Sport Sciences for Health (2018) 14:201–208
https://doi.org/10.1007/s11332-018-0441-6

ORIGINAL ARTICLE

# Match-play performance comparisons between elite and sub-elite hurling players

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Received: 17 December 2017 / Accepted: 3 March 2018 / Published online: 12 March 2018


## Abstract

**Background** The current study aimed to describe the differences in the external and internal loads between elite and sub-elite male senior hurling match-play and across halves of play.

**Methods** Global positioning systems (5-Hz) and heart rate (HR) monitors were used to collect data from 24 elite and 24 sub-elite hurling players during 16 games. Data [total distance (TD), distance per speed zone, max speed, number of entries, length of run, and mean HR] were presented per min (relative) for the total game and per half.

**Results** Elite players covered a greater relative TD ($p < 0.001$, ES = 1.85) and TD walking ($p < 0.009$, ES = 1.21) but covered lower TD running ($p < 0.001$, ES = 4.00) than sub-elite players. Temporal decreases between halves occurred in relative TD ($p = 0.039$, ES = 0.36), and the first five speed zones ($p < 0.05$) for sub-elite players and for distance covered walking ($p = 0.001$, ES = 0.98), jogging ($p < 0.001$, ES = 0.77), HSR ($p = 0.022$, ES = 0.46) and mean number of entries at HSR ($p = 0.002$, ES = 0.72) at elite level.

**Conclusion** Games specific conditioning activities to assist players to repeat the running performances for the duration of the match is significant, especially at a sub-elite level. The current results are the first to highlight the differences in external and internal workloads between sub-elite and elite male senior hurlers and across halves of play.

**Keywords** Team sport · Match analysis · Performance · Heart rate · High-speed running · Sprint distance

## Introduction

Hurling is an Irish 15-a-side invasion game organized by the Gaelic Athletic Association (GAA). Matches are played on approximately a 145 m long and 90 m wide grass surface over a duration of 60 min (mins) and 70 min for sub-elite and elite, respectively. All players represent their sub-elite (club) team and compete in a county championship. The best players at sub-elite level are selected to represent their elite (inter-county) team who compete for the National League and All-Ireland Championship [1]. Those who are selected to represent their elite team maybe released back to sub-elite level where management sees appropriate [2]. Players perform unique skills with a stick made of ash (hurley) and leather outer-layered ball (sliotar) similar sized to a cricket ball but softer. A high degree of hand–eye coordination is required to perform sports specific skills such as catching the ball in the air, balancing the ball on the hurley, striking the ball long distances (> 80 m) and blocking opposing players with the hurley while they attempt to strike the sliotar [3]. Like other team sports, hurlers contest for possession and aim to score through the opposing team's goalposts. A goal or point is scored by striking the ball under or over the crossbar, respectively [3]. The ball can travel quickly from defense to attack where players contest to gain possession [4]. Providing coaches with the knowledge of the external and internal match-play performances at both elite

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and sub-elite levels can aid specific conditioning program design to facilitate the transition between levels of competition [5].

Previously, global positioning systems (GPS) technology has been used to quantify player's running performances during competitive matches in hurling and other team sports [4, 6–9]. GPS devices are compatible with heart rate (HR) technology which facilitates the collection of both running and HR intensities [1] and have been shown to provide valid and reliable measures of team sports performance [10–12]. Furthermore, the GPS device provides a breakdown of the distances covered within various speed zones [e.g. very low-speed movement (VLSM), walking, jogging, running, high-speed running (HSR), sprinting] [13], which allows the evaluation of athletes' match-play performance [14]. Finally, the number of entries between speed zones and the length of distance sprinted can provide useful information about the amount of changes in speed and the length of sprint performed.

