

Validity of a new tracking device for futsal match

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Purpose: The purpose of this study was to evaluate the validity of a new tracking device that allows measuring different performance factors in futsal real game situations.

Methods: 10 high elite futsal players performed a typical futsal training task, this is, a 4v4 in 28×20m with a duration of 180 seconds, where players wore two tracking devices, the new one (OLIVER) and the already validated device (WIMU PRO). Data recorded by the OLIVER and WIMU PRO systems were compared after the training session. Descriptive analysis was performed for each variable, and a one-way ANOVA was developed to calculate the validity of OLIVER compared with WIMU PRO report.

Results: The results reported good validity for most of the variables analysed, such as the total distance ($P = .385$), the distance traveled at high intensity ($P = .786$) and maximum intensity ($P = .460$), as well as the number of accelerations ($P = .690$) and decelerations ($P = .073$) and maximum speed ($P = .114$). However, the distance traveled at low speed ($P = .013$) and the number of high accelerations ($P = .028$) reported statistical differences from OLIVER to WIMU PRO.

Conclusions: The OLIVER system can be stated as a valid technology for monitoring most of the external load variables in specific training tasks in futsal, which ensures an improvement in the monitoring training process.

Keywords: inertial measurement unit; acceleration; max speed; metrics; team sports.

Introduction

Futsal is a team sport practised on a covered track of 40 x 20 metres.¹⁻⁵ In this sport, two teams of five players face each other on the court. These players will be four court players and a goalkeeper.¹⁻⁵ During the match, the substitutions of one player for another are made without stopping time, and there is no substitution limit. The matches are split into two halves of 20 minutes each with a 10 minutes match break between the two halves. During the match time there is a high pace of play, in which intermittent efforts stand out, of short duration but of very high intensity, since players perform 13.7 % of their total distance at high intensity and 8.9% maximum intensity stroke.^{1-4, 5}

The players during the development of the game and training carry out certain actions such as high intensity runs (500-700m), maximum intensity runs (100-350m), accelerations (70-90) and decelerations (80-100).^{3, 6, 7} Due to the physical demand of this performance factors, the evaluation of external load parameters is of great importance.⁶ It is essential that the coaching staff of each team carry out training planning taking into account the demands of this type of action characteristic of futsal. The design of the training sessions should aim to adapt the player to the maximum competitive demands.¹

In recent years, electronic devices have been introduced to control

external load, such as global positioning systems (GPS), local position measurement (LPM), tracking systems, accelerometers, or video analysers.⁶ It has been shown that the use of GPS in indoor sports and with reduced spaces is limited by a loss of accuracy in the data obtained.⁶ This loss of accuracy is due to the fact that GPS requires outdoor spaces to obtain correct data, and also increases because indoor sports involve faster and shorter actions than outdoor sports, so GPS does not provide accurate data for indoor sports.⁶ Therefore, a feasible option for external load control that does not suffer from these limitations is the accelerometer in indoor sports.⁸

The devices with accelerometers help to evaluate the physical aspect, data that is important to know precisely the competitive demands (and even the worst case scenarios) and to adjust specific training programs that increase performance,⁹ for this the devices most commonly used in team sports are Inertial Measurement Unit (IMU) devices.⁶ These devices are used to control and monitor load parameters in team sports.⁷ Some of the parameters obtained during matches or training sessions are: total distance covered, distance covered at high and maximum intensities, accelerations and decelerations, that is, the player load.^{7, 9, 10} The appearance of IMU devices in team sports has made it much easier to control these parameters, however their use and available data in futsal are scarce.^{1, 7, 11, 12}

For coaches, having the measurement of external loads through

these electronic devices facilitates the design of sessions related to the efforts and requirements of the competition. The design of these sessions based on the previously mentioned data increases performance and decreases the risk of injury.¹¹⁻¹⁶ Therefore, to improve the accuracy of the data obtained by IMU devices it is necessary to carry out scientific validation studies in specific futsal variables.^{15, 16}

Validity implies the difference between the data obtained by the devices and the criterion measurements.⁷ This analysis allows us to better interpret the results. In the existing bibliography, validation studies of different devices were developed on athletics tracks with pre-set distances, for example, 200m or 20m, or designed circuits.¹² Currently, there are not validations carried out specifically with training tasks for each sport, such as tasks in reduced space in futsal. In addition, these studies only validate variables in isolation such as the total distance and maximum speed and not all of them together.¹²

To our knowledge, only one device that has been specifically validated on a circuit with typical futsal action, which is divided into four sections with the most common actions: a) 120° direction changes performed high intensity ($>14 \text{ km}\cdot\text{h}^{-1}$), b) medium-low intensity running ($<14 \text{ km}\cdot\text{h}^{-1}$), c) medium-low intensity running with maximum sprint and maximum stop deceleration, and, d) walking.⁶ Therefore, scientific evidence validating IMU sensors during specific futsal actions is lacking and further studies are needed. For these reasons, the aim of the present study was to evaluate the validity of a new IMU device that allows measuring different variables in futsal in integrated tasks or real game situations.

