

Internal load of soccer players during preparatory games with a medium number of players

HOLIENKA MIROSLAV

Department of Sports Games, Faculty of Physical Education and Sports, Comenius University in Bratislava
SLOVAKIA

Published online: June 25, 2016

(Accepted for publication June 03 2016)

DOI:10.7752/jpes.2016.02086

Abstract

Identification of the training load is a continuous cyclical process in the training practice of soccer players at different performance levels. The aim of our paper is to point out the training load in two preparatory games (PG) with a medium number of players (four-on-four and six-on-six). The group consisted of students at the Faculty of Physical Education and Sports (n=12), specializing in soccer with an average age of 23.39±1.15 years. The average value of the heart rate achieved in the 4-on-4 PG was 168.21±0.90 heartbeats a minute. During this preparatory game the players spent 58 percent of the total load time in the maximum intensity zone. The average value of the heart rate achieved in the 6-on-6 PG was 163.49±1.52 heartbeats a minute. During this preparatory game the players remained 47.5 percent of the total load time in the maximum intensity zone.

In order to determine the significance of differences in achieved mean values of the heart rate, we applied the Wilcoxon T-test. We have found only in one case significant differences in the heart rate at the 5 percent level of the statistical significance.

Keywords: soccer, preparatory games with a medium number of players, internal load, heart rate measurement

Introduction

Preparatory games with various targeting are an important methodological and organizational form, preferred in the training process of soccer players of different age and performance levels. Preparatory games are an adequate methodological and organizational form to develop creative thinking and actions of the player. In the conditions of situational unexpectedness they are in fact an intermediary between a training game and the match itself (Kačáni 2002).

In preparatory games we focus on the improvement and stabilization of gaming activities, their technical and tactical aspect of the gaming activity of an individual as well as the development of creative potential of players. By appropriately altering the rules and the content of the preparatory games we meet the stressed training goals and tasks (Peráček 2003).

Preparatory games with a medium number of players (4-on-4 to 6-on-6) as a specific training means are used for comprehensive development of the wide range of performance factors. They are focused on developing game fitness and the coordination of individual and group tactical thinking and acting through the cooperation of players' formations, groups and blocks of players.

The training load in preparatory games with a medium number of players is at the level of an intensive match load (Kačáni 2002). This training load is characterized by:

- high load on the circulatory system,
- high demands on the aerobic-anaerobic metabolism,
- appropriate number of gaming activities,
- appropriate mental load.

The training process is a process aimed at creating specific adaptations induced by repeated adaptation stimuli. In the training process, the organism of the player responds to the repeated training stimuli in line with the rules of adaptation.

The training load as the basic stimulus (i.e. set of stimuli) in the form of training exercises leads to the induction of the current changes in the functional activity of the organism of an athlete in accordance with the objectives of the training process (Lehnert 2008).

In the training process the nature of the load on the player is given by the total amount of physical activities, the wide range of gaming activities and by solving a number of unrepeatable game situations. The training load causes in players individual internal reactive responses of the organism. Given the diversity of individual skills of players, these internal responses of the organism will be different.

Holienka (2012) says that from the practical point of view, in the organization of the training process it is

necessary to distinguish between external and internal load. In our case, we monitored the internal - physiological load through the heart rate.

Heart rate monitoring is one way of measuring the internal load and measuring the effectiveness of the training load on the player's organism.

Under natural conditions in sports games, its evaluation is more difficult, as movements with maximum effort change in the game with sections of reactive peace. (Laczo 2012).

Methodology

In our research we focused on assessing possible changes in heart rate in a group of players (n=12), who are students of the 1st year of the master's degree study at the Faculty of Physical Education and Sports, Comenius University, specialized in soccer. Students are players of different teams at the level of performance soccer. The average age of players monitored was 23.39±1.15 years, with an average maximum heart rate of 182.14±3.62 beats per minute. The maximum heart rate was calculated using a field test - three minutes of low intensity running, two minutes of walking, three minutes of moderate intensity running, two minutes of walking, and three minutes of maximum intensity running.