The differences between elite and sub-elite levels have previously been reported in Australian football (AF), soccer and rugby league. Elite AF players covered higher TD ($128 \pm 12$ vs. $117 \pm 15$ m $min^{-1}$; $p < 0.01$) and high-intensity efforts ($2.9 \pm 0.6$ vs. $2.4 \pm 0.6$; $p < 0.01$) compared with sub-elite players [5]. Similarly, elite soccer and rugby league players performed more high-intensity running than in sub-elite competitions [15, 16]. Limited data exists which assesses the match-play performances in elite and sub-elite hurling players [17, 18]. It was shown that elite hurlers achieved higher speeds during match-play and undertakes a greater volume of high-intensity work compared to their sub-elite counterparts with no difference in total work rate [18]. The higher match-play demands of elite level are likely to have implications for conditioning players to perform at the optimum level. Therefore, further analysis of the difference between elite and sub-elite levels will aid the design and implementation of conditioning programs to help players transition to the top tier competition.

Comparing metrics between first and second halves can present temporal changes in running ability [19]. It was previously shown that such metrics decrease as the match progresses in hurling [4], soccer [20], AF [21], rugby [22] and elite Gaelic football [8, 19]. Research to assess the in-game physiological demands of hurling has lagged behind Gaelic football and other field matches [3]. Although the work rates in elite senior hurling match-play have been recently investigated [4], further details to describe the differences between elite and sub-elite playing standards are required. Sub-elite players can be selected to the elite panel at any time during the year, thus having a knowledge of the differences between elite and sub-elite match-play demands will assist the transition between levels [2]. Therefore, the aims of the study were first to examine the differences in the external and internal loads between elite and sub-elite male senior hurling match-play, and second, to examine the differences in the external and internal loads across halves of play. It was hypothesized that the external and internal loads would be higher at elite level and would decrease between halves at both levels.

## Methods

### Experimental approach to the problem

The current study was designed to investigate the differences in external and internal loads between elite and sub-elite male senior hurlers during match-play and investigate the differences in performances between playing halves. A total of one hundred and ninety-two GPS and HR data files were collected from 24 elite and 24 sub-elite male senior hurlers during competitive matches ($n = 16$). All players had completed at least a 3-month skills and physical conditioning program with their respective squad. All matches were played between 14.00 and 21.00 h. Match duration was 70 and 60 min for elite and sub-elite, respectively. Match day temperatures ranged from 10 to 18 °C. GPS tracking units recorded player's movements throughout the game and stored the HR signal transmitted from the player's HR monitor. Only players who participated in the full duration of the matches were included in the study. Players were at least 24 h free from organized training or matches before participating.

### Subjects

Forty-eight male senior hurling players (age $26.1 \pm 4.1$ years, height $182 \pm 5$ cm and body mass: $85.1 \pm 5.3$ kg) volunteered to participate in the current study. The players were selected from members of elite senior National Hurling League squads ($n = 24$) and sub-elite championship squads ($n = 24$). Only those who were free from injury and illness were eligible to partake in the study. The subjects were informed of potential risks of the study and were free to withdraw at any time and signed a written consent and a medical declaration. The team's medical staff evaluated and approved participant's inclusion in the study. Finally, the University Franche-Comté approved all procedures and the study was conducted according to the Declaration of Helsinki (1975) for studies involving human subjects.

