Original Article

Comparison of load intensity in IceHockey players at different game positions during a match

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Abstract:

Introduction: The presented article focuses on the analysis of load intensity in extra-league ice hockey players during a match. Monitoring the load intensity of sports game players in matches and during training is one of the most important areas of sports training. Heart frequency level (HF) is one of the more easily accessible physiological indicators, but it is also considered to be a reliable benchmark for the assessment of load intensity.

Objective: The objective was to analyze the progress of load intensity of the most utilized players during a junior top league ice hockey championship in relation to their game positions (defensemen – forwards). To monitor heart rate during the match, the Polar TEAM2 system was used. **Results:** The results of the study point at statistically significant differences in the load intensity of players in relation to their positions (p-value < 10⁻³ at 5% level of significance). The calculated mean value of HR_{max} for extra-league players in the defensemen position was 87.8 ± 7.7 % HR_{max}, the mean value of players in the position of forwards was calculated at 90.9 ± 9.7 % of maximum HR determined during a load test in laboratory conditions. When assessing the aforesaid difference from the view of practical significance (“effect size”), the difference has low significance (Cohen’s d= 0.38). **Conclusion:** The stated differences in the load intensity of players are mostly caused by their different game positions, as well as different tasks during the match. The analyzed load intensity of the individual players during a match is very important for the subsequent preparation of training. Based on the presented results, it is possible to recommend including suitable game exercises in the training plan of the same age and performance category and to perform them with as identical intensity as possible.

Keywords: Icehockey, team sport, heart rate, load intensity, heart rate monitor

Introduction

Ice-hockey is one of the most popular and most watched sports all around the world (as most team sports). Its speed, both in the movement of players and in the solution of game situations, has recently increased and it is very likely that this trend will continue in the future. Ice-hockey matches are usually very dynamic and it is typical that players take turns in short time intervals, during which they usually move on the ice with submaximal or maximal intensity. From a physiological point of view, it is an interval and intermittent type of physical activity. The ongoing changes are also influenced by the continuous development in the players’ apparel and gear, as well as by the improved work of trainers and implementation teams who now include experts in the individual areas, such as scouting, statistics, fitness or nutrition (Lorenzo et al., 2010; O’Donoghue, 2014; O’Donoghue & Holmes, 2014; Shynkaruk et al., 2020).

It is not possible to train players in the same way as twenty years ago, especially with respect to the continuous development of the game itself. If we want to be successful trainers today and train players in this “modern” ice-hockey, to perform in the best possible way, both individually and in team work, we need to respond to those changes appropriately. Monitoring and deducing correct conclusions become a necessity in this respect as they influence the conception of training with regard to the matches, but above all, with regard to a long-term development of the game performance. The efficiency in training elite athletes, in this case players of ice-hockey, depends on the timely acceptance of modern approaches to training (Allen & Hopkins, 2015; Koet al., 2016; Lignell et al., 2018; Steeves & Campagna, 2019).

The relation between the load in training and the load in matches is the fundamental and the most important problem in sports game training in general, i.e., also in ice hockey (Vala & Petr, 2013; Vala, Valová, & Pacut, 2019). According to some authors (e.g., Douglas et al., 2019), the load can be divided into external, related to the physical activity, and internal, which may be understood as a response of the organism to such an activity. The presented article focuses on the internal load that can be expressed by a series of characteristics. The heart rate level (hereinafter HR) is currently one of the most often applied and easily accessible

physiological indicators. At the same time, however, it is considered to be a reliable quantifier in the assessment of load intensity (Benson & Connolly, 2011; Essner et al., 2013).

