ORIGINAL ARTICLE

Physical demands of a national U20 rugby team in international tournaments

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ABSTRACT

The quantification of the load in rugby is an activity that has been carried out for some years. However, after reviewing the literature, there is little information on the demands that players present in international tournaments. The objectives of this research were to characterize the demands of players in international tournaments, to find out if there were significant differences depending on the specific position (forwards or backs), the parts of the game (first or second half) or the type of tournament (European vs. World Cup). To do this, a national team was quantified during all the matches they played in a European tournament and in a world tournament. All the players analysed were from the Under 20 category (n = 32). Each player wore a Catapult Vector S7 inertial device. Different ANOVA analyses were performed. The results showed differences in most of the variables analysed depending on the playing position, the part of the game and the type of tournament. In addition, the results showed a greater demand in players with a Back position who participated in the European tournament. In the process of individualization, training programs should be tailored according to players' positions on the field and their specific demands.

Keywords: Performance analysis, Team sport, Load monitoring, External load, Inertial devices, Ball in play.

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INTRODUCTION

Rugby is a sport that in recent years has experienced an increase in practitioners and followers, reaching 10 million practitioners around the world. (World Rugby, 2018). This increase is due to the increase in the number of people practicing team sports and seeking an intense activity with great physical demands (Cummins et al., 2013). For this reason, this modality, rugby, is characterized by being a contact sport, intermittent and with high intensity actions. These demands require the athlete to perform repeated running actions, collisions and static efforts of different jobs interspersed with rest periods (Duthie et al., 2003). This sport has evolved in recent years in the physical aspect of the players. Currently, rugby players perform a greater number of explosive actions, at greater intensity and for a longer duration than a few years ago. This fact has caused the practice of rugby to increase its visibility and number of practitioners due to its greater spectacle for fans.

As a result of these specifications in the load supported by the users of this sport, the incidence of injuries is one of the highest in team sports (Williams, et al., 2013) according to the different injury monitoring in recent years (Williams, et al., 2013; Cruz-Ferreira, et al., 2017). William et al. (2013) indicated that the incidence of injuries in senior men's professional rugby matches was 81 per 1000 player match hours. Rugby Europe's latest Injury Surveillance report, in the Under-20 category (U20), found an incidence rate of 83.33 injuries per 1,000 player match hours. Of the total injuries, 32.62% are serious and forced the athlete not to practice for at least 28.50 days (Cruz-Ferreira, et al., 2023c).

A typical match consists of two 40 min halves separated by 10–15 min, with frequent intense bouts of high-intensity activities such as running, kicking, passing, and tackling interspersed with low-intensity exercise (Gabbett et al., 2008). Furthermore, during a match rugby players perform a high number of accelerations and decelerations with change of direction involving eccentric muscle actions (Gabbett et al., 2008). Because of these demands, significant skeletal muscle fatigue and muscular damage are reported after a rugby match (Tavares et al., 2017). Inappropriate management of training load (TL) has quickly become one of the main risk factors in non-contact injuries (Soligard et al., 2016; Jones et al., 2017) or increased levels of fatigue, as well as higher risk of illness (Jones et al., 2017).

To facilitate this handicap and provide knowledge, in recent years, the use and exploitation of microtechnology in sports has been exponential. Although rugby was the first sport in which technology was used to quantify player demands, football popularized this technique and helped improve the process. Rugby has used Global Positioning Systems (GPS) using IMUs with microsensor technology (Jones et al., 2015) since 2008 to quantify volume and intensity during competition (Hartwig et al., 2008) and training load (Cunniffe et al., 2011) since 2011. Currently, it has been studied at senior club level (Takamori et al., 2022) and at international level (Olsen et al., 2023). But current information on the U20 category is limited.

Reviewing the existing literature, we are unaware of the existence of studies that analyse the U20 category at different competitive levels at an international level. Therefore, the objective of our study were: i) To describe the demands that rugby presents in a world championship and in a European championship in the U20 category; ii) To analyse whether there are differences between both championships carried out by the same team; iii) To find out whether there are differences in the load demands of the players depending on the playing position.

