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ORIGINAL ARTICLE

Analysis of the injuries and workload evolution using the RPE and s-RPE method in basketball

Observación de las lesiones y la evolución de la carga mediante el método RPE y el s-RPE en baloncesto

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Abstract The quantification of training loads provides valuable information to reduce overtraining and detecting the risk of injury. The present study looks into the evolution of the training load using the RPE and s-RPE method and describes the injuries observed. It is an observational study based on 9 subjects of the Pardinyes basketball team (Leb Plata category) who, in each practice and match, recorded their RPE. This value, together with the volume (in minutes), provides the s-RPE. All injuries and their typology were also recorded during the first round of the competition. A total of 124 sessions were registered and 14 injuries were described in the period that went from 09/19/2019 to 02/15/2020. The load evolution of each player has been compared to the team average and to the one perceived by the coach. The lower extremity was, by far, the most injured one (13/14 injury events). The highest percentage of injuries was registered during the last part of the training sessions and matches, coinciding with the highest physical and psychological fatigue, and 64% of them were due to microtrauma. These inexpensive and easy-to-use methods (RPE and s-RPE) provide valuable data for planning, in order to adjust loads and prevent overtraining and injuries. It is necessary to manage workload to provide the player with the ideal stimulus, minimizing the risk of injury and, at the same time, maximizing their performance.

Introduction

The Rating of Perceived Exertion (RPE) is a useful subjective method for monitoring the internal training load.[1] The s-RPE method (session RPE) connects the RPE to the duration of the exercise (minutes that the session or match lasted) which

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provides the training load (TL)[2]. According to Svilar et al.,[3] s-RPE is an overall indicator of load in intermittent sports. The s-RPE is an indicator that could facilitate the development of a suitable periodization of the training load, which would reduce the likelihood of overloads, overtraining and injuries.[4] This method is very accessible, costless, and applicable to any type of practice and also to official competition.[5]

External load refers to the work completed by the players regardless of their individual characteristics. Instead, the internal load is measured by evaluating the response to the psychological and psychophysiological stress that the external load causes in each player.[6]

The RPE is a useful tool for monitoring the internal load of basketball practice. The demands of basketball involve greater intensity and density in training and therefore emphasize the need to monitor the internal load, as training programs are generally planned according to the parameters of external load.[1] The RPE is considered a useful, valid, and ecological tool for managing the training load in professional women's basketball as pointed out by Piedra et al.[2] It is connected to other methods of assessment of the internal load, such as blood lactate and VO2, which require greater training and preparation of the technical staff, even though they are more objective methods.[7]

According to the study by Foster et al.,[8] a relationship was found between HR (heart rate) and RPE in basketball, which points to a consistent relationship between both exercise monitoring methods.[8]

It was chosen to use the double RPE scale of the player compared to the RPE perceived by the coach, which allowed to establish how the player assimilated the loads with respect to the planning, and gave the possibility of readjusting according to the information received, which would reduce the risk of injury.[9]

According to Blanch et al.,[10] the ideal training stimulus (Sweet Spot) is one that maximizes the performance potential with an adequate load, while limiting the negative consequences of training (injuries, illness, fatigue, overtraining). In terms of risk of injury, the ratio of acute-chronic load should be between 0.8-1.3, considered the "Sweet Spot" training.[11] Blanch et al.[10] suggest a training and injury prevention paradox in which hard (and appropriate) physical training can prevent injuries despite the risk of soft tissue injury.

According to Matas,[12] it is unknown how many consecutive indicators of RPE should be recorded or what the risk threshold is. Taking into account this situation, he decides to evaluate the tendency of the player and the team and the patterns are studied.