Studies focusing on the load on athletes and sports players have been conducted for many years, for example, by McInnes, Carlson, Jones, & McKenna, (1995); Coutts, Reaburn, & Abt (2003); Mathew & Delextrat (2009); Durocher et al., (2010); Montgomery, Pyne, & Minahan, (2010); Cameron et al., (2012) and Vala et al., (2013). At the same time, demands on the players' fitness have been increasing and the importance of fitness indicators in assessing players has also been rising. Recent studies (Conte et al., 2016; Holienka, 2016; Sannicandro, Cofano, & Rosa, 2016; Cuberek et al., 2017; Gantois et al., 2017; Puente et al., 2017; Vanrenterghem et al., 2017; Babic, Holienka, & Mikulic, 2018; Sánchez-Sánchez et al., 2018; Surina-Marysheva et al., 2018; Surina-Marysheva et al., 2019; Impellizzeri, Marcora, & Coutts, 2019) thus respond to the changes occurred in the load of sports game players. Since the apparel and gear of players is continuously developing and the work of trainers and implementation teams is improving, further studies in the field of sports game players' load intensity are to be expected in the future. We consider the analysis of the load of individual players during championship or friendly matches to be a very important part of the trainer's activity, essential for the related preparation of a training plan, the check and control of the training process, and the selection of suitable game exercises in training (Vala & Litschmannová, 2012, Vala, Valová, & Pacut, 2019).

Aim

The objective of the study was to compare the load intensity of extra-league (top league) ice hockey players during a junior championship match in relation to the game positions.

Material & methods

Research group

The research group included the 10 most utilized players in a junior extra-league (top league) team, whose heart rates were monitored during the match. As Table 1 shows, the average age of the monitored players was 18.6 ± 1.1 , with an average height of 183.1 ± 5.2 cm, and the average body weight of the group was 81.5 ± 6.4 kg.

Table 1: Basic Descriptive Statistics of the Group and Mean HR Values of Players in Matches (Expressed in HR Values)

Position and No	Age	Weight [kg]	Height [cm]	Mean HR [beats/min]	SD
Defenseman 1	18	84	185	195.1	7.2
Defenseman 2	18	90	190	195.2	6.4
Defenseman 3	17	79	183	193.4	7.1
Defenseman 4	19	95	190	190.9	6.5
Forward 5	21	84	186	186.1	12.4
Forward 6	18	76	180	188.3	11.1
Forward 7	19	76	175	187.1	11.5
Forward 8	18	76	180	183.9	12.4
Forward 9	19	80	186	181.7	9.1
Forward 10	19	75	175	181.5	9.4
MEAN $\pm$ SD	18.6 $\pm$ 1,1	81.5 $\pm$ 6.4	183.1 $\pm$ 5.2	188.3	9.31

Note: Mean HR – mean heart rate during championship matches (expressed in HR values), SD – Standard Deviation

Methods

The maximum heart rate of all monitored players was determined at the beginning of the season within load tests in laboratory conditions. The heart rate during the test was permanently monitored using a Polar heart rate monitor. The Polar Team² system (Polar Electro, Oy, Finland) was used to diagnose the level of heart rate in the players during matches. In total, four domestic championship matches in the top junior ice hockey league were analyzed. In each match, ten of the most utilized players who played at least 14 minutes in the match were monitored.

Statistical data processing

To assess the obtained data, the Polar Precision PerformanceTM SW was used. The calculations of the mean HR values of the players only included the values of the individual second sections in which the players were actively involved in the game, while the “live time” was running (Abdelkrim, El Fazaa, & El Ati, 2007; Vala & Litschmannová, 2012). The obtained data were statistically processed using the IBM SPSS Statistics 23.0 program. The statistic decision was made at 5% level of significance. The normality of data as a condition

for the use of parametric forms of tests was rejected (Shapiro-Wilk test, p -value < 0.05) and therefore, non-parametric forms of tests were used for the assessment of statistical significance (Kruskal-Wallis test and Mann-Whitney test). The obtained results were also assessed with respect to practical significance using the “effect of size” by Cohen (1988) who recommends the values for “Cohen’s d ” for the effect of size ($0.2 =$ low effect, $0.5 =$ medium effect, $0.8 =$ large effect).