### Procedures

An individual lightweight (76 g) 5-Hz GPS unit (48 mm × 20 mm × 87 mm) (SPI Pro, GPSports, Canberra, Australia) was used to record players' movements during elite senior National Hurling League matches ($n = 8$) and sub-elite county league matches ($n = 8$). The GPS unit was placed between the player's shoulder blades in a protective pocket within a purpose-built sports vest and worn underneath the player's jersey. Activation and satellite lock was established 15 min before game commencement [23]. The validity and test–retest reliability of these units were already established [24]. Data collected included total distance (TD) covered, distance per minute (relative TD), TD per speed zone (VLSM 0–0.7 km $h^{-1}$; walking 0.7–7.2 km $h^{-1}$; jogging 7.2–14.4 km $h^{-1}$; running 14.4–19.8 km $h^{-1}$; HSR 19.8–25.2 km $h^{-1}$; sprinting > 25.2 km $h^{-1}$) [13], maximum velocity, number of entries (movement between) per speed zones and length of run performed in the top two speed zones (HSR, sprinting). External mechanical load parameters (e.g. accelerations and decelerations) were not included in this study due to the limited accuracy and reliability of these variables measured by the 5-Hz GPS units used [12, 24]. Data ($n = 192$ files) for the full duration of each match were collected and later separated into first and second halves. Due to the difference in total playing duration between levels, performance metrics were calculated per minute (relative) to allow elite and sub-elite to be compared. A HR transmitter belt (Team Polar, Polar Electro Oy, Kempele, Finland) collected HR data throughout the sixteen matches. The HR data were transmitted by Bluetooth, recorded and stored synchronously (in 1-s intervals) in the GPS tracking device. Mean HR ($HR_{mean}$) information was collected. GPS and HR data were transferred to a computer through the Team AS software (SPI Elite, GPSports, Canberra, Australia) to be stored and analysed.

### Statistical analysis

The statistical analysis was performed using statistical software (SPSS 20, IBM, USA) package. The normality of the distribution of the data was checked by the Shapiro–Wilk's test. The sphericity of data was analysed by the Mauchly's test. A two-way ANOVA was performed considering factor for group (two levels: county and club) and factor for time (two levels: first and second half). Bonferroni post hoc correction was used to calculate paired differences when an interaction was found. Effect sizes (ES) were calculated and interpreted as < 0.2, trivial: 0.2–0.6, small: 0.6–1.2, moderate: 1.2–2.0, large: and > 2.0, very large [25].

## Results

Descriptive statistics (mean ± SD) for relative metrics are presented in Table 1. Relative match performance results showed that elite players cover a greater TD per minute than sub-elite ($p < 0.001$). Sub-elite players covered a greater TD at VLSM ($p < 0.001$), and running ($p < 0.001$), but covered a lower TD walking ($p = 0.008$) compared with elite players. Similar relative distances were found between elite and sub-elite at jogging ($p = 0.212$), HSR ($p = 0.218$) and sprinting ($p = 0.437$) speeds. No differences were observed for the relative number of entries at both HSR ($p = 0.250$) and sprinting ($p = 0.518$) speeds between elite and sub-elite players. There was no difference ($p = 0.091$) in the length of run at HSR at elite level (7 ± 1 m) compared to sub-elite level (8 ± 2 m). Similarly, no difference ($p = 0.82$) was found in the length of run sprint at elite level (4.7 ± 2.9 m) compared to sub-elite level (6.2 ± 0.4).

Descriptive statistics (mean ± SD) for relative metrics per halves are presented in Tables 2 and 3. At elite level, lower relative TD were covered at walking ($p = 0.001$), jogging ($p = 0.001$) and HSR ($p = 0.039$) speeds in the second half compared to the first half, with no differences observed at VLSM ($p = 0.239$), running ($p = 0.138$) and sprinting ($p = 0.897$) speeds between halves. At sub-elite level, relative TD covered in each of the first five speed zones decreased in the second half (VLSM $p < 0.001$, walking $p < 0.001$, jogging $p < 0.001$, running $p < 0.001$, and HSR $p = 0.044$), with no difference found between halves at sprinting speed