A time-loss injury according to Collin W. Fuller et al.[13] refers to any injury caused in a match or practice that forces the player to miss the next sporting event or training session. Depending on the injury mechanism, these can be classified as traumatic or caused by overuse. Trauma refers to injuries which result from an identifiable event, and injuries from overuse are caused by repetitive microtraumas without a single identifiable event or responsibility for the injury.[13] According to Drakos et al.,[14] lower limb injuries are by far the most common ones and those that lead to more missed matches, followed by upper limb, trunk and head injuries. The most affected structures are the ankle (LLE sprain), lumbar, patella, knee and foot.

The aim of the study is to observe the evolution of the load during the first competition round of the 2019/2020 season, to describe the injuries that took place in that period of time and to analyze the possible relationship between the application of loads and the risk of injury due to microtrauma (overuse).

Materials and methods

Participants

Eight basketball players and the coach of Pardinyes, who competed in the “Leb plata” category during the 2019-2020 season, were analyzed. The mean age of the players was 23.50 ± 2.56 years, the mean height was 192.00 ± 5.15 cm and the mean weight was 92.40 ± 12.13 kg. The percentage of participation in matches had to be of at least 50% to be included in the study criteria. The 1964 Declaration of Helsinki was taken into account for the usage of data[15].

Materials and tools

This is a one-center observational study. The modified scale of Foster et al.[16] was used to obtain the RPE in which players rated between 0 and 10 their perception of the overall fatigue of a given practice or match, and the coach rated his perception of how tired the players were. The volume was expressed in minutes at the end of each session including warm-up.

Injuries were recorded following the parameters of Caine et al.[17] and C. W. Fuller et al.[18].

A total of 124 sessions were recorded over 21 weeks (the first round of competitions) including track and gym sessions, as well as matches.

Variable recording

1 Subjects were informed about the use and proper operation of the modified scale by Foster et al.,[16] which was tested during the preseason so that it could be used with maximum accuracy. They rated the RPE 30 minutes after each session from 0 (low fatigue) to 10 (maximum fatigue), providing the integer in which they found themselves and filled the spreadsheet. The value was then multiplied by the minutes that the session or match lasted and the s-RPE was obtained.
2 Injuries suffered by players were recorded on the spreadsheet by entering the parameters mentioned above and limiting it to time-loss injuries.[13]

Both records were obtained meticulously during these 21 weeks.

Data analysis

The descriptive statistics indexes of the quantitative variables are presented by means of their frequency or count, their mean and their respective standard deviation. It is verified if the distribution of the variables follows a normal distribution according to the Shapiro-Wilk test and, if so, the Pearson correlation coefficient (r_{xy}) is presented; if not, the Spearman's Rho (ρ) test is applied. Once the application

Table 1 Total number of sessions and injuries.

	Total sessions	Practice sessions	Matches	Total minutes of sessions	Total minutes of practice	Total minutes of matches	Total injuries	Practice injuries	Matches injuries	Injuries due to microtrauma
P02	97	75	22	6655	6455	200	0	0	0	0
P03	93	71	22	6624	6060	564	1	1	0	1
P04	94	72	22	6795	6070	725	2	1	1	2
P06	97	75	22	7032	6425	607	1	0	1	0
P07	88	68	22	6435	5975	460	0	0	0	0
P09	92	70	22	6477	5970	507	3	2	1	0
P10	44	33	11	3014	2805	209	4	3	1	3
P11	85	66	19	6134	5730	404	3	3	0	3
Total	99	77	22				14	10	4	

assumptions have been verified, a simple regression analysis is applied considering the number of injuries due to microtrauma as a dependent variable of RPE and volume. The level of statistical significance is $p < 0.05$. Statistical analyses were performed using the JASP version 0.13 program (Department of Psychological Methods, University of Amsterdam, Netherlands).

Results

The results obtained in this first 21-week macrocycle show that 13 out of 14 time-loss injuries occurred in the lower limb, while the remainder one affected the lumbar area. Nine injuries (64%) were caused by microtrauma (overuse), five of which (56%) had a previous injury history. It is observed that sprains were the most frequent injuries, and were located in the ankle and knee. Ankle injury is the one that affected a wider range of players: instead, knee injury is the one that affected more times the same player. Coinciding with Drakos et al.,[14] the knee and the ankle are the most frequently injured structures; the former being the one that causes a higher number of missed matches.