By means of the heart rate telemetry we investigated its changes in the training conditions in two preparatory games having a medium number of players (4-on-4, 6-on-6). For telemetry we used POLAR TEAM 2 PRO system (Polar Electro Oy, Kempele, Finland). The system recorded the heart rate into the interface with an immediate transfer of 5Hz at one-second intervals, with a measurement error of 5 beats. We set 5 zones of load intensity, while the intensity zones were set at 8 to 10 percent differences. The highest intensity was defined in the range of 93 to 100 percent of the maximum heart rate, submaximal 85 to 92 percent, medium 75 to 84 percent, low 65 to 74 percent and resting 55 to 64 percent of the maximum heart rate.

The heart rate measurement was conducted in the 4-on-4 preparatory game (field size 40 x 20 meters) and in the 6-on-6 preparatory game (field size 50 x 35 meters). The preparatory games were aimed in both cases at improving ball control - a goal was valid only after transferring the ball behind the end line and subsequently stepping on it. The load interval in the two preparatory games was four minutes. The rest interval was two minutes and the number of repetitions was two times. To evaluate the data we used the Wilcoxon T-test.

To compare values of the heart rate between the preparatory games we included only 7 players who played in both preparatory games. The aim of the study was to identify possible differences in internal load indicators in the preparatory games with a medium number of players by adjusting the number of players and the field size.

Results

Using POLAR TEAM2 PRO system we measured the following results in the training process in the preparatory games with a medium number of players.

4-on-4 preparatory game (PG) – internal load on Figure 1

- Game in the end zone.
- Improvement of ball control.
- Two four-member teams play in a specified area using any number of touches. A team scores a point for transferring the ball by any player behind the end line with subsequent stepping on the ball.
- Aerobic, aerobic-anaerobic load.
- Field with dimensions of 40 x 20 meters.
- Batch loads: LI (load interval): 4' NR (Number of repetitions): 2
RI (rest interval): 2' NS (Number of series): 1

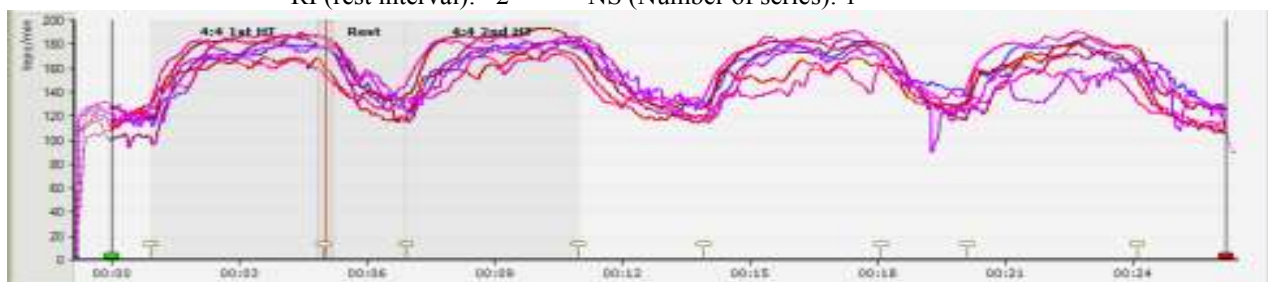


Figure 1 | Heart rate curves in the 4-on-4 preparatory game

The average value of the maximum heart rate (HR_{max}) during the first load interval was 182.14±3.62 heartbeats per minute. The lowest measured value was 178 heartbeats per minute and the highest measured value was 188 heartbeats per minute. In terms of the time spent in the selected load intensity zone, most time in the maximum intensity zone was spent by player L.S. - 3.27 min. (85.7% of the PG time). On average, players stayed in the maximum intensity zone 2.24±0.83 minutes and above the level of the anaerobic threshold 3.09±0.29 minutes.