MATERIALS AND METHODS

Design

The design of the present study is framed within an empirical methodology, specifically a quasi-experimental study (Ato, López, & Benavente, 2013), whose objective is to understand the external load demands of rugby players during an international championship. The quasi-experimental design is because the objective of the research is to test a hypothesis by manipulating a variable since a random group design cannot be carried out.

Participants

The research consisted of 32 international level U20 rugby players. The analysed team comprised 15 Back position players (average weight of 83.6 ± 7.5 kilograms and an average height of 178.9 ± 5.3 cm) and 17 Forwards position players (average weight of 104 ± 7.0 kilograms and an average height of 187.7 ± 7.4 cm).

Sample

The sample of this research consisted of 11 matches (5 matches from the European Championship and 6 matches from the World Rugby U20 Trophy Championship) involving a total of 417 cases (n = 417). Each player was equipped with a Catapult inertial device, which was attached to the athlete using a sport-specific anatomical harness. The research was conducted under the criteria of the bioethics committee issued to the university to which the researchers belong.

Instruments

All players were equipped with a GPS device Catapult Vector S7 (Catapult, Melbourne, Australia) with a recording capacity of 10Hz, which was attached using a fitted anatomical harness suitable for sports practice.

Variables

The research included the variables playing position (backs and forwards), match period (first half and second half), and tournament (World or European), which were selected by the research team as independent variables. Additionally, the following were used as dependent variables:

- Play time: This is the number of minutes that the game has been in play (measured in minutes).
- Total distance: Number of meters covered by the players during the game (measured in meters).
- Distance at >7km/h: Number of meters covered by the players during a game at a speed greater than 7 km/h. (measured in meters).
- High intensity distance: Number of meters covered by the players during the game at a speed greater than 16 km/h (measured in meters).
- Distance/Minute: Number of meters covered per minute of play (measured in meters).
- Accelerations and decelerations: Number of times that the athlete makes a positive or negative increase of 2 m/s2 in the speed of movement.
- Accelerations/min: Number of times that the athlete makes a positive increase in the speed of movement per minute of play
- Player load: calculates the physical effort of the athlete during the movement. It calculates it by adding the acceleration in all directions, based on each of the 3 axes and the time of the acceleration.
- RHIE total bouts: Repeated high intensity efforts provide the ability to identify periods where athletes have performed repeated "*high intensity*" speed efforts without adequate recovery. Successive single high intensity efforts repeated within a predetermined time frame are grouped into RHIE bouts.

- Contact involvement count: Calculates the cumulative sum of player load from 0 to 20 seconds after contact involvement. If greater than 1.0, the player is considered active after contact involvement. Otherwise, the player is considered passive.

The analysis of the variables was conducted only during the moments when the ball was in play (Ball in Play, BIP). Therefore, all moments when the match did not meet this BIP condition were excluded.

Procedure

First of all, A meeting was held with the staff of the selected national team. General information about the research was provided, as well as any doubts and questions they had were answered. Once the request was accepted by the national team, a meeting was held between the coaching staff and the players where the research that was going to be carried out was explained, the positive aspects of the results obtained and that it did not pose any risk to the players.

Prior to the championships, the players began to train with the material that was going to be used in the matches so that ignorance or discomfort could be a contaminating variable in the research. Next, all players were equipped before each match 45 minutes prior to the start of the match. Only the players who were playing in the match were taken into account for the analysis (the players who were on the bench were not analysed). Furthermore, with the information from the players and the analysis of the match, the Ball in Play (BIP) moments were selected and the results obtained were analysed.

Statistical analysis

Assumption checks were performed to ensure that the recorded variables met the normality criteria (Kolmogorov-Smirnov test). Therefore, a non-parametric hypothesis testing model was used. A descriptive analysis (means and standard deviation) was carried out to explain the behaviour of the dependent variables during the performance in the competition. Additionally, independent samples T-tests were conducted to compare based on the different independent variables (Field, 2009). The significance level used was $p < .05$, and the software used was SPSS 25.0 (Field, 2009)

RESULTS

Table 1 shows the results of the load values obtained by the study participants based on the type of tournament (World or European) and the part of the match (first half and second half). The results indicate significant differences related to the load borne by the players depending on the type of tournament and the part of the match. The results show that the first halves of matches in both World and European tournaments are more intense and place greater demands on the athletes than the second halves.