**Table 1** Movement analysis adjusted per minute of match-play for elite and sub-elite senior hurlers

| | TD (m $min^{-1}$) | TD VLSM (m $min^{-1}$) | TD walking (m $min^{-1}$) | TD jogging (m $min^{-1}$) | TD running (m $min^{-1}$) | TD HSR (m $min^{-1}$) | TD sprinting (m $min^{-1}$) | Number of entries HSR (m $min^{-1}$) | Number of entries sprinting (m $min^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|
| Elite | 118 ± 9 | 30 ± 2 | 32 ± 5 | 25 ± 6 | 11 ± 2 | 2.9 ± 1.1 | 0.24 ± 0.20 | 0.37 ± 0.12 | 0.04 ± 0.03 |
| Sub-elite | 93 ± 16^ | 36 ± 4^ | 27 ± 3^ | 26 ± 5 | 19 ± 2^ | 3.3 ± 0.4 | 0.27 ± 0.03 | 0.43 ± 0.10 | 0.04 ± 0.01 |
| Difference (95% CI) | 24 (13–34) | 6 (4–9) | 4 (1–7) | 1 (− 3 to 6) | 7 (6–9) | 0.4 (− 0.03 to 1) | 0.03 (− 0.08 to 0.14) | 0.06 (− 0.03 to 0.14) | 0.001 (− 0.017 to 0.019) |
| Effect size | 1.85 | 1.90 | 1.21 | 0.18 | 4 | 0.48 | 0.21 | 0.54 | 0 |

Data presented as mean ± SD, difference (95% confidence intervals) and effect size

*TD* total distance, *VLSM* very low speed movement, *HSR* high-speed running, *CI* confidence interval

^Significantly ($p < 0.05$) different from elite

**Table 2** Players' relative first and second half movement analysis for sub-elite and elite

| | TD (m min$^{-1}$) | | TD VLSM (m min$^{-1}$) | | TD walking (m min$^{-1}$) | | TD jogging (m min$^{-1}$) | | TD running (m min$^{-1}$) | | TD HSR (m min$^{-1}$) | | TD sprinting (m min$^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Elite | Sub-elite | Elite | Sub-elite | Elite | Sub-elite | Elite | Sub-elite | Elite | Sub-elite | Elite | Sub-elite | Elite | Sub-elite |
| First half | 118 ± 9 | 96 ± 17^ | 16 ± 3 | 20 ± 3^ | 17 ± 3 | 15 ± 2 | 14 ± 4 | 15 ± 3 | 6 ± 1 | 10 ± 2^ | 1.6 ± 0.6 | 1.8 ± 0.2 | 0.12 ± 0.09 | 0.16 ± 0.03 |
| Second half | 115 ± 10 | 90 ± 16*^ | 14 ± 1 | 16 ± 1* | 15 ± 0.6* | 12 ± 2*,^ | 11 ± 3* | 12 ± 3* | 5 ± 1 | 8 ± 2*,^ | 1.3 ± 0.6* | 1.5 ± 0.3* | 0.11 ± 0.13 | 0.12 ± 0.03 |
| Difference (95% CI) | 2 (− 3 to 7) | 5 (0.3–10) | 1 (− 0.8–3) | 4 (2–6) | 2 (1–4) | 3 (2–4) | 3 (1–4) | 3 (2–5) | 0.8 (− 0.3 to 2) | 2 (1–3) | 0.3 (0.02–0.53) | 0.3 (0.01–0.52) | 0.003 (− 0.04 to 0.05) | 0.04 (− 0.01 to 0.08) |
| Effect size | 0.32 | 0.36 | 0.89 | 1.79 | 1.39 | 1.5 | 0.85 | 1.00 | 1.00 | 1.00 | 0.50 | 0.67 | 0.09 | 0.42 |

Data presented as Mean ± SD, difference (95% confidence intervals) and effect size

*TD* total distance, *VLSM* very low speed movement, *HSR* high-speed running, *HRmean* mean heart rate, *CI* confidence interval

*Significantly ($p < 0.05$) different from first half

^Significantly ($p < 0.05$) different from elite

($p = 0.083$). Elite level players performed a higher number of entries into the HSR ($p = 0.003$) zone in the first half compared to the second half, with no differences between halves observed at sub-elite ($p = 0.11$) level.