The average value of the maximum heart rate during the second load interval was 182.40±6.55 heartbeats per minute. The lowest maximum value was 172 heartbeats per minute and the highest was 192 heartbeats per minute. In terms of the time spent in the selected load intensity zones, most time in the maximum intensity zone

was spent by player L. S. - 3.43 min. (91.9 % of the PG time). On average, players stayed in the maximum intensity zone 2.41 ± 0.80 minutes and above the level of the anaerobic threshold 2.94 ± 0.49 minutes.

The average value of the heart rate achieved by the players during the entire 4-on-4 preparatory game was 168.21 ± 0.90 heartbeats per minute. On average the players stayed during this preparatory game 2.32 ± 0.12 minutes (58 % of the total load time) in the maximum intensity zone.

6-on-6 preparatory game (PG) – internal load on Figure 2

- Game in the end zone.
- Improvement of ball control.
- Two six-member teams play in a specified area using any number of touches. A team scores a point for transferring the ball by any player behind the end line with subsequent stepping on the ball.
- Aerobic, aerobic-anaerobic load.
- Field with dimensions of 50 x 35 meters.
- Batch loads: LI: 4' NR: 2
 RI: 2' NS: 1

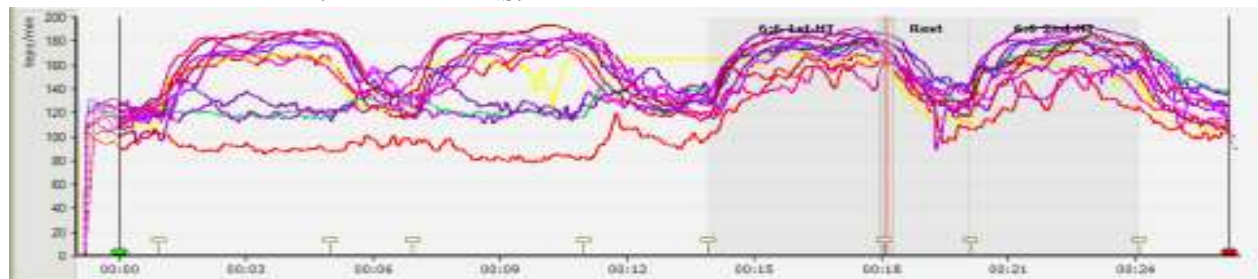


Figure 2 | Heart rate curves in the 6-on-6 preparatory games

The average value of the maximum heart rate during the first load interval was 178.57 ± 10.14 heartbeats per minute. The lowest measured value was 161 and the highest measured value was 191 heartbeats per minute. In terms of the time spent in the selected load intensity zone, most time in the maximum intensity zone was spent by player L. S. - 3.29 minutes (85 % of the PG time). The average time values reached in the maximum intensity zone were 2.12 ± 1.14 minutes and above the level of the anaerobic threshold 2.67 ± 1.12 minutes.

The average value of the maximum heart rate during the second load interval in the preparatory game was 176.28 ± 11.54 heartbeats per minute. The lowest achieved value of the heart rate was 160 and the highest was 191 heartbeats per minute. Most time in the load zone of the maximum intensity was spent by player L. S. - 3.28 minutes (87.2 % of the PG time). The average time values in the maximum intensity zone were 1.69 ± 1.14 minutes and above the level of the anaerobic threshold 2.09 ± 1.43 minutes.

The average value of the heart rate achieved during the entire 6-on-6 preparatory game was 163.49 ± 1.52 heartbeats per minute. On average the players stayed during this preparatory game 1.90 ± 0.30 minutes (47.5 % of the total load time) in the maximum intensity zone. The value heart rate measured in booth preparatory games we present in Table 1.