It was quantified that 64% of the injuries occurred during the second half of matches or training sessions. During the month of September, 4 injury events were reported (29%) and between the end of December and the beginning of January, after the holiday break, there were 7 referred events (50%).

The load (RPE and s-RPE) of gym sessions was not recorded since it was observed that the 0-10 scale of Foster et al.[16] did not correctly express the fatigue of the players in this type of session.

Finally, we used data from 99 sessions (77 practices on the court and 22 matches), recorded in a total of 21 weeks (Table 1) (Table 2).

The average RPE of the players was obtained throughout the 21 weeks of registration and it was compared to the average observed by the coach (Fig. 1). A slight dissimilarity can be seen in the last three weeks, in which the coach RPE perception was lower than the average RPE perceived by the players in that last period of the record (Fig. 1).

Finally, the supposed relationship between injuries due to microtrauma and RPE was analyzed, and a directly proportional and statistically non-significant association r_{xy}=0.762 was observed ($F = 3.492$; $p = 0.112$). The equation that models the relationship is: $y = 7.990$ - (1.468 RPE $\times$ 0.073 volume) (Table 3).

To verify the association between the team's and the coach’s average perceived exertion (RPE), after checking that the assumption of normality is violated ($W = 0.766$; $p<0.001$), the Spearman correlation coefficient is calculated, obtaining $\rho = 0.775$; $p < 0.001$, so it is concluded that there is a directly proportional and statistically significant association between the team's RPE and the one perceived by the coach (Fig. 2).

Discussion

A statistically non-significant relationship of the RPE variables and volume of practice and matches is observed in relation to microtrauma injuries. This shows that these

Table 2 RPE and s-RPE averages from practice and matches.

	Total RPE	Practice RPE	Match RPE	Total s-RPE	Practice s-RPE	Match s-RPE
P02	7,47	7,71	7,23	350	653	66
P03	6,91	6,29	7,52	376	524	193
P04	6,81	5,81	7,81	392	478	257
P06	7,83	7,07	8,59	439	598	237
P07	8,19	7,52	8,86	442	654	185
P09	7,92	7,39	8,45	425	622	195
P10	6	5,27	6,73	299	426	128
P11	7,44	7,14	7,74	401	618	165
Total	7,32	6,78	7,87	396	577	181

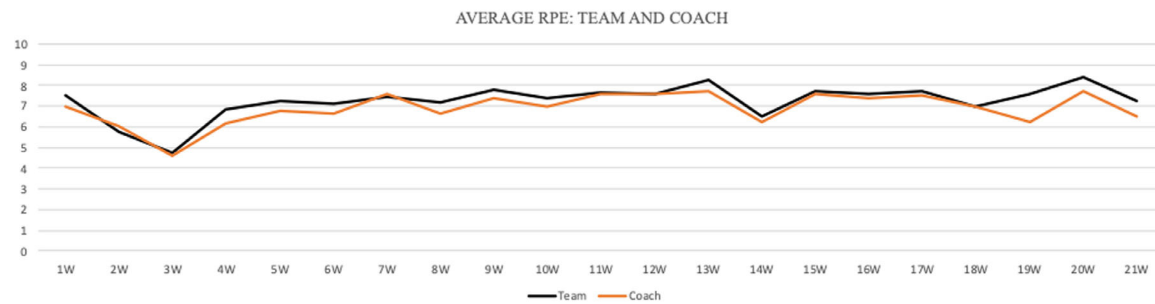

Fig. 1 RPE average perceived by the team and observed by the coach during the 21 weeks.

Table 3 Regression analysis considering the number of microtrauma injuries (overuse) as a dependent variable of RPE and time exposure (volume).