On the other hand, Table 2 provides information related to the players' positions on the field (distinguishing between backs and forwards). As can be seen, players in the Back position perform higher intensity actions and greater effort in physical variables compared to players in the Forwards position in both World and European championships.

DISCUSSION

Load quantification in rugby competitions is a common practice when dealing with high-level competitive teams. This research aimed to understand the differences in demands borne by players of a national team in different international U20 tournaments.

Table 1. Descriptive and inferential results of the matches grouped by tournament and match period.

	European Tournament					**World Rugby Trophy**					
	First half		Second half			First half		Second half			ANOVA
	Mean	ST	Mean	ST	Sig.	Mean	ST	Mean	ST	Sig.	Sig.
Play time	34.95	7.71	27.46	13.09	.001*	30.02	14.70	21.42	15.66	<.000*	.001*
Total distance	3660.15	745.48	2860.49	1355.77	<.000*	2432.47	732.06	1656.34	938.35	<.000*	<.000*
Distance at <7 km/h	2386.38	524.71	1863.50	892.66	.001*	1343.12	279.88	888.66	438.93	<.000*	<.000*
High intensity distance	758.57	365.89	583.07	383.91	.017*	989.89	542.02	602.83	474.90	<.000*	.073
Accelerations & decelerations	53.00	31.20	41.41	31.72	.059	26.93	13.84	17.88	13.38	<.000*	<.000*
Player load	405.18	87.74	320.42	148.83	.001*	256.57	58.69	174.66	86.76	<.000*	<.000*
RHIE total bouts	18.10	7.26	14.13	8.51	.012*	8.41	4.26	5.15	4.04	<.000*	<.000*
Contact involvement count	18.89	11.05	14.92	11.28	.068	11.95	6.38	6.89	5.78	<.000*	<.000*
Metres per minute	105.97	17.87	103.58	16.74	.472	91.99	24.79	89.25	24.92	.349	<.000*
High speed running	20.29	8.34	20.26	7.67	.983	17.85	10.14	15.82	9.34	.076	<.000*
Acc/min	0.68	0.40	0.70	0.52	.408	0.56	0.44	0.50	0.41	.246	.089

Play Time: *This is the number of minutes that the game has been in play (measured in minutes);* ***Total Distance****: Number of meters covered by the players during the game (measured in meters);* ***Distance at >7km/h****: Number of meters covered by the players during a game at a speed greater than 7 km/h. (measured in meters);* ***High Intensity Distance****: Number of meters covered by the players during the game at a speed greater than 16 km/h (measured in meters);* ***Distance/Minute****: Number of meters covered per minute of play (measured in meters);* ***Accelerations and Decelerations****: Number of times that the athlete makes a positive or negative increase of 2 m/s2 in the speed of movement;* ***Accelerations/min****: Number of times that the athlete makes a positive increase in the speed of movement per minute of play;* ***Player Load:*** *calculates the physical effort of the athlete during the movement. It calculates it by adding the acceleration in all directions, based on each of the 3 axes and the time of the acceleration;* ***RHIE total bouts:*** *Repeated high intensity efforts provide the ability to identify periods where athletes have performed repeated "high intensity" speed efforts without adequate recovery. Successive single high intensity efforts repeated within a predetermined time frame are grouped into RHIE bouts;* ***Contact Involvement Count****: Calculates the cumulative sum of player load from 0 to 20 seconds after contact involvement. If greater than 1.0, the player is considered active after contact involvement. Otherwise, the player is considered passive.*

Table 2. Descriptive and inferential results grouped by playing position according to the type of competition.