Table 1 | Heart rate values in the 4-on-4 and 6-on-6 preparatory games in relation to HR_{max}

Player	Test	4-on-4 PG		6-on-6 PG	
	HR_{max}	4-LI ₁	4-LI ₂	6-LI ₁	6-LI ₂
RA	178	169	177	169	180
DB	179	180	182	182	181
TL	188	188	192	183	185
LM	184	186	185	184	175
MO	179	170	172	161	160
LS	184	190	187	191	191
DV	183	179	182	180	162
Me	183,00	180,00	182,00	182,00	180,00
x	182,14	180,29	182,43	178,57	176,29
xmin	178,00	169,00	172,00	161,00	160,00
xmax	188,00	190,00	192,00	191,00	191,00
V _r	10,00	21,00	20,00	30,00	31,00
s	3,63	8,38	6,55	10,15	11,54

Discussion

The heart rate (HR) is a generally recognized and widely used objective physiological indicator of the player's motion activity in the training process, or, where possible, even in the match. When interpreting the

results of HR measurements using sport testers, it must be respected that HR is only an indirect indicator of the load on the player's organism also in preparatory games that we applied.

HR_{max} percentages are equally only a relative indicator of the intensity of the motion load (Bunc 1990) as soccer belongs to sports that have an alternating (intermittent) nature of load. The heart rate monitoring confirms this nature of load also in the players we monitored in both preparatory games.

The average value of HR_{max} in the case of the first and second interval of the load in the **4-on-4 preparatory game** is almost identical. This shows that the rest interval was sufficient and the activity of the players was appropriate. But it was not sufficient with all the players, because the difference between the lowest and highest measured HR values in LI₁ is only 10 beats per minute, but in LI₂ it is 20 beats per minute. In the duration of the time that players spent in the maximum intensity zone and above the level of the anaerobic threshold, there are also minimal differences in both load intervals. Despite the minimal differences in the duration of the time that players spent in the maximum intensity zone in the first LI and the second LI, a statistically significant relationship between these LI was confirmed at the 5 percent level ($p \leq 0.05$) – Figure 3. The statistical significance can be explained by the fact that in LI₂ all players reached higher values than in LI₁.

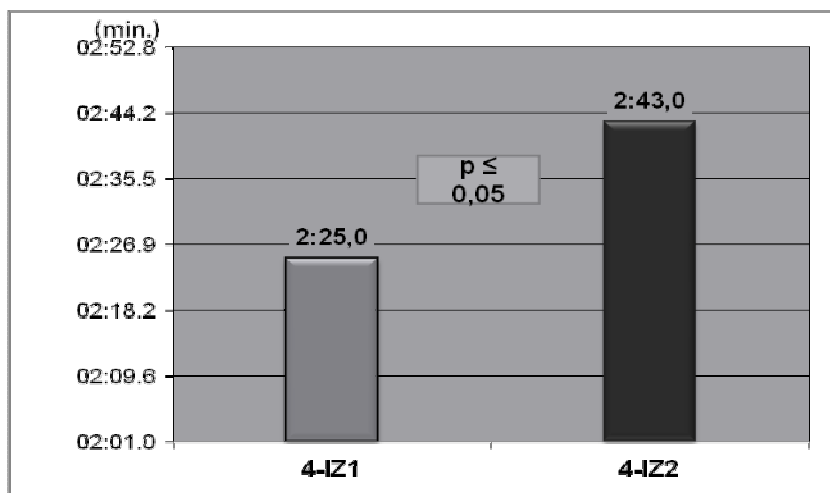


Figure 3 | Time spent in the maximum load intensity zone in the 4-on-4 preparatory game

The average value of HR_{max} in the case of the first and second load interval in the 6-on-6 preparatory game similarly as in the 4-on-4 preparatory game was different only minimally. The difference between the lowest measured HR value and the highest in LI₂ is 31 beats per minute. However, statistical significance was not demonstrated significantly in either preparatory game.

It was neither shown even in the case of the time spent in the maximum intensity zone. Although the time players spent in the maximum intensity zone in LI₂ compared to LI₁ was greatly reduced in the 6-on-6 preparatory game unlike the 4-on-4 preparatory game.