Model	R	R2	Adjusted R2	F	p
1. Matches and practice	0,763	0,583	0,416	3.492	0.112
	B	Standard Error	β	t	p
Model (Constant)	7.99	6.842			
RPE	-1.468	0.556	-0.775	2.638	0.046
Time exposure (volume)	0.073	0.117	0.182	0.62	0.562

measures may be valid to be used as an indicator of the risk of injury caused by microtrauma but they do not determine the risk on their own. The systematic review of 35 articles by Drew et al.[19] showed moderate evidence in the relationship between the training load applied to a player and the risk of injury.[19]

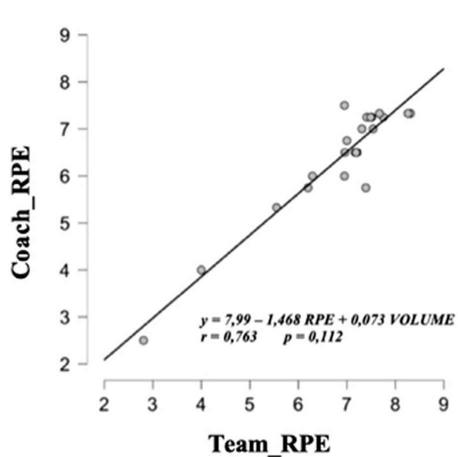

Fig. 2 Association of the RPE between the team average and the one observed by the coach.

From the results of the injury events, we highlight the highest incidence in the lower limb (14 out of 15 events). Although basketball is a contact sport, 60% of the injuries in this study were due to microtrauma (9 events) and in 5 of them (56%) the player had already reported a previous medical history in the same area, which suggests the need to pay attention to players' discomfort and reaffirms the importance of achieving a full recovery from injuries. The results of the study show that injuries increase significantly during the second half of practices or matches (64% of them) or after holiday periods, in which load becomes a key element to manage.

Higher protection against injuries is also seen as the time of exposure to specific training is increased, as indicated by Piedra et al.[2] in the results of the study. A specific example taken out from the study sample was players P10 and P11: they were the ones with less accumulated minutes (3014 and 6134 respectively) but, at the same time, they were the ones who suffered more microtrauma injuries (3 each, out of the 9 reported in the whole team).

The introduction of the coach's RPE data in the study has provided a different and interesting approach for the detection of possible excesses or low levels of fatigue of the players according to the planning. The coach's subjective perception about players' fatigue in a practice or match (0-10 scale) compared to the team average allows us to know if the coach's perception is in line with the reality of the players. This procedure provides a tool to rethink practice or match loads and thus reduce the risk of injury, favoring permanent training adjustment.[20]

In this study, 8 players who are part of a semi-professional team were analyzed, which means that some of them carry out activities (working hours, physical activity not prescribed by the team, etcetera.) outside training hours that may condition their fatigue, a circumstance that was not contemplated in the study. It is also possible that mental load interactively influences physical load, not only regarding fatigue and mental performance but also physical performance.[21] Another limitation was the fatigue generated by some players during gym sessions, which could increase the fatigue in practices.

Conclusions

Indicators suggest that there is a directly proportional but statistically non-significant relationship in the connection between microtrauma injuries and RPE, but there is a directly proportional and statistically significant association between the team's RPE and the one perceived by the coach in semi-professional men's basketball.

The RPE method, widely used, brings us closer to controlling the load parameter, in order to better understand the abnormal fatigue states of our players and anticipate possible injuries.

Study limitations and future outlook

A longer period of familiarization with the RPE scale would help reduce erroneous conclusions and would allow to obtain more objective results from these values .[2] This study only presents a sample of 9 subjects and the follow-up of one round of competitions during the 2019-2020 season.

It is known the existence of other factors such as sleep quality, diet and mood, among others, which must be taken into account since they also condition the appearance of injuries.[22]

Nowadays, load control is a reality not only for the control of semi-professional teams, but also in training categories to have an impact on the prevention of injuries and to optimize players' performance.[23]

Conflicts of interest

The authors have no conflict of interests to declare.

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