Methods

Participants

The study included 10 elite players (TIER 4)¹⁷ from a First Division team of the Spanish Futsal League (age 28.3 ± 2.8 years, height 1.77 ± 0.08 m, weight 72.1 ± 6.5 kg). Of which there are three defenders, five wings and two pivots. Only players who participated in full training session were considered for inclusion. Exclusion criteria were injuries resulting in loss of one or more futsal matches/training sessions in the preceding 4 weeks prior to the initiation of the study. The data collection took place during the fifth month, out of the ten, of the competitive season, in a training session of a competitive microcycle. Goalkeepers will not be included in this analysis, as well as two players who

were injured. Players train five 75 minutes long court sessions, one gym session, and one game per week. The sample size was chosen by convenience, also a post hoc analysis of the achieved power for this sample size was conducted (G*Power software vs. 3.1), with $\alpha = .05$, $(1 - \beta) = .8$, effect size = .5, statistical test = means: difference from constant (one sample case), with a moderate power (.43).

Design

A cross-sectional study was proposed to validate the indicated IMU (OLIVER, Barcelona, Spain). The results of the IMU OLIVER software (Recorder and Analyser, Barcelona, Spain) will be compared with the WIMU PRO GPS model (RealTrack Systems, Almería, Spain). The OLIVER is an IMU with a small size ($4 \times 5 \times 1.5 \text{ cm}$) and a low weight (15 g). The actions that are recorded by the IMU hardware work with 27 Hz (Recorder and Analyser, Barcelona, Spain). All the players were verbally informed about the purpose and procedures of the study and all of them signed the informed consent according to the Declaration of Helsinki, which was approved by the University's Research Ethics Committee (IEC-35/2022).

Methodology

All players had both devices synchronized. At the beginning of the training, they put on the vest with the WIMU PRO device on their back. At the same time, the OLIVER device was placed on the calf. Both devices turned on at the same time just before start warming up. Once the training task was completed, the devices were turned off and the data from the devices was downloaded and all variables were analysed in the OLIVER software (TryOliver Platform) and the WIMU PRO software (RealTrack Systems, Almería, Spain) to compare both results. Once the data from both devices had been analysed, they were exported to Excel so that the statistical analysis could later be carried out. Players will participate with both devices simultaneously. The test developed is two series of a 4v4 in $28 \times 20 \text{ m}$ with a duration of 180 seconds to ensure a minimum of data recording in all players, with a rest of. The rest between sets was 120 seconds, so recovery time was enough to prevent fatigue from affecting his performance. Considering that OLIVER and WIMU PRO have in common that they collect data on variables of distances at high intensity, accelerations and decelerations, as well as maximum speed; these variables will be taken into account for this study. Therefore, the variables collected for both devices

Table 1. One-Factor ANOVA (Welch) for the WimU and Oliver devices

	WIMU		OLIVER		P
	Mean	SD	Mean	SD	
Total distance (m)	468.49	164.72	426.37	160.51	.385
[0-6] $\text{km}\cdot\text{h}^{-1}$ (m)	215.33	59.40	172.33	53.35	.013*
[6.1-12] $\text{km}\cdot\text{h}^{-1}$ (m)	167.23	71.53	131.17	60.55	.072
[12.1-18] $\text{km}\cdot\text{h}^{-1}$ (m)	80.05	44.61	76.56	41.95	.786
[18.1-3600] $\text{km}\cdot\text{h}^{-1}$ (m)	0.5	1.8	1.00	2.71	.460
High Acc quantity ($>2 \text{ m}\cdot\text{s}^{-2}$)	20.65	9.4	15.22	6.47	.028*
High Dec quantity ($> -2 \text{ m}\cdot\text{s}^{-2}$)	22.96	11.54	27.35	12.05	.214
High Acc (m) ($>2 \text{ m}\cdot\text{s}^{-2}$)	77.22	35.78	81.55	37.23	.690
High Dec (m) ($> -2 \text{ m}\cdot\text{s}^{-2}$)	77.74	37.5	59.77	28.02	.073
MAX Speed ($\text{km}\cdot\text{h}^{-1}$)	17.17	1.13	17.73	1.21	.114

