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Original

VALIDEZ Y FIABILIDAD DE LA APLICACIÓN MY JUMP 2 PARA LA ESTIMACIÓN DEL TIEMPO DE VUELO Y LA ALTURA DEL SALTO VERTICAL CON UNA SOLA PIERNA EN FUTBOLISTAS DE ÉLITE SUB-20.

VALIDITY AND RELIABILITY OF THE MY JUMP 2 APPLICATION FOR ESTIMATING FLIGHT TIME AND VERTICAL ONE-LEGGED JUMPING HEIGHT IN ELITE UNDER-20 SOCCER PLAYERS.

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ESTIMACIÓN DEL TIEMPO DE VUELO Y LA ALTURA DEL SALTO VERTICAL REALIZADO CON UNA SOLA PIERNA EN FUTBOLISTAS DE ÉLITE SUB-20.

RESUMEN

La evaluación y análisis del salto vertical son habituales en los procesos de seguimiento en el rendimiento deportivo y la rehabilitación de los deportistas. Estas evaluaciones se llevan a cabo en ambientes de laboratorio y utilizando tecnologías costosas y complejas que requieren la experiencia de los evaluadores. Recientemente, la aplicación móvil My Jump 2 demostró su validez en comparación con las placas de fuerza en el salto vertical a dos piernas. Sin embargo, la validez de esta aplicación móvil para estimar los valores de las variantes de salto con una pierna SJ (Squat Jump) y CMJ (Countermovement Jump) en jugadores de fútbol aún está por determinarse. Veinticuatro jugadores de fútbol sub-20 de élite participaron en este estudio. Fueron evaluados simultáneamente con el dispositivo OptoGait y la aplicación My Jump2 siguiendo el protocolo de la variante de una pierna SJ y CMJ. Hubo una excelente concordancia entre My Jump 2 y OptoGait, tanto SJ como CMJ con una sola pierna para el tiempo de vuelo y la altura del salto (coeficiente de correlación intraclase = 0,902-0,929, $p < 0,05$; sesgo de Bland-Altman = % de diferencia 7-15) . Se estableció una buena repetibilidad y reproducibilidad para las mismas variables en miembro inferior derecho e izquierdo entre evaluadores (coeficiente de correlación intraclase = 0,591- 0,835, $p < 0,05$; coeficiente de variación porcentual = 2,87 a 10,72). Los resultados sugieren que la aplicación My Jump2 es un instrumento práctico, rentable y válido para la evaluación del salto en jóvenes futbolistas de élite, así como una alternativa portátil de fácil manejo en el campo para uso de los profesionales de las Ciencias del Deporte y Fisioterapia.

Palabras clave: Salto vertical; OptoGait; MyJump; Squat Jump; Countermovement Jump

ESTIMATING FLIGHT TIME AND VERTICAL ONE-LEGGED JUMPING HEIGHT IN ELITE UNDER-20 SOCCER PLAYERS.

ABSTRACT

The evaluation and analysis of the vertical jump are regular in the follow-up processes in sports performance and the rehabilitation of athletes. These assessments are conducted in laboratory environments and using expensive and complex technologies that require evaluators' expertise. Recently, the My Jump 2 mobile application proved its validity compared to force plates in the two-legged vertical jump. However, the validity of this mobile application for estimating the values of the SJ (Squat Jump) and CMJ (Countermovement Jump) one-legged jump variants in soccer players is still being determined. Twenty-four elite under-20 soccer players participated in this study. They were assessed simultaneously with the OptoGait device and the My Jump2 application following the SJ and the CMJ one-legged variant protocol. There was an excellent agreement between My Jump 2 and OptoGait, both SJ and CMJ one-legged jump for flight time and jump height (intraclass correlation coefficient = 0.902-0.929, $p < 0.05$; Bland-Altman bias = % difference 7-15). Good repeatability and reproducibility were established for the same variables in both the right and left lower limb between evaluators (intraclass correlation coefficient = 0.591- 0.835, $p < 0.05$; variation coefficient percentage = 2.87 to 10.72). The results suggest that the My Jump2 application is a practical, cost-effective, and valid instrument for the assessment of jumping in young elite soccer players, as well as a portable alternative of easy operation in the field for the use of professionals in Sports Science and Physiotherapy.

Keywords: Vertical Jump; OptoGait; MyJump; Squat Jump; Countermovement Jump

Journal of Sport and Health Research 2024, 16(3):373-384

Introduction

The vertical jump is a benchmark in health promotion and musculoskeletal disease prevention processes. Also, it is used as an indicator of performance status and neuromuscular adaptations in athletes (Marques & Izquierdo, 2014; Watkins et al., 2017), allowing the monitoring of the training load and the rehabilitation process of sports injuries (Gagnon et al., 2017).

Jumping is a motor task that makes it possible to demonstrate the ability to generate elastic-explosive force both in two-legged and one-legged support (Maulder & Cronin, 2005). Mainly, the analysis of one-legged jumping performance contributes to the knowledge of the symmetry state in lower limbs by evaluating the imbalances in the elastic-explosive force between the dominant and non-dominant lower limb or between an injured and non-injured limb (Yanci & Camara, 2016).

In this regard, Meylan et al., 2010 evaluated the reliability of different kinetic and temporal variables involved in different types of one-legged jumping. They concluded that the eccentric and concentric maximum force, and maximum concentric power, are the only reliable measures among the different types of jumps evaluated. Likewise, Murtagh et al., 2017 described that one-legged countermovement jumping (CMJ) performance consistently differentiates between elite and amateur soccer players.

