 5 and 6, i.e. outside hitters (18 bpm and 13 bpm). The difference was above all caused by a higher number of hits during the first measurement, which results from these players' offensive activity record and game record analysis.

Also in the B preparatory game AHR and HRmax values in the first and second measurements differed minimally and were neither statistically nor logically significant (TABLE 2). The measured AHR values represented 76.9% and 74.8% of HRmax. However, the interindividual variability between the first and second measurements was considerable (1.2–16.4 bpm) with the biggest difference in the no.1 (diagonal) player. From whence it follows, among others, that it is very questionable to evaluate exercise's demandingness according to the HR average values of a whole team because individual circulation response and any particular player's game involvement can differ markedly. The video record shows that the differences in repetitions of training exercises in tested players were especially influenced by different game dynamics, the amount of activity participation, and other influences, which are typical for sports games and which can significantly modify the training load parameters.

In A and B preparatory games we counted the average values of AHR and CL from the first and second exercises and subsequently we compared the preparatory games (TABLE 3). With regard to the mentioned HR data we can state that the differences between the A and B preparatory games in AHR (12 bpm) and in ZC (7%) represent, in terms of load manipulation, a significant difference, whose statistical significance was confirmed in both cases (we also counted the values of the median which did not significantly differ from the arithmetic mean and therefore we consider these values to be characteristic enough).

TABLE 1
Preparatory game A – average and maximal heart rate values of tested players and verification of difference in significance in two repetitions (n = 6)

Indicator		Player						$\bar{x}$	SD	CL	Z
		1	2	3	4	5	6				
AHR	M1	181	150	144	155	167	160	159.5	12.04	83.1	.00
	M2	178	155	149	155	149	147	155.5	10.52	81.1	
HRmax	M1	192	166	168	169	186	178	176.5	9.76	92.0	.00
	M2	192	170	172	172	171	167	174.0	8.23	90.7	

Legend:
M1 – first measurement; M2 – second measurement; AHR – average heart rate; HRmax – maximal heart rate; $\bar{x}$ – average value of a parameter in tested group; SD – standard deviation; CL – circulation load in % of maximal heart rate determinated by Leger test; Z – Wilcoxon test criterion value
Statistically significant values ($p < 0.05$) are in bold characters.

TABLE 2
Preparatory game B – average and maximal heart rate values of tested players and verification of these differences' significance in two repetitions (n = 6)

Indicator		Player						$\bar{x}$	SD	CL	Z
		1	2	3	4	5	6				
AHR	M1	165	140	147	145	152	136	147.5	9.32	76.9	.41
	M2	149	141	142	151	149	129	143.5	7.48	74.8	
HRmax	M1	182	155	169	162	178	156	167.0	10.33	87.1	.00
	M2	169	157	169	170	177	157	166.5	7.25	86.8	

Legend:
M1 – first measurement; M2 – second measurement; AHR – average heart rate; HRmax – maximal heart rate; $\bar{x}$ – average value of a parameter in tested group; SD – standard deviation; CL – circulation load in % of maximal heart rate determinated by Leger test; Z – Wilcoxon test criterion value
Statistically significant values ($p < 0.05$) are in bold characters.

TABLE 3
Basic statistical characteristics of the parameters in view and verification of preparatory games A and B values in terms of the differences' significance (n = 6)

Parameter	Med	$\bar{x}$	SD	R	Z
AHR I	154.5	157.7	11.46	33.1	2.04
AHR II	146.1	145.4	8.66	25.1	
CL I	80.9	82.5	3.82	9.7	2.04
CL II	76.4	75.8	4.50	12.6	

Legend:
AHR I – average heart rate in A preparatory game; AHR II – average heart rate in B preparatory game; CL I – circulation load in % of maximal heart rate in preparatory game A; CL II – circulation load in % of maximal heart rate in preparatory game B; Med – median; $\bar{x}$ – arithmetic mean; SD – standard deviation; R – range; Z – values of sign test criterion
Statistically significant values ($p < 0.05$) are in bold characters.