In the first half, elite players covered more relative TD than sub-elite players (MD 22 m min$^{-1}$; 95% CI 12–33; ES = 1.61; $p < 0.001$). However, sub-elite players covered more TD at VLSM (MD 4.7 m min$^{-1}$; 95% CI 2.8–6.5; ES = 1.34; $p < 0.001$) and running speeds (MD 4.4 m min$^{-1}$; 95% CI 3.3–5.5; ES = 2.53; $p < 0.001$) than elite players. No difference between levels were found at walking ($p = 0.057$), jogging ($p = 0.229$), HSR ($p = 0.292$), sprinting ($p = 0.120$) speed zones, and the number of entries at HSR ($p = 0.582$) and sprinting ($p = 0.546$) speeds.

In the second half, elite players covered more relative TD than sub elite players (MD 26 m min$^{-1}$; 95% CI 15–36; ES = 1.87; $p < 0.001$). Sub-elite players travelled a greater TD at running speed (MD 2.8 m min$^{-1}$; 95% CI 1.7–3.9; ES = 1.90; $p < 0.001$). Whereas elite players covered a greater TD at walking speed (MD 1.9 m min$^{-1}$; 95% CI − 0.1 to 3.8; ES = 1.35; $p = 0.008$). No differences were observed between levels in the second half for VLSM ($p = 0.093$), jogging ($p = 0.299$), HSR ($p = 0.273$) sprinting ($p = 0.938$) speed zones and the number of entries to HSR ($p = 0.142$) and sprinting ($p = 0.617$) speeds.

## Discussion

The purpose of the current study was to describe the differences in external and internal loads between elite and sub-elite male senior hurlers. To allow for differences in total match duration between elite and sub-elite games, each metric was presented as a relative (per min of match-play) value. Elite level senior hurlers performed a greater relative TD and TD at walking speeds compared with sub-elite players. However, sub-elite players covered a higher relative TD at running speed than elite players. These findings highlight that differences exist between elite and sub-elite hurling levels, which are in agreement with previous research in other team sports [5, 26]. Temporal differences were found between halves at both levels for relative TD at walking, jogging and HSR speeds. Also, sub-elite players experienced a decrease in relative TD, VLSM and running speed between halves. These findings can aid conditioning staff in preparing sub-elite players to be able to withstand the match-play demands of elite senior hurling. Currently, there is limited information available that describes the match-play performances in hurling, therefore, cross comparisons with previous literature are challenging.

The current results found moderate difference in relative TD between levels, with elite players covering a greater distance per minute. This demonstrates a higher running

**Table 3** Players' relative first and second half number of entries and length of run for elite and sub-elite

| | Number of entries HSR | | Number of entries Sprinting | |
|---|---|---|---|---|
| | Elite | Sub-elite | Elite | Sub-elite |
| First half | 0.24 ± 0.08 | 0.25 ± 0.05 | 0.02 ± 0.02 | 0.03 ± 0.01 |
| Second half | 0.18 ± 0.07* | 0.23 ± 0.07 | 0.02 ± 0.02 | 0.02 ± 0.01 |
| Difference (95% CI) | 0.06 (0.02–0.09) | 0.03 (− 0.01 to 0.06) | 0.004 (− 0.003 to 0.012) | 0.006 (− 0.002 to 0.013) |
| Effect size | 0.80 | 0.33 | 0.00 | 0.99 |

Data presented as mean ± SD, difference (95% confidence intervals) and effect size