	European Tournament					**World Rugby Trophy**					
	Back		Forwards			Back		Forwards			ANOVA
	Mean	ST	Mean	ST	Sig.	Mean	ST	Mean	ST	Sig.	Sig.
Play time	32.42	11.60	29.09	11.73	.138	25.94	15.63	23.91	15.98	.269	.115
Total distance	3537.61	1127.35	2918.64	1203.71	.007*	2165.13	927.57	1798.84	923.47	<.000*	<.000*
Distance at <7 km/h	2352.91	739.57	1864.66	788.99	.001*	1215.90	416.89	948.36	429.02	<.000*	<.000*
High intensity distance	941.85	348.71	429.73	231.59	<.000*	1183.54	486.76	409.20	245.47	<.000*	<.000*
Accelerations & decelerations	57.38	32.37	37.38	28.80	.001*	31.78	13.62	13.09	7.82	<.000*	<.000*
Player load	349.57	113.98	360.27	147.70	.677	210.07	76.90	204.50	93.95	<.578	.965
RHIE total bouts	19.24	7.89	13.04	7.45	<.000*	9.22	4.33	4.19	2.99	<.000*	<.000*
Contact involvement count	12.69	8.65	19.62	12.25	.001*	7.35	4.43	10.13	7.58	<.000*	<.000*
Metres per minute	110.94	14.71	99.53	17.42	<.000*	96.08	26.33	85.67	22.64	<.000*	<.000*
High speed running	26.63	5.98	15.25	5.19	<.000*	23.60	7.85	10.94	6.97	<.000*	<.000*
Acc/min	2.34	0.60	0.54	0.39	.250	0.756	0.44	0.34	0.29	<.000*	.197

Play Time: *This is the number of minutes that the game has been in play (measured in minutes);* ***Total Distance****: Number of meters covered by the players during the game (measured in meters);* ***Distance at >7km/h****: Number of meters covered by the players during a game at a speed greater than 7 km/h. (measured in meters);* ***High Intensity Distance****: Number of meters covered by the players during the game at a speed greater than 16 km/h (measured in meters);* ***Distance/Minute****: Number of meters covered per minute of play (measured in meters);* ***Accelerations and Decelerations****: Number of times that the athlete makes a positive or negative increase of 2 m/s2 in the speed of movement;* ***Accelerations/min****: Number of times that the athlete makes a positive increase in the speed of movement per minute of play;* ***Player Load:*** *calculates the physical effort of the athlete during the movement. It calculates it by adding the acceleration in all directions, based on each of the 3 axes and the time of the acceleration;* ***RHIE total bouts:*** *Repeated high intensity efforts provide the ability to identify periods where athletes have performed repeated "high intensity" speed efforts without adequate recovery. Successive single high intensity efforts repeated within a predetermined time frame are grouped into RHIE bouts;* ***Contact Involvement Count****: Calculates the cumulative sum of player load from 0 to 20 seconds after contact involvement. If greater than 1.0, the player is considered active after contact involvement. Otherwise, the player is considered passive.*

A review of the literature shows there is not much information available for this sports stage. Therefore, with the results obtained, the intention is to determine if the analysed U20 players show similar results to professional athletes in the senior category.

Results based on match period

The results grouped based on the match period show that the first halves of all matches (both in European and World competitions) are more intense and require athletes to make a greater number of efforts. These efforts lead to a higher accumulated load than in the second halves of the matches. Firstly, the average time of the analysed matches shows greater utilization in the European tournament matches, making the game more continuous. Additionally, the first halves in both the European and World tournaments have more playtime than the second halves. In line with this, Guerrero-Esteban et al., (2023) demonstrated that playtime in rugby can be affected by different variables, making it difficult to generalize a value. Regarding the total distance covered, the results show distances close to 3000 meters per half during the European tournament, while the results during the World matches drop to an average of 2000 meters per half. These results align with some data observed in the literature (Blair et al., 2017; Clarke et al., 2016), where the distance covered in both studies is lower than the results obtained here. In contrast, Suarez-Arrones et al. (2016) in their research on women's rugby showed results closer to those obtained in this research.

