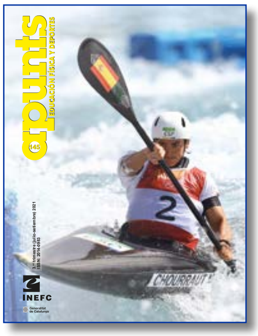
External Load Demands and Positional Differences in Elite Futsal Using UWB Technology

apunts EDUCACIÓN FÍSICA Y DEPORTES

ISSUE 145

Published 01 July 2021
https://doi.org/10.5672/apunts.2014-0983.es.(2021/3).145.07

PHYSICAL PREPARATION



OPEN ACCESS

External Load Demands and Positional Differences in Elite Futsal Using UWB Technology

Jordi Illa[1*], Òscar Alonso[1], Fabio Serpiello[2], Ryan Hodder[2] & Xavier Reche[1]

[1] Sports Performance Area, Futbol Club Barcelona, Barcelona (Spain).
[2] Institute for Health and Sport (IHES), Victoria University, Melbourne (Australia).

Cite this article:
Illa, J., Alonso, O., Serpiello, F., Hodder, R. & Reche, X. (2021). External Load Demands and Positional Differences in Elite Futsal Using UWB Technology. *Apunts Educación Física y Deportes, 145*, 53-59. https://doi.org/10.5672/apunts.2014-0983.es.(2021/3).145.07

Editor:
© Generalitat de Catalunya
Departament de la Presidència
Institut Nacional d'Educació
Física de Catalunya (INEFC)

ISSN: 2014-0983

***Corresponding author:**
Jordi Illa Solé
jordi.illa@fcbarcelona.cat

Section:
Physical Preparation

Original language:
Spanish

Received:
14 July 2020

Accepted:
25 January 2021

Published:
1 July 2021

Cover:
Maialen Chourraut (ESP) competing in Rio de Janeiro Olympic Games (2016), Whitewater Stadium. Women's Kayak (K1) Semi-final. REUTERS / Ivan Alvarado

Abstract

The physical conditioning demands on professional athletes in competition have been a subject of study over recent decades. The first objective of this study is to describe the external load demands on elite futsal players and then to verify whether there are differences among the specific playing positions. Fourteen professional first-division players in the Spanish National Futsal League were categorised into three groups according to their specific position on the court: stopper (S), flank (FL) and forward (FO). Goalkeepers were not included in this study. In the 2017-2018 season, a total of 15 official league matches were recorded using ultra wideband (UWB) technology with WIMU PRO devices The following variables were analysed: total distance travelled (TD); total distance travelled over 18 km·h^{-1} (TDHI: >18 km·h^{-1}); player load (PL); and number of high-intensity accelerations and decelerations (>/<2 m·s-^{2}). S, FL and FO did not present substantial differences in TD and PL, but they did in TDHI, where FL and S ran more metres at high intensity (FL = 274 ± 118 m; S = 249 ± 85 m) than FO (FO = 195 ± 60 m) and had more high-intensity accelerations (FL = 134 ± 46; S = 139 ± 40; FO = 118 ± 21) and high-intensity decelerations (FL = 128 ± 46; S = 131 ± 36; FO = 116 ± 23). The results of this study could support coaches, technicians and physical trainers in planning, designing and adjusting their players' training loads.

Keywords: competition; EPTS; external load; futsal; monitoring; team sport.

Introduction

Futsal is a team sport played on a court measuring 40 x 20 metres by two teams with five players (four players on the court and one goalkeeper per team). Any number of substitutions can be made without having to stop the clock, thus favouring a very high intensity throughout the match (Medina et al., 2001). Intermittent effort predominates in the matches, which consist of two 20-minute halves (Barbero, 2003) characterised by the repetition of short bursts of high-intensity effort and quick-paced play (Medina et al., 2001). with many changes in direction. Consequently, technical staff have to adjust their planning to the physical conditioning needs of competition by designing sessions intended to provoke positive and necessary adaptations of the players and the team by placing them in contexts as similar as possible to those they will subsequently encounter in competition (Casamichana et al., 2018).