The average HR value during a soccer match ranges from 155 to 170 heartbeats per minute depending on the level of competition and player's position. The values of various experts measured in a match are presented in Table 2.

Table 2 | Comparison of values of average HR measured in matches

Author/Year	Average HR (heartbeats/min.)	Type of match
Selinger/1968	165	Competition
Van Gool/1988	167	Preparatory
Ali a Farrally/1991	169	Competition
Bangsbo/1994	164	Competition
Reilly/1996	157	Preparatory
Frýbort/2010	158	Preparatory

In the preparatory games that we applied, players reached an average value of 168.21 ± 0.90 heartbeats per minute in the 4-on-4 PG and 163.49 ± 1.52 heartbeats per minute in the 6-on-6 PG. Of the measured average values in the preparatory games it emerges that the load in them corresponds to the requirements that are imposed on the player in the game.

Conclusions

Based on our measurements in the selected preparatory games we can conclude that the number of players, the field dimensions and the selected load intervals and the rest intervals enabled to reach during the

training a load level corresponding to matches. Potential anticipated differences in the load intensity (expressed through HR) in the preparatory games were not statistically confirmed, although we observed significant differences in them. Statistical significance at the 5 percent level was confirmed in one case.

To better test the effectiveness of the training load in the preparatory games in the future we will increase the number of their repetitions and we will hold a motivational interview with the players so that they make every effort during the preparatory game.

References

- Ali, A. & Farrally, M. (1991). *Recording soccer player's heart rates during matches*. *Journal of Sports Sciences*, 9(2), 183-189.
- Bangsbo, J. et al. (1994). *Activity profile of competition soccer*. *Canadian Journal of Sports Sciences*, 16(2), 110-116.
- Bekris, E. et al. (2012). *Supernumerary in small sided games 3Vs3 & 4Vs4*. *Journal Physical Education and Sport*, 12(3), 398-406.
- Bunc, V. (1990). *Biokybernetický přístup k hodnocení reakce organismu na tělesné zatížení*. Praha: VÚTK.
- Clemente, F. (2012). *The usefulness of small-sided games on soccer training*. *Journal Physical Education and Sport*, 12(1), 93-102.
- Frýbort, P. et al. (2011). *Pohybové zatížení hráče fotbalu během utkání v závislosti na hráčských funkcích*. In: V.Süss, M. Tůma, et al., *Zatížení hráče v utkání* (pp. 108-117). Praha: Karolinum.
- Holienka, M. (2012). *Zaťaženie a zatažovanie hráčov v tréningovom procese v športových hrách v závislosti od hráčskej funkcie*. In: M. Holienka et al., *Tréningové a zápasové zaťaženie hráča v športových hrách* (pp. 5-20). Bratislava: ICM Agency.
- Kačáni, L. (2002). *Futbal - Tréning hrou*. Bratislava: PEEM.
- Laczo, E. (2012). *Tréningové (súťažné) zaťaženie*. In: T. KAMPMILLER et al. *Teória športu a didaktika športového tréningu* (pp. 57-70). Bratislava: ICM Agency.
- Lehnert, M. (2008). *Teoretická východiska tréningového zatížení a zatěžování ve sportovních hrách*. In: *Efekty pohybového zatížení v edukačním prostředí tělesné výchovy a sportu* (pp. 24-31) Olomouc: FTK UP.
- Michailidis, Y. (2013). *Small sided games in soccer training*. *Journal Physical Education and Sport*, 13(3), 392-399.
- Peráček, P. et al. (2003). *Teória a didaktika športových hier*. Bratislava: PEEM.
- Reilly, T. (1996). *Science and soccer*. London: E&FN Spon.
- Seliger, V. (1968). *Heart rate as an index of physical load in exercise*. In: *Scripta Medicina* (pp. 231-240). Brno: Medical Faculty.
- Van Gool, D. et al. (1987). *The physiological load imposed on soccer players during real match - play*. In: T. Reilly et al. *Science and Football* (pp. 51-59). London: E&EF Spon.