Results & discussion

When comparing the load intensity of the monitored players only expressed by HR values, the load intensity in extra-league defensemen (193.6 ± 6.8 beats per minute) was higher than in the forwards (184.7 ± 10.9 beats per minute). Also, defenseman no. 2 achieved the highest value of the maximum HR (namely 204 beats per minute). As Table 1 suggests, this player also showed the highest mean HR value in matches, namely 195.2 ± 6.4 beats per minute. It is clear that the presented difference in the load of players in the individual positions is statistically significant, and this difference can also be considered to be very significant from the practical significance point of view (Cohen’s $d = 0.98$).

However, when assessing the load intensity of athletes, various individual maximum HR values of the individual players need to be taken into account. In our case, the maximum HR values of all the players were determined in laboratory conditions before the season. Table 2 shows the analyzed values of the load intensity of the players during the match (in the individual periods), in maximum HR percentage. The mean values of load at the level of $89.3 \pm 8.2 \% \text{HR}_{\text{max}}$ were analyzed in all monitored players regardless of their game positions. Table 2: Load Intensity of Ice hockey Players during Matches in Relation to Their Game Positions (Expressed in $\text{HR}_{\text{max}} \%$)

Period	Position	Mean (95 % CI)	SD	Max. Percentage of $\text{HR}_{\text{Max}} (\%)$	p-value	ES
1st Period	Defensemen	87.7 (87.5; 88.1)	7.65	101.5	$< 0,001$	0,26
	Forwards	89.8 (89.3; 90.3)	9.09	98.1		
2nd Period	Defensemen	87.8 (87.4; 88.2)	8.22	103.0	$< 0,001$	0,45
	Forwards	91.6 (91.3; 91.8)	9.42	102.3		
3rd Period	Defensemen	87.8 (87.5; 88.1)	7.21	101.7	$< 0,001$	0,42
	Forwards	91.2 (90.6; 91.6)	10.35	101.4		
Total	Defensemen	87.8 (87.5; 90.1)	7.71	103.0	$< 0,001$	0,38
	Forwards	90.9 (90.2; 91.5)	9.69	102.3		

Note: 95% CI – 95% Confidence Interval for Mean (Lower Bound; Upper Bound). SD – Standard Deviation,

Max. Percentage of HR_{max} – maximal percentage of maximal heart rate during championship matches, p -value (Mann-Whitney test), ES – Effect Size (Cohen’s d)

No statistically or practically significant differences in the load intensity of the defensemen were analyzed during the match (i.e., during all three periods) and overall, the mean value for all defensemen during the monitored matches was calculated at $87.8 \pm 7.7 \% \text{HR}_{\text{max}}$. The mean value for the forwards was calculated at $90.9 \pm 9.7 \% \text{HR}_{\text{max}}$. As Table 2 implies, the load intensity of the forward position was lower in the first period when compared with the second and third period. The table also shows the specific differences in the load intensity of the players in relation to their game position during the match, as well as overall. Those differences can be considered to be statistically significant (p -value $< 10^{-3}$), however, from the practical significance point of view, the presented differences have a low significance (Cohen’s $d = 0.26$ to 0.45).

The presented results of load intensity of ice hockey players are in full compliance with the results of publications about most sports games. Authors such as Abdelkrim, El Fazaa, & El Ati (2007), Mathew & Delextrat (2009), Vala & Litschmannová (2012); Vala & Petr (2013) and Puente et al., (2017) agree that the game position where the individual players are is one of the most important factors that have a substantial effect on the load intensity of sports game players. One of the most significant factors affecting the intensity of exercise load of sports game players is the player’s position, with the observed differences being assessed as statistically significant (Abdelkrim, El Fazaa, & El Ati, 2007; Mathew & Delextrat, 2009; Vala & Litschmannová, 2012; Vala & Petr, 2013, Abbott, Brickley, & Smeeton, 2018).