The advent of GPS devices in sports competition and training has made it possible to monitor athletes' movements in both training and competition (Castellano & Casamichana, 2014). Numerous published articles have analysed the characteristics and positional differences of the competitive demands of different sports teams both outdoors (Dalen et al., 2016; Martín-García et al., 2018; Wehbe et al., 2014) and indoors, such as basketball (Fox et al., 2018; García et al., 2020; Puente et al., 2017; Svilar et al., 2018; Vázquez-Guerrero et al., 2018) and handball (Karcher and Buchheit, 2014). However, there are few studies on futsal, and most of them (Barbero, 2003; Barbero et al., 2014; Dogramaci et al., 2011; Hernández, 2001; Medina et al., 2001; Naser et al., 2017) refer to specific indicators, without taking the globality and complexity of the competitive demands into consideration, focusing rather on describing locomotor variables by means of video analysis (Barbero-Álvarez et al., 2008; Dogramaci et al., 2011; Hernández, 2001; Naser et al., 2017). Consequently, the main objectives of this study were: (I) to describe the physical conditioning demands on elite futsal players in official matches, and (II), to compare the differences in external load according to specific playing position.

Methodology

Participants

The external load of 14 professional players ($N=14$) (27.5 ± 3 years; 174.9 ± 6.8 cm; 72.2 ± 5.3 kg) from the same first-division team in the Spanish National Futsal League, categorised into three groups according to their specific position on the court; stopper (S = 5), flank (FL = 7) and forward (FO = 2), was recorded; goalkeepers were excluded from the study. At the time of the study, the players were doing between four and six training sessions and playing between one and three matches per week. The data analysed were obtained by monitoring the players on a daily basis, so that all their activities were regularly monitored throughout the season. The procedures used in this study observed the tenets of with the Declaration of Helsinki and were approved by the Scientific Research Ethics Committee (CEIC) of the Catalan Sports Council of the Government of Catalonia with number 17/CEICGC/2020. Before participating, the participants in the study were duly informed and provided their consent for their data to be used anonymously.

Design and procedure

The players were monitored over 15 official matches in the regular phase of the 1st division of the National Futsal League in the 2017-2018 season (11 victories, 3 ties and 1 defeat, ending the league in 2nd place). The matches were all played on the same court (matches played as the home team) and in similar environmental conditions. During the regular phase of the National Futsal League, each one of the 16 participating teams played a total of 30 matches in a regular league system with home and away matches, and the top 8 teams went on to the playoff as contenders for the league title.

The total length of the matches analysed was 80.0 ± 6.0 minutes (mean ± standard deviation), and the players' participation was 33.0±9.6 minutes, with FO being the players with the highest participation, with an average of 36.2±7.3 minutes, S with 32.8±12.4 minutes and FL with 32.2±9.8 minutes.

The players' external load was monitored using WIMU PRO™ inertial devices (Realtrack Systems S.L., Almería, Spain) with UWB technology. These devices have different sensors (accelerometers, gyroscopes, magnetometers, GPS and others). The frequency at which the accelerometer, gyroscope and magnetometer recorded data was 100 Hz, while the UWB data were recorded at a frequency of 18 Hz.

Between 8 and 12 minutes before the start of the match, and after a standard 24-minute warm-up, the devices were fitted on each one of the bibs worn by the players under their jerseys; the bibs were fitted and designed specifically to secure the devices to the upper back, just above the shoulder blades, without limiting trunk or arm mobility in any way. The players were monitored throughout all matches, although the external load was only quantified when the player was on the court (e.g., the data were not included when a player was substituted, during time-out or at halftime). At the end of every match, the data were downloaded and synchronised so that they could be analysed using the corresponding software (SPRO™, Realtrack Systems S.L., Almería, Spain).