*P: differences between WimU and Oliver, $P < .05$
SD: Standard deviation.

were: total distance (m), high intensity distance 12-18 km·h⁻¹ (m), maximum intensity distance >18.1 km·h⁻¹ (m), high acceleration (m) (>2 m·s⁻²), high deceleration (m) (> -2 m·s⁻²), number of accelerations and decelerations and MAX speed (km·h⁻¹), since they are the most common actions that occur in the futsal.^{4, 6, 7}

Statistical analysis

All variables showed a normal distribution (Shapiro-Wilk test). Data are presented as mean and standard deviation (SD). Statistical analysis was performed using JAMOWI 1.2.25 software (Sydney, Australia). The validity of the data obtained by Oliver with respect to WIMU PRO was analysed through a one-way analysis of variance (one-way ANOVA). The significance level used was $P < .05$

Results

In Table 1 One-Factor ANOVA results are shown for the WIMU PRO and Oliver devices. The mean of each of the variables obtained between both devices were compared. Significant differences were observed for the variables distance travelled between 0-6 km·h⁻¹ ($P = .013$) and number of accelerations at high intensity (>2 m·s⁻²) ($P = .028$), that is, both variables reported lower values in WIMU PRO device compared with the Oliver one, which implies that both items cannot be compared with data reported by the previous validated device, WIMU PRO. For the rest of the variables, no significant differences were found ($P > .05$).

Discussion

To date, this is the first study that performs the validation of an IMU within a reduced space training task in an elite futsal team. Likewise, it is the very first study to validate several variables that have not been validated in other studies. The main findings of this research are: a) the new device shows significant validity for monitoring the external load in real game situations in futsal; b) the variables of total distance and maximum speed are validated; c) in contrast to other studies,^{6, 7, 16, 18} the variables of jogging distance (6.1-12 km·h⁻¹), high intensity distance (12.1-18 km·h⁻¹) are also validated, maximum intensity distance (>18.1 km·h⁻¹), high acceleration (m) (>2 m·s⁻²), high deceleration (m) (> -2 m·s⁻²) and number of decelerations (> -2 m·s⁻²).

Several studies have analysed the validity of a GPS in team sports. Beato et al.⁷ validate the variables of total distance and maximum speed with 3 tests, which are: a 400m test, a specific 128.5m team sports circuit that replicated the actions of team sports and a 20m sprint. In addition, Beato et al.¹⁶ validate the variables of total distance and maximum speed by performing a specific team sports circuit and a 20m sprint. Another research by Muñoz-López et al.¹⁸ validates the variables of total distance and maximum speed by carrying out a 146m circuit based on team sports movements. According to the authors' knowledge, only one study by Lago et al.⁶ has studied the validity of an IMU for futsal at different intensities, such as: without activity (standing or walking), medium-low intensity at a speed <14 km·h⁻¹, high intensity at a speed >14 km·h⁻¹. The researchers carried out this validity through a circuit with specific indoor football actions. This circuit had four zones: a) 120° direction changes carried out at high intensity, b) medium-low intensity race, c) medium-low intensity race with maximum sprint and maximum deceleration with stop, and, d) walk. However, this validity arises in a circuit, a situation with actions not typical of competition. Thus, in the present study the validity was analysed

in a task of high ecological validity, that is, a situation of 4×4 in 28×20m for 180 seconds. In addition, a greater number of variables were analysed, closer to the competitive demands in futsal following some studies on the demands of futsal,^{13,19} such as: total distance (m), high intensity distance 12-18 km high deceleration (m) (> -2 m·s⁻²), number of decelerations and MAX Speed (km·h⁻¹).

Regarding the participants in these validation studies of various devices, it is important to highlight that they were not of elite athlete status. In the study by Beato et al.⁷ and Beato et al.¹⁶ 20 students were the participants, in the study by Muñoz-López et al.¹⁸ there were two physically active men and in the study by Lago et al.⁶ 11 youth futsal players. However, 10 elite players from a First Division team of the Spanish Futsal League participated in our study, making it the first study to perform a validation with high level male indoor football players.