*HSR* high-speed running, *HRmean* mean heart rate, *CI* confidence interval

*Significantly ($p < 0.05$) different from first half

requirement by sub-elite players when transitioning to elite level. Players at elite level cover similar relative TD to players in soccer (110 m min$^{-1}$) [27], AF (108 m min$^{-1}$) [28] and Gaelic football (116 ± 21 m min$^{-1}$) [29]. However, relative TD at both elite and sub-elite level is higher than found in rugby (84.5 ± 3.0 m min$^{-1}$) [7]. The positioning of the players in a line to receive the ball and stay on-side in rugby compared to the dynamic freedom of the playing positions in hurling may allow a greater relative TD to be performed. Comparisons between elite and sub-elite levels show differences performed at walking speed. The number of scoring chances at the elite level may be higher than sub-elite, therefore once the ball goes over the end line (following a score or wide) the ball is out of play and there is additional non-playing time where players can perform low-intensity activities. Sub-elite players covered a higher distance running and lower TD jogging compared with elite players. Differences in the elite player's ability to read the game may allow them to cover more distance in the walking and jogging speed zone before performing a change in speed. In comparison to sub-elite players who may try to make up for this reading of the game by completing a higher TD at running speed to get into position to gain possession. In addition to the differences found in walking and running intensity between levels, sub-elite players cover more relative distance at VLSM than elite players. Sub-elite players may need to use this VLSM to recover from the higher running intensity compared to elite players. In addition, to gain an advantage over their opponent, elite players may be trying to keep moving so they are in the correct position to receive the ball coming from the opposite half. No differences were observed for TD jogging, HSR, sprinting and the number of entries into the HSR and sprinting speed zone. The commonality in pitch size, playing numbers and how players must contest for possession may account for similar results at the higher speeds between levels.

Similar maximum speeds were observed at both elite and sub-elite level. This compares favourably with previous research at senior elite hurling level (29.6 ± 2.2 km h$^{-1}$) [4] and results found between elite (28.2 ± 1.3 km h$^{-1}$) and sub-elite (28.9 ± 0.9 km h$^{-1}$) AF players [5]. The parallels between invasion-type games may account for such similar results. Indeed, while attacking, players may have to accelerate to high speeds to get away from defenders to gain or maintain possession and score, similarly, while in defense, players may reach peak speed chasing attackers to reduce opportunities to score [29]. The number of entries into HSR and sprinting zones were comparable between elite and sub-elite levels. However, they were lower than found in rugby (18–20; 46 > 20 km h$^{-1}$; 34) [30], and AF (> 18 km h$^{-1}$; 85) [9]. The contrasting styles of play and tactical ploys between games may account for these differences. In hurling, players frequently strike the ball long distances (> 80 m) into the opposition half to score, therefore minimizing the opportunities to reach the top speeds repeatability. Whereas in rugby and AF players are permitted to carry the ball for longer distances and shorter passes are used to transition from defense to attack [4]. The short length of run in the sprinting speed zone in the present study is in contrast to reported individual sprint distances of 21 ± 5 m in rugby [31], 21 ± 3 m in soccer [6], and 27 (95% CI 24.0–30.9) m in AF [28]. Differences in speed zone classification make it difficult to compare between sports. However, a possible reason for covering shorter distances at high speeds in hurling is that players are only allowed to hold the ball in their hand for a maximum of four consecutive steps [32], after that they must carry the ball on their hurley or strike the ball with their hurley or hand. It can be difficult to reach high speeds with the ball on the hurley while trying to avoid an opponent tackling to regain possession, whereas in rugby, players are permitted to hold the ball in their hand for an indefinite amount of steps and are only required to release possession when on the ground [33].

Elite level players recorded a higher $HR_{mean}$ than sub-elite players during the match. The increased volume of TD performed at the elite level may account for this difference. Elite hurling players recorded similar $HR_{mean}$ with AF (168 ± 8 b min$^{-1}$) [21], soccer (165 ± 11 b min$^{-1}$) [34], and rugby (172 b $min^{-1}$: 95% CI 167–177 b $min^{-1}$) [30] players, whereas sub-elite players had a lower $HR_{mean}$ similar to previously reported in Gaelic football (160 ± 6 b $min^{-1}$) players [35]. The stop–start nature of each sport where the ball is regularly in and out of play and the large percentage of TD covered at VLSM and walking may allow player's HR to recover. Finally, intermittent running demands and contesting for possession in each of these sports may account for the similarity.