Based on previous studies in basketball (García et al., 2020; Puente et al., 2017; Vázquez-Guerrero et al., 2018) analysing physical conditioning demands in competition, the following variables were analysed and presented in absolute and relative terms per minute: total distance travelled (TD) in m and total relative distance (TD_{REL}) in m·min-1; total distance travelled over 18 km·h-1 (TDHI: > 18 km·h^{-1}) in m and total relative distance travelled over 18 km·h^{-1} ($TDHI_{REL}$) in m·min-1; player load (PL) in arbitrary units (au) and relative player load (PL_{REL}) in au·min-1; number of high-intensity accelerations (> 2 m·s-²) and relative number of high-intensity accelerations in n·min-1; and number of high-intensity decelerations (> 2 m·s-²) and relative number of high-intensity decelerations in n·min-1. These variables were also chosen because they represent all the parameters used to monitor and quantify the daily external load by different sports and teams in the Sports Performance Area in the club to which all the players participating in the study belonged.

Data analysis

To analyse the differences in the means of the variables between playing positions, a general mixed linear model was built (PROC MIXED) using Statistical Analysis System (version 9.4 of SAS Studio - SAS Institute Inc., Cary, NC, USA). The random effects were player identity (to account for repeated measurements in the players), match identity (to account for the mean general differences between the matches) and the residual (to account for the differences between the players in the matches). Separate variances were estimated for each playing position, the random effect of the player and the residual, and these variances were combined to obtain standard deviations (SD) observed between players in each position. The three SDs were then averaged (via weightings of the degrees of freedom of the variances) to yield a general result of the player's SD in a typical match, and this SD was used to standardise the differences between the means of the playing positions. The playing positions were used as fixed effects (three levels). A Poisson regression was used to analyse the variables expressed as tallies. The magnitude thresholds for the fixed effects were < 0.2, 0.2, 0.6, 1.2, 2.0 and 4.0 for trivial, small, moderate, large, very large and extremely large, respectively (Hopkins et al., 2009).

The uncertainty in the estimates of the effects is presented as 90 % compatibility limits. The decisions based on the magnitudes of the effects were based on unilateral hypotheses of substantial magnitudes (Lakens et al., 2018). The p value to reject a hypothesis of a given magnitude was the t-distribution area of the statistic of the effect with values of that magnitude. The hypotheses of substantial decreases and increases were rejected if their respective p values were under .05. If a hypothesis was rejected, the p value for the other hypothesis was interpreted as evidence of that hypothesis, as the p value corresponds to the subsequent likelihood of the true effect size in a previous minimally informative Bayesian reference analysis (Hopkins and Batterham, 2019). The p value is reported qualitatively using the following scale: .25 – .75, possible; .75 – .95, probable; .95 – -.995, very probable; > .995, more probable (Hopkins et al., 2009). If none of the hypotheses was rejected, the effect size was regarded as unclear and is displayed without a probabilistic descriptor.

Results

Table 1 presents the mean values ± standard deviation of each one of the variables analysed for each specific playing position including the effect magnitude ± confidence intervals and the decision for the positional differences.

The objectives of this study were to describe physical conditioning demands on elite futsal players in official competition and to examine whether there were differences between specific playing positions. The results suggest the following: (1) the mean external load values per player per match were: TD = 3052 ± 804 m; TD_{REL} = 88.7 ± 15.3 m·min^{-1}; TDHI = 254 ± 101 m; $TDHI_{REL}$ = 7.5 ± 2.9 m·min^{-1}; PL = 57.2 ± 15.2 au; PL_{REL} = 1.7 ± 0.3 au·min^{-1}; high-intensity accelerations = 135 ± 41 *n*; relative high-intensity accelerations = 3.9 ± 1.0 n·min^{-1}; high-intensity decelerations = 129 ± 39 *n*; relative high-intensity decelerations = 3.8 ± 1.0 n·min^{-1}; (2) no substantial differences were found between S and FL for any of the external load variables analysed; (3) TD and TD_{REL}, PL and PL_{REL} do not seem to be dependent on playing position, with all three specific playing positions presenting similar values; and (4) substantial differences were observed between positions in variables related to intensity in both absolute values (TDHI, high-intensity accelerations and decelerations) and relative values ($TDHI_{REL}$, high-intensity relative accelerations and decelerations).