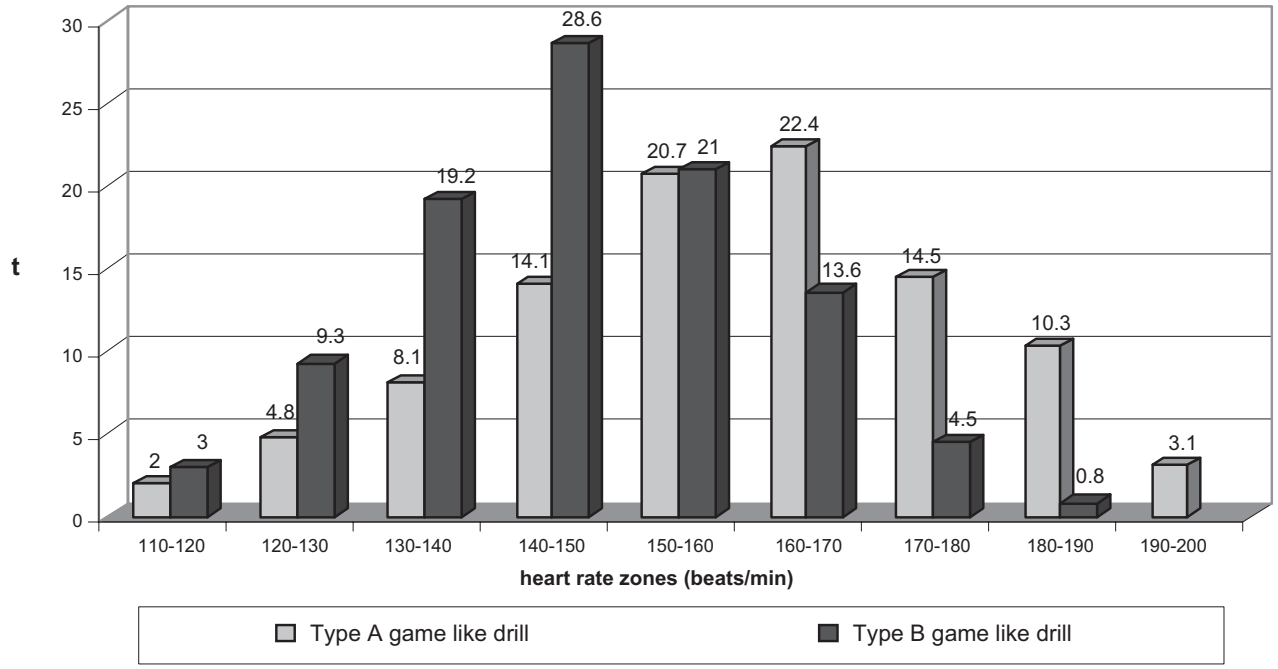
The cause of significant differences in load intensity was a different game content including a number of offensive and defensive actions realized by both teams. In some players we can assume that, based on quite high HR values, the A preparatory game stimulated anaerobic glycolysis and mobilized carbohydrate energy sources. Therefore it is obvious that break shortening and extension of load intervals during the preparatory game result in an increase of training efficiency, under the condition that there is also optimal recovery.

To complete the image of a circulation response to both types of preparatory games we can use the HR values' distribution in particular zones (Fig. 1). While in the B preparatory game, the lower HR zones' load dominated, the A preparatory game is represented distinctively more in HR zones higher than 160 bpm. Also from this picture it is possible to assume that in light of the intensity of the inner load, the A and B preparatory games represented two completely different stimuli and that a relay extension due to an additional ball toss in the A preparatory game resulted in a significant increase of the circulation load.

To specify the data about differences in particular players we counted average HR values of the players from both repetitions of preparatory games A and B.

From TABLE 4 it is obvious that in all tested persons we found higher values of AHR and CL in the A preparatory game but the difference was considerably diverse. From the tested group the biggest difference was found in players 1 and 6 (diagonal player and outside hitter). The video record shows that the difference was, in the first case, due to a higher participation of the diagonal player in offensive actions connected with locomotion to the attacking zone in back row positions. For a diagonal player it is the typical participation in offensive game combinations, which was emphasized in the preparatory game. Also in the case of an outside hitter, there was an expressive increase in the number of passes and net attacks. It is probable that due to a higher involvement of anaerobic glycolysis, this kind of load exhausts the player's muscle glycogen more than in the preparatory game without a change of rules. Thanks to the increased requirements of the A preparatory game we can assume its higher training effect if conditions allow optimal recovery.