On the other hand, there are large differences between systems that could be due to the frequency of the actions that are recorded by the GPS hardware, since a higher frequency provides a more reliable measure compared to systems that have a lower frequency.⁷ The GPS that appears in the study by Beato et al.⁷ which is the Statsports Viper has 10 Hz. In the study by Beato et al.¹⁶ two STATSports Apex GPS models appear, one with a frequency of 10Hz and the other with a 18 Hz frequency. In the study by Muñoz-López et al.¹⁸ The GPS used by WIMU has a frequency of 5Hz. In the research by Lago et al.⁶ the IMU they use, which is the Overtraq, has a frequency of up to 200 Hz. The device analysed in this study has 10Hz outdoor GPS and 27Hz IMU indoor, so the Hz of the new IMU used in this study are higher than those of WIMU for outdoor and the Hz of the new IMU doubles those of GPS. The frequency, measured in Hz, at which the device operates in this study ensures optimal signal reception for comprehensive data acquisition. This is due to the fact that a higher Hz count results in an improved signal received by the IMU, subsequently leading to more precise and accurate data. Furthermore, each device is composed by an algorithm calculation that can generate different metrics according to their manufacturer. Notwithstanding, these algorithms calculated from accelerometer data are one of the strongest points of these devices related to its usefulness, specially linked with the monitoring process of workloads.²⁰

Finally, in relation to the variables analysed, it has been observed that total distance, jogging distance (6.1-12 km·h⁻¹), high intensity distance (12.1-18 km·h⁻¹), maximum intensity distance (> 18.1 km·h⁻¹), high acceleration (m) (>2 m·s⁻²), high deceleration (m) (> -2 m·s⁻²), number of decelerations and maximum speed, have been validated in the present study. The total distance, the distance by speeds, accelerations, decelerations, and maximum speed are reference values evaluated in competition, so the relevance of this device is maximum to be able to compare our data with the benchmarks at a competitive level. In addition, this device, given its location in the calf area inside a sock, makes it much more practical for the player, since it is a garment that players are used to wearing and that does not restrict their movements, as could be the vest case. In the study by Lago et al.⁶, the other device validated in futsal (OVERTRAQ) appears, it does not have reference data in real game situations, in addition to the fact that the validated variables are far from competitive needs and training, or performance factors specific to futsal. Although low speed distance has not been validated, it is a less relevant variable for the training process and should be considered on a practical level regarding its possible measurement error in the training process. However, to date, no devices have objectively validated this variable. Despite the findings obtained, this

research has the limitation that it has not been possible to cross-validate all the variables given that each franchise/device has some of its own variables. Despite the limitation, this is the first study that validates a device with specific actions for futsal.

Practical Applications

This is the first study that validates a device in real game situations, with the variability of the device compared to closed or analytical situations. Based on these results, it will be possible to analyse the external load in a valid context, allowing coaches and physical coaches to design training tasks and sessions adjusted to the individual needs of each player, as well as to plan the training process in similar to the competition needs. Future studies should evaluate the reliability of this device, as well as to analyse the external load in training tasks to define the most demanding situations of training and compare them with competitive demands. Other variables such as accelerations and decelerations at different intensities could also be validated.

Conclusions

This study shows good validity of the OLIVER system to determine the total distance, the distance traveled at high intensity and distance at maximum intensity, as well as the number of accelerations and decelerations and maximum speed, which means that the new IMU device was able to objectively and accurately monitor and record the main external load variables typical of futsal, situation similar to the real game, so the use of this device is proposed to monitor training and competition loads. That is, this study confirms the OLIVER system as a valid system to record and monitor distances at different intensities, number of accelerations and decelerations in futsal. This type of technology is of great importance in team sports in the field of high performance for physical trainers, therefore this new technological option should be considered to keep track of the loads of individual players, both in training and in matches, being able to adapt the loads throughout the season.

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Ethical Committee approval

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Universidad Europea del Atlántico (IEC-35/2022).

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Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

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Conflicts of interest

The authors have no conflicts of interest to declare.

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Declaration if used ChatGPT

We don't used ChatGPT.

Author-s contribution

Conceptualisation, C.L.-F., H.G.U. and E.M.P.; methodology, C.L.-F., H.G.U, A.B.A. and E.M.P; formal analysis, C.L.-F., and A.P.-C.; investigation, H.G.U, E.I, and C.S.; data curation, H.G.U, E.I, and C.S...; writing—original draft preparation, H.G.U, C.L.-F.; writing—review and editing, C.S., E.M.P.; visualisation, A.B.A and E.M.P.; supervision, H.G.U, C.L.-F., A.B.A, E.I, C.S. and E.M.P. All authors have read and agreed to the published version of the manuscript.

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