To our knowledge, this is the first study to conduct an analysis of external load demands in elite futsal official competition using UWB technology while also comparing

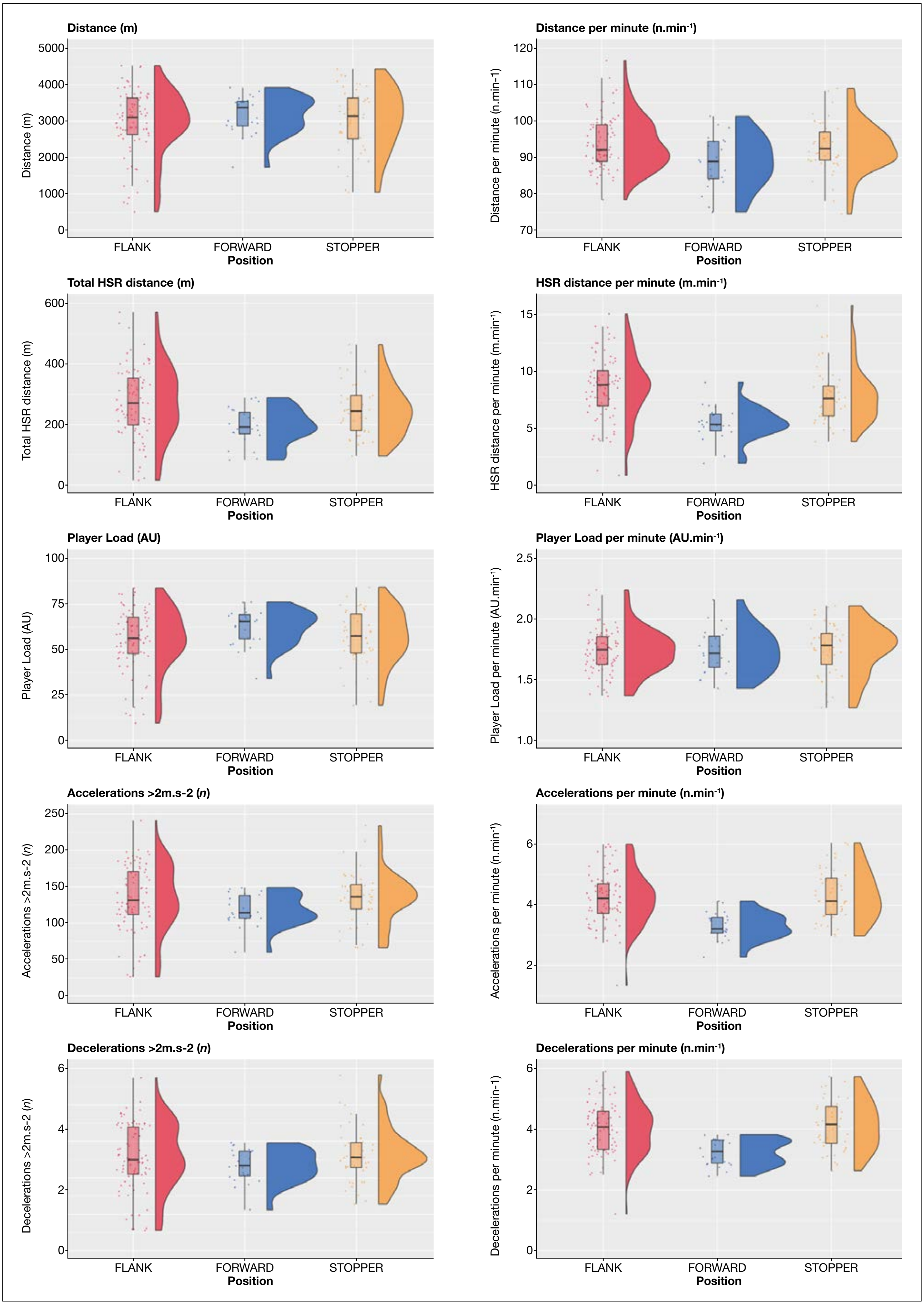


Figure 1
Box plot and violin plot and data distribution by variable in absolute and relative values.

Table 1
Mean values and standard deviations (SD) of the different variables analysed by position and differences between positions.