Fig. 1
Average HR values distribution of the tested group in particular zones of preparatory games A and B



Legend:
t – drill time with average HR within particular HR zones (%)

TABLE 4
Comparison of preparatory games A and B – average HR values and circulation load in individuals

Player	pmm PG	AHR (CL)	SD	/d/
1	A	179.5 (89.5)	4.44	22.6
	B	157.2 (79.2)	8.51	
2	A	152.7 (81.7)	8.25	12.2
	B	140.5 (75.1)	3.26	
3	A	146.7 (79.9)	8.82	2.4
	B	144.3 (77.6)	3.55	
4	A	155.2 (84.3)	3.90	7.9
	B	147.8 (80.3)	4.12	
5	A	158.3 (80.0)	10.8	7.6
	B	150.7 (75.1)	4.80	
6	A	153.7 (79.8)	10.49	21.6
	B	132.1 (67.7)	4.70	

Legend:
PG – preparatory game; AHR – average heart rate; CL – corresponding value of circulation load in %; SD – standard deviation; d – difference of values in preparatory games A and B

CONCLUSIONS

1. A comparison of average HR values and the load circulation of players in the first and second performances of the verified types of volleyball preparatory games showed logically and statistically insignificant difference in the inner load. However, the difference in particular players was distinctively diverse.
2. We found out that in the tested group the A preparatory game represented a stronger training stimulus in terms of inner load. The differences in the observed parameters were diverse in particular players.

3. The amount of load in both types of preparatory games, as well as the differences, is necessary to view in connection with the performance level of players, quality of their training habits, keeping to tactical instructions, the motivation of players and other influences.
4. It was confirmed that the average HR values of the whole group do not give a proper view of the load of particular players and they can be a source of error in training control.

PRACTICAL RECOMMENDATIONS

In training process control we recommend to take into consideration possible differences between HR values in a tested group and individuals.

Requirements of the drills for particular players can be significantly modified by a coach. In drills of this kind we recommend to intentionally regulate the players' participation, especially by setting tactical tasks and by the placing of or setting the difficultness of the additional balls. In this way we can prepare a background for creating game like situations of a particular type and perfection of solving the situations in compliance with the actual needs of the players and the team.

The complex character of the A preparatory game and the possibility of changing the game conditions enable its use not only for perfection of the technical-tactical aspects of game performance but also for the development of specific volleyball endurance. We recommend including the A preparatory game during the preparatory period, especially in its second half. It is advisable to use it in stabilization and competition microcycles (here it is necessary to decrease the volume and to take into account the location within a training microcycle according to an oncoming match).

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INTENZITA ZATÍŽENÍ PŘI HERNÍCH CVIČENÍCH VE VOLEJBALU

(Souhrn anglického textu)

V současném tréninkovém procesu vyspělých družstev ve sportovních hrách jsou preferována tréninková cvičení komplexního charakteru vyžadující zapojení a úzkou spolupráci více hráčů. Předpokladem efektivní manipulace se zatížením je dokonalé poznání používaných cvičení. Cílem provedeného sledování, jehož se zúčastnilo 6 hráčů seniorského volejbalového družstva (průměrný věk 21.2 ± 1.6 let) bylo zjistit, jaké zatížení představují dvě ověřované varianty průpravných her a zda bude zatížení při dvou opakováních stejného typu průpravné hry podobné. Porovnání průměrných hodnot srdeční frekvence sledovaného souboru volejbalistů při prvním a druhém provedení ukázalo na věcně i statisticky nevýznamný rozdíl ve velikosti vnitřního zatížení. Rozdíly hodnot sledovaných charakteristik srdeční frekvence u jednotlivců však potvrdily vysokou intraindividuální variabilitu velikosti vnitřního zatížení. Z porovnání průměrných hodnot srdeční frekvence a zatížení cirkulace u dvou typů průpravných her vyplynulo, že z hlediska vnitřního zatížení představovaly odlišné tréninkové stimuly. Z výsledků studie vyplývá, že při manipulaci se zatížením ve volejbalu u herních cvičeních a průpravných her je vhodné považovat údaje o průměrných hodnotách srdeční frekvence pouze za orientační.

Klíčová slova: řízení sportovního tréninku, sportovní hry, srdeční frekvence, tréninkový proces.

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