In line with the distance covered, it is interesting to analyse the distance covered at speeds of 7 km/hour. The results for this variable show a significant difference between championships (European tournament matches show higher values than World Cup matches). Additionally, in terms of match periods, the first halves show higher results than the second halves. These results contradict existing literature. On one hand, van den Berg et al. (2017) demonstrated that the results between the two halves were usually similar. Similarly, Portillo et al. (2014) also showed that the results between match periods were usually similar. Furthermore, related to distance, in the high-intensity distance variable, this research's results show that the first halves are more intense and require players to cover more distance at this intensity than in the second halves. However, during the World Cup matches, the results are higher than during the European matches. Finally, the meters per minute variable provides information on the distance players cover per minute, indicating the match's intensity. The matches played in the European tournament show higher values than those played in the World Cup. Additionally, the first halves are more intense than the second halves. Goodale et al. (2017) in their research showed similar data where the first halves of matches were more intense than the second halves. However, Ross et al (2015) found a higher intensity in the analysed matches compared to the results obtained in this research. Conversely, Ganatalli et al. (2014) provided lower data than those obtained in this research. The main reasons for such dispersion and variety in the results could be the competitive level of the analysed samples.

The results obtained for the acceleration and deceleration variables show significant differences between tournaments. In line with the results obtained, different investigations demonstrated in players values similar to those obtained in this investigation (Varley et al., 2012). In addition, in a sample of under-20 players Cunningham et al. (2016) demonstrated these differences mentioned. These similarities may be due to the fact that there are many similarities between the samples analysed and the sample of this investigation.

Results based on playing position

Results analysed based on playing position demonstrate that Back players in both the European tournament and World Cups show higher game demands than Forward players.

The distance covered by players also varies based on their playing position on the field. Back players covered greater distances in both the European tournament and World Cups compared to Forward players. These results are consistent with those found in Portillo et al.'s research (2014). In contrast to this assertion, Ross et al. (2014) demonstrated that in rugby sevens, another form of rugby with similar principles to the analysed rugby, Forward players cover greater distances than Back players. The distance covered per minute by players is also higher among Back players than Forward players in both tournaments. The values obtained exceed those shown by Cunningham et al. (2016) in both U20 and amateur samples across different tournament phases. Conversely, Suárez-Arrones et al. (2016) found higher results in a sample of rugby sevens compared to those obtained in this research. The main differences in distance per minute can be found in the competitive level of the analysed sample. However, in rugby sevens, despite it being the same playing field, with fewer participants, the intensity and player involvement are higher, leading to greater intensity in the game.

The results show that Back players performed a greater number of accelerations and decelerations compared to Forward players. Consistent with these findings, Ball et al. (2019) demonstrated that in various rugby situations, Back players not only performed more accelerations and decelerations but also at higher intensity. In another analysed sample, Goodale et al. (2017) obtained similar results in women. The main reasons possibly related to these differences could be the inherent game demands and the different actions required of each player based on their position.

The High Intensity Events (HIE) conducted indicate a higher number of actions in Back players, with more occurring during the European tournament than the World Cup. Sheehan et al. (2022) showed that HIE values are related to the competitive level and the player's position on the field. These values are difficult to generalize and are multifactorial. In line with the above, Negro and Gabbett (2015) obtained lower HIE values in both professional and semi-professional players.

Conclusions and practical applications

Analysing the results obtained in this research, it can be concluded that the demands on an international U20 team vary depending on the type of tournament they participate in. The results show significant differences between the demands of the European tournament and those of the World Cup. Additionally, the matches analysed in both tournaments were characterized by being more intense in the first halves compared to the second halves, with the analysis between halves of the match being significant. Lastly, Back players achieved higher values in variables related to accelerations, decelerations, and all distance-related variables (including high-intensity ones), leading to significant differences between positions (Backs and Forwards).

The main practical applications of this research are related to player training processes. The data obtained provide information for individualizing training processes. These results can help coaches and physical trainers understand the demands athletes face during competition. Furthermore, in the process of individualization, training programs should be tailored according to players' positions on the field and their specific demands. Lastly, regarding match planning, observing that first halves are more intense than second halves can assist coaches in making decisions regarding player selection throughout the game

AUTHOR CONTRIBUTIONS

DMT and MRR contributed to the conceptualization and design of the study. Data collection was carried out by MRR and HAF, while MAP was responsible for data curation and organization. The formal data analysis was conducted by DMT, HAF, and MAP. DMT contributed to the interpretation of the findings. The original

draft of the manuscript was prepared by MRR, HAF, and DMT. All authors participated in reviewing and editing the manuscript critically, approved the final version, and take responsibility for the integrity of the work.

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No potential conflict of interest was reported by the authors.

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