	Season average (Mean ± SD)			Positional differences (Effect size ± confidence intervals; decision)		
	Flank	Forward	Stopper	Flank-Forward	Flank-Stopper	Forward-Stopper
TD (m)	2961 ± 893	3184 ± 522	3034 ± 852	-0.32 ± 0.78; unclear	-0.03 ± 0.82; unclear	0.29 ± 0.89; unclear
TD_{REL} (m.min^{-1})	93 ± 10	89 ± 7	93 ± 7	0.42 ± 2.24; unclear	0.03 ± 0.40; unclear	-0.38 ± 1.93; unclear
TDHI (m)	274 ± 118	195 ± 60	249 ± 85	0.71 ± 0.70; moderate**	0.16 ± 0.70; unclear	-0.55 ± 0.31; small***
$TDHI_{REL}$ (m.min^{-1})	8.6 ± 2.8	5.4 ± 1.5	7.9 ± 2.4	1.12 ± 0.74; moderate***	0.16 ± 0.77; unclear	-0.95 ± 0.83; moderate**
PL (AU)	55 ± 17	62 ± 10	57 ± 15	-0.57 ± 0.70; small**	-0.11 ± 0.78; unclear	0.46 ± 0.70; unclear
PL_{REL} (AU.min^{-1})	1.7 ± 0.2	1.7 ± 0.2	1.8 ± 0.2	-0.18 ± 2.20; unclear	-0.08 ± 0.78; unclear	0.11 ± 1.62; unclear
HIA >2m.s^{-2} (*n*)	134 ± 46	118 ± 21	139 ± 40	0.25 ± 0.71; unclear	-0.21 ± 0.73; unclear	-0.46 ± 0.61; small**
HIA_{REL} >2m.s^{-2} (n.min^{-1})	4.2 ± 0.9	3.3 ± 0.4	4.3 ± 0.8	1.09 ± 0.71; moderate***	-0.23 ± 0.82; unclear	-1.32 ± 0.77; large***
HID >-2m.s^{-2} (*n*)	128 ± 46	116 ± 23	131 ± 36	0.18 ± 0.87; unclear	-0.19 ± 0.71; unclear	-0.36 ± 0.93; unclear
HID_{REL} >-2m.s^{-2} (n.min^{-1})	4.0 ± 0.8	3.2 ± 0.4	4.1 ± 0.8	1.03 ± 0.67; moderate***	-0.29 ± 0.92; unclear	-1.32 ± 0.80; large***

Note. TD: total distance (m); TD_{REL}: total relative distance (m·min^{-1}); TDHI: distance travelled at high intensity (> 18 km·h^{-1}) (m); $TDHI_{REL}$: relative distance travelled at high intensity (> 18 km·h^{-1}) (m·min^{-1}); PL: player load (AU); PL_{REL}: relative player load (AU·min^{-1}); HIA: high-intensity accelerations (> 2 m.s^{-2}) (*n*); HIA_{REL}: relative high-intensity accelerations (> 2 m.s^{-2}) (n·min^{-1}); HID = high-intensity decelerations (> -2 m.s^{-2}) (n); HID_{REL}: relative high-intensity decelerations (> -2 m.s^{-2}) (n·min^{-1}); **: probable; ***: very probable

the differences between the different positions on the playing court. Previous studies have described the TD travelled by futsal players during competition, such as the study by Dogramaci et al., (2011), which described how Australian players travelled a total distance of 4277±1030 m per match. These values are similar to those recorded on players of a futsal team in the Spanish Professional Futsal League, who ran an average of 4313±2139 m per match (Barbero-Álvarez et al., 2008). The recording methodology in both studies (both used video analysis technology) may account for the differences with the results found in our study (TD = 3052±804 m).

FO seem to be exposed to a lower total external load than their teammates, as is also the case in basketball (Vázquez-Guerrero et al., 2018). S and FL recorded higher high-intensity activity indexes than FO, made more accelerations and decelerations and travelled a greater distance at high intensity. These results might be explained by the anthropometric features and the physical and technical qualities of FO, and especially by the fact that FO generally play within the team's tactical system and the play model.

As described in other team sports (Varley and Aughey, 2013; Vázquez-Guerrero et al., 2018), identifying specific acceleration profiles may help coaches, technical staff and sports scientists to tailor exercises for each position with the goal of improving the athletes' level of physical conditioning.