The highest values of load intensity were found in the forward positions of extra-league players at $90.9 \pm 9.7 \% \text{HR}_{\text{max}}$ during the second periods. In contrast, the lowest values were found in the defensemen in the first periods of the monitored matches ($87.8 \pm 7.7 \% \text{HR}_{\text{max}}$).

The total difference in the load intensity of the players according to their game positions is $3.1 \% \text{HR}_{\text{max}}$ and this difference can be considered to be statistically significant (p -value $< 10^{-3}$), whereas the effect is low with respect to practical significance (Cohen’s $d = 0.38$).

Table 1 also shows that maximum HR as determined in laboratory conditions is regularly exceeded during matches. In this case, it seems to be more appropriate to determine the HR_{max} values of the players using field tests, such as “Yo-Yo Intermittent Recovery Test Level 1” (Abadet al., 2016; Bangsbo, Iaia, & Krstrup, 2008), which better “simulate” the typical load of players of sports games with typical intermittent load.

Picture 1: Graph of Load Intensity Distribution of Players in Individual Zones by Game Positions Expressed in HR_{max} (%)

The graph in picture 1 shows that extra-league players in the forward position moved above the level of 90 % HR_{max} during 56 % of the time played, while it was only 44 % of the played time for the defensemen. In general, the differences in the load intensity of sports game players are caused by the various game positions and the related various game roles in the sports field. The utilization of the individual players at various positions in the game is related, above all, to the used game defense (zone-based or personal defense system, passive or various types of active pressure defense etc.) and forward systems (gradual or quick counterattack). The specific tasks of the individual players then depend on the selected game systems, when some players need to be constantly on the move, both in defense and forward, while, for example, defensemen may do several game activities of a “positional or static character”. Also, we need to emphasize that this is a junior category as the HR values are influenced by one important factor, which is the experience of the players gained during their career, leading to changes in the structure of the player’s game performance.

Apart from the player’s position, the load intensity may also be influenced by the result of the individual matches when the best players of oneteam are forced to play with maximum intensity against the best rival players during the entire match, in the case of a balanced situation. On the contrary, when the match result is obvious, the load intensity might gradually decrease during the match. Monitoring load intensity in sports games, for which interval load is typical, is a complicated matter. Unlike more accurate indicators, such as oxygen consumption (VO_2), HR monitoring represents a practical and broadly applicable method (Achten & Jeukendrup, 2003; Buchheit, 2014; Aoki et al., 2017). For a more detailed specification of the load of players in an ice hockey match, research will have to include heart rate monitoring in a larger group (teams and players), to monitor load in several matches while observing the same conditions. It would also be appropriate to analyze load intensity in relation to the number of minutes played, or monitor the players’ HR during the entire match, including the parts of the game when the players are on the bench, and then look for the proper moments for getting the best players back in the game.

Conclusion

The analysis of the game load of players during a match should point to the basic parameters that trainers should use in their training plans. The training process can also include the use of fitness trackers and heart rate monitors. The objective of the study was to analyse the progress of load intensity of ice hockey players during a match in relation to game positions (defensemen and forwards). While the calculated mean value of HR_{max} in extra-league players in the position of forwards was 90.9 ± 9.7 % HR_{max} , the mean load intensity value in the defensemen was analysed to be 87.8 ± 7.7 % of maximum HR determined during a load test. The different HF values are caused, above all, by the different game roles as well as specific tasks of the individual players. Defensemen play for more minutes in the matches, but forwards ice-skate at a higher intensity than defensemen. In sports practice, we do not usually encounter situations of random selection and thus the load intensity results were also assessed with regard to practical significance (“effect size”). The difference in the load intensity we determined can be considered to have low significance (Cohen’s $d = 0.38$). In conclusion, we can state that the

results provide a better understanding of the game and help trainers choose suitable exercises for precise training sessions based on the individual requirements. The submitted study has a pilot study character, however, the obtained results of load intensity of players in championship matches were used as a basis for the preparation of a training plan and they were also taken into account when selecting suitable methodological and organisational forms in the training process of the team.

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