Match-play performances deteriorated in the second half for all metrics at both levels. Elite and sub-elite players experienced a drop off in TD between halves similar to previous research in elite hurling [4]. Temporal decreases in sub-elite running performances were observed in each of the first five speed zones, and in the walking, jogging and HSR speeds at elite level. This deterioration between halves may be a result of the style of play, tactical ploys or level of motivation as the match outcome may have been already decided [4, 15]. Level of fatigue is also a possible cause of performance deterioration between halves, as previously reported in hurling and other team sports [4, 15, 36, 37]. No difference between halves was observed in the sprinting zone at both elite and sub-elite levels. However, the distance covered at sprinting speed was very low in the first half, and this might explain the maintenance of sprinting distance in the second half. In addition, $HR_{mean}$ reduced in the second half at both elite and sub-elite level. This concurs with findings that reveal a decrease in HR between halves in rugby (177 vs. 167 b $min^{-1}$) [30], soccer (164 ± 1 vs. 158 ± 1 b $min^{-1}$) [38] and AF (173 ± 8 vs. 163 ± 16 b $min^{-1}$) [21]. No $HR_{mean}$ differences between halves currently available for Gaelic football. Even though running performances in the current study deteriorated between halves, $HR_{mean}$ could have remained elevated due to the continuity of exercise, emotions and muscle actions performed in the match [30].

The present study comes with some acknowledged limitations and some interesting future perspectives. First, the number of accelerations and decelerations was not included in this study due to the limited accuracy and reliability of these variables measured by the 5-Hz GPS units used [12, 24]. Further research is required to analyse the technical elements of match-play with the number of accelerations and decelerations to investigate an association with gaining or maintaining possession. Second, differences in players' role performances were not included. It is acknowledged that data of this type could assist trainers and conditioners to plan individualized training sessions, but the present sample size was not suitable for that purpose. In addition, it is accepted that the small sample size did not allow for a CV calculation. The data collection only included $HR_{mean}$ for each subject and not HR across zones, future studies should include HR across each zone to identify the intensity of the game. Finally, metabolic power data were not included for the motivations reported in the literature [39]. However, the goodness of such estimation was recently questioned, and it should be interpreted with caution [40].

## Conclusions

Understanding the external and internal loads is necessary to provide appropriate training stimulus to prepare players to meet the competing demands. In hurling, players are selected to represent their elite team based on their performances during the sub-elite competition. Therefore, knowledge of the sport demands at both levels is necessary to facilitate the transition from sub-elite to the elite level. Current data shows differences in running performances between playing standards. Elite level senior hurlers performed a greater relative TD and TD at walking speeds. However, elite players covered a lower TD at running speed than sub-elite players. Players (sub-elite) who may be selected for elite level competition may need additional conditioning to withstand the performances during higher level match-play, especially for the total volume as expressed as TD. Hurlers at both levels perform sprints over short distances. Therefore, conditioning drills should reflect these short distances sprinted. Monitoring the number of changes in speed and distance covered at the top two speed zones in training is necessary to ensure players can perform the minimum amount found during games. Temporal differences were found between halves at both levels for relative TD, TD at walking, jogging and HSR speeds. A reduction between halves in metrics analysed may be related to player's ability to repeat effort. Games specific conditioning activities to assist players to repeat the running performances for the duration of the match is essential particularly at a sub-elite level where TD performance deteriorated in each of the first five speed zones.

**Acknowledgements** The research was funded by Grants from the French Ministry of National Education, of Research and of Technology (EA3920) and from Tomsk Polytechnic University Competitiveness Enhancement Program Grant, Project № ВИУ-ИСГТ-108/2017—TPU CEP-HSTI-108/2017

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** This study was approved by the University Franche-Comté and the athletes were informed of the purposes and inherent risks associated with this research.

**Informed consent** The athletes provided their written informed consent.

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