Although physical conditioning demands have been generally expounded and described in outdoor team sports such as football (Martín-García et al., 2018) and rugby (Gabbett et al., 2012) using absolute values, the internal logic of futsal, with rules that make for a free, unlimited dynamic of substitutions, seems to require the use of relative load values as a more representative method to describe the competition load. In basketball, for example, the TD_{REL} per player fluctuates between 76.6 and 86.8 metres (Puente et al., 2017), in handball it varies between

87 and 101 metres (Barbero et al., 2014), while in futsal it ranges from 108 to 117.3 metres (Barbero-Álvarez et al., 2008), these latter values being higher than those recorded in our study ($TD_{REL} = 88.7 \pm 15.3$ m·min^{-1}). This decrease in the TD_{REL} may be related to the increase in the amount of time dedicated in recent years by teams to the 5c4 playing system (a system in which the goalkeeper is replaced by a field player, creating constant on-court numerical superiority).

Although the small sample size could be considered a limiting factor, it should be borne in mind that all the players participating in the study were on the same team, a common fact in studies based on professional teams. Consequently, given that the team's play model analysed may have conditioned the results to a certain extent, caution should be exercised when decisions based on them are taken. Another factor to consider is that in this study only external load values obtained via devices equipped with ultra wideband (UWB) technology were analysed. Including internal load variables (e.g., variables based on heart rate or on the subjective perception of effort) in future studies could herald a significant contribution to the process of monitoring competitive and training loads. Such future studies should also include a larger sample of participants, if possible from other teams in the same category, and should analyse more matches in order to confirm these results.

Conclusions

The findings of this study offer a new perspective of knowledge about physical conditioning demands in elite futsal, in the understanding that their description, based solely on speed-related locomotor variables, may not be sufficient to understand the complexity of competition and training.

In this context, the differences observed in the intensity variables between different specific playing positions should help coaches, physical trainers and other technical staff to design training tasks and sessions that fit each athlete's individual needs better and to plan the training process best suited to the demands of competition.

References

Barbero, J. C. (2003). Análisis cuantitativo de la dimensión temporal durante la competición en fútbol sala. *European Journal of Human Movement*, *10*, 143-163.

Barbero, J. C., Granda-Vera, J., Calleja-González, J. & Coso, J. D. (2014). Physical and physiological demands of elite team handball players. *International Journal of Performance Analysis in Sport*, *14*(3), 921-933. https://doi.org/10.1080/24748668.2014.11868768

Barbero-Álvarez, J. C., Soto, V. M., Barbero-Álvarez, V. & Granda-Vera, J. (2008). Match analysis and heart rate of futsal players during competition. *Journal of Sports Sciences*, *26*(1), 63-73. https://doi.org/10.1080/02640410701287289

Casamichana Gómez, D., Gómez Díaz, A. J., Cos Morera, F. & Martín García, A. (2018). Wildcard Players during Positional Games. *Apunts Educación Física y Deportes*, 133, 85-97. https://doi.org/10.5672/apunts.2014-0983.es.(2018/3).133.06

Castellano, J. & Casamichana, D. (2014). Sport with global positioning devices (GPS): Aplications and limitations. *Revista de Psicología del Deporte*, *23*(2), 355-364.

Dalen, T., Jørgen, I., Gertjan, E., Geir Havard, H. & Ulrik, W. (2016). Player Load, Acceleration, and Deceleration During Forty-Five Competitive Matches of Elite Soccer. *The Journal of Strength & Conditioning Research*, *30*(2), 351-359. https://doi.org/10.1519/JSC.0000000000001063

Dogramaci, S., Watsford, M. & Murphy, A. (2011). Time-Motion Analysis of International and National Level Futsal. *Journal of Strength and Conditioning Research / National Strength & Conditioning Association*, *25*, 646-651. https://doi.org/10.1519/JSC.0b013e3181c6a02e

Fox, J. L., Stanton, R. & Scanlan, A. T. (2018). A Comparison of Training and Competition Demands in Semiprofessional Male Basketball Players. *Research Quarterly for Exercise and Sport*, *89*(1), 103-111. https://doi.org/10.1080/02701367.2017.1410693

Gabbett, T. J., Jenkins, D. G. & Abernethy, B. (2012). Physical demands of professional rugby league training and competition using microtechnology. *Journal of Science and Medicine in Sport*, *15*(1), 80-86. https://doi.org/10.1016/j.jsams.2011.07.004

García, F., Vázquez-Guerrero, J., Castellano, J., Casals, M. & Schelling, X. (2020). Differences in Physical Demands between Game Quarters and Playing Positions on Professional Basketball Players during Official Competition. *Journal of Sports Science & Medicine*, *19*(2), 256-263.

Hernández, J. (2001). Análisis de los parámetros espacio y tiempo en el fútbol sala. La distancia recorrida, el ritmo y dirección del desplazamiento del jugador durante un encuentro de competición. *Apunts Educación Física y Deportes*, *65*, 32-44.

Hopkins, W.G. & Batterham, A. M. (2019). A Spreadsheet for Bayesian Posterior Compatibility Intervals and Magnitude-Based Decisions. *Sportscience*, *23*, 5-7.

Hopkins, William G., Marshall, S. W., Batterham, A. M. & Hanin, J. (2009). Progressive Statistics for Studies in Sports Medicine and Exercise Science. *Medicine & Science in Sports & Exercise*, *41*(1), 3-12. https://doi.org/10.1249/MSS.0b013e31818cb278

Karcher, C. & Buchheit, M. (2014). On-Court Demands of Elite Handball, with Special Reference to Playing Positions. *Sports Medicine*, *44*(6), 797-814. https://doi.org/10.1007/s40279-014-0164-z

Lakens, D., Scheel, A. M. & Isager, P. M. (2018). Equivalence Testing for Psychological Research: A Tutorial. *Advances in Methods and Practices in Psychological Science*, *1*(2), 259-269. https://doi.org/10.1177/2515245918770963

Martín-García, A., Casamichana, D., Díaz, A. G., Cos, F. & Gabbett, T. J. (2018). Positional Differences in the Most Demanding Passages of Play in Football Competition. *Journal of Sports Science & Medicine*, *17*(4), 563-570.

Medina, J. A., Ostariz, E. S., Salillas, L. G., Marqueta, P. M. & Virón, P. C. (2001). Perfil cardiovascular en el fútbol-sala. Adaptaciones al esfuerzo. *Archivos de medicina del deporte: Revista de la Federación Española de Medicina del Deporte y de la Confederación Iberoamericana de Medicina del Deporte*, *18*(82), 143-148.

Naser, N., Ali, A. & Macadam, P. (2017). Physical and physiological demands of futsal. *Journal of Exercise Science and Fitness*, *15*(2), 76-80. https://doi.org/10.1016/j.jesf.2017.09.001

Puente, C., Abián-Vicén, J., Areces, F., López, R. & Del Coso, J. (2017). Physical and physiological demands of experienced male basketball players during a competitive game. *Journal of Strength and Conditioning Research*, *31*(4), 956-962. https://doi.org/10.1519/JSC.0000000000001577

Svilar, L., Castellano, J., Jukic, I. & Casamichana, D. (2018). Positional Differences in Elite Basketball: Selecting Appropriate Training-Load Measures. *International Journal of Sports Physiology and Performance*, *13*(7), 947-952. https://doi.org/10.1123/ijspp.2017-0534

Varley, M. C. & Aughey, R. J. (2013). Acceleration profiles in elite Australian soccer. *International Journal of Sports Medicine*, *34*(1), 34-39. https://doi.org/10.1055/s-0032-1316315

Vázquez-Guerrero, J., Suarez-Arrones, L., Gómez, D. C. & Rodas, G. (2018). Comparing external total load, acceleration and deceleration outputs in elite basketball players across positions during match play. *Kinesiology*, *50*(2), 228-234.

Wehbe, G. M., Hartwig, T. B. & Duncan, C. S. (2014). Movement Analysis of Australian National League Soccer Players Using Global Positioning System Technology. *The Journal of Strength & Conditioning Research*, *28*(3), 834-842. https://doi.org/10.1519/JSC.0b013e3182a35dd1

Conflict of Interests: No conflict of interest was reported by the authors.