Historically, height or flight time measurement has been the method of choice for estimating jumping performance. However, in recent years, several high-precision devices have made it possible to estimate with accuracy several parameters from the temporal results obtained in the evaluation of jumping. These devices include contact platforms, accelerometers, optical systems, or even direct measurements with force plates (Buckthorpe et al., 2012). These equipment's require the handling of sophisticated and expensive instruments that limit their application to some groups of professionals and demand substantial theoretical recognition and technical skills on the part of those performing the measurements. In addition, these devices have great difficulty in transportation and adaptation in uncontrolled environments, which limits their use to laboratories that are difficult to access for many professionals (Balsalobre-Fernández et al., 2015).

Testing the validity of this type of measurement generated through motion captures with mobile applications such as My Jump2 under low-cost operating systems such as Android, currently available in virtual stores, would facilitate the calculation of temporal variables associated with jumping. These temporal variables allow us to estimate more complex variables such as speed or power and compare the performance of each lower limb to determine their symmetry in different modalities of explosive strength manifestation. Such measurements between the lower limbs can facilitate authentic, accurate, portable, easy use, and low-cost control in monitoring sports performance, rehabilitation, and sports readaptation processes. Thus, the present study aims to the flight time and the vertical jump height in one-legged assessment in elite under-20 soccer players.

Materials and Methods

Participants

This study was cross-sectional with a quantitative approach and a correlational scope. The sample included a total of 24 under-20 elite soccer players, all male, from the Club Deportivo Pereira and was selected in a non-probabilistic way by convenience. The medical staff of the soccer club reported that all the athletes selected for the study did not present or report any conditions that would interfere with the assessment. Participants also reported no musculoskeletal injuries in the last six months that prevented them from performing the one-legged jump tests. Participants were advised not to use performance-enhancing substances at least 24 hours before the measurement, which may

Journal of Sport and Health Research 2024, 16(3):373-384

alter their test performance. The entire evaluation protocol was performed during a single session.

The study protocol was adjusted to the human experimentation criteria of the Helsinki Declaration and the resolution 008430 of the Colombian Ministry of Health and Social Protection. This study also was evaluated and endorsed by the ethics committee of the Universidad Tecnológica de Pereira (49-280621). The research's risks and objectives were explained to participants before starting the evaluation protocol and the execution of each physical test. After that, the participants expressed their acceptance and understanding of the risks and benefits of research participation by signing the informed consent form.

Procedure

First, the weight's soccer players were assessed using a SECA scale with an accuracy of 100 g and the height with a stadiometer of the same brand with an accuracy of 0.1 cm. Measurements were performed according to the guidelines established by the International Society for the Advancement of Kinanthropometry ISAK (Stewart et al., 2011). After that, each soccer player performed a neuromuscular warm-up which included short, high-intensity exercises following the protocol reported by Patiño-Palma et al., 2022. Finally, a dynamic global stretching, as suggested by Andrade et al., 2015, was performed.

Next, familiarization with the single-legged vertical jumping motor task was performed to achieve sufficiency in the jumping technique, according to Bishop et al., 2021. Once the warm-up and familiarization phase was completed, two single-legged jumps were performed alternately with the Squat Jump (SJ) and Counter-movement Jump (CMJ) variants. Each jump was performed considering a recovery period of 2 minutes between jumps.

Direct flight time measurement was performed with the OptoGait device (Microgate, Bolzano, Italy), a valid instrument for estimating vertical jump height and power. (Glatthorn et al., 2011). Synchronously, we record a video with a mobile device Galaxy J7 Prime (Samsung Inc., China) with 720 pixels and 30 frames per second. The video recording focused on the feet of soccer players from a frontal plane at a distance of approximately 1.5 meters. After that, the recorded photograms were imported into the My Jump 2 application. The jump height was estimated based on flight time in both SJ and CMJ according to the specifications and proposal of Balsalobre-Fernández et al., 2015 and the methodological approach of Bosco et al., 1983. Two evaluators captured the video recordings and randomly determined the flight time and jump height in the My Jump 2 application from two attempts of each of the jumps used in the measurement protocol.

Statistical analysis

The statistical analysis and data processing was performed with SPSS 25 software and GraphPad Prism 8. We describe measures of central tendency and dispersion of body composition variables and the performance of each jump. Next, we tested the normal distribution of variables with the Shapiro Wilk test due to its high statistical power for samples of different sizes (Mohd Razali & Bee Wah, 2011), which showed a normal or parametric behavior in the data analyzed ($p > 0.05$).

Due to the normal distribution of the data, to determine the concordance, reliability, and concurrent validity between the My Jump 2 application and the OptoGait, we used a Bland-Altman analysis graph, coefficient variation (CV), and Pearson's correlation coefficient correspondingly. In addition, we used the intraclass correlation coefficient (ICC) to observe the reliability between the My Jump2 application and the OptoGait and determine inter-rater reliability. We established a statistical significance level at a p-value < 0.05, and all the calculations mentioned above were determined with their respective 95% confidence intervals.

Results

We evaluated 24 elite under-20 soccer players from the Club Deportivo Pereira. The

Journal of Sport and Health Research 2024, 16(3):373-384

characteristics of the sample are described in Table 1, highlighting an average weight of 68.92 ± 8.41 kg, a height of 176.29 ± 7.86 cm, and a body mass index of 22.11 ± 1.4 (Kg/m^2), classifying this population according to the parameters of the World Health Organization (WHO) with a normal weight.

The average heights of the one-legged jumps assessed with the OptoGait stand out, showing an average height of 17.53 ± 3.29 cm for the right lower limb (RLL) and 18.09 ± 2.94 cm for the left lower limb (LLL) in the SJ variant, while for the CMJ, we observed an average height of 18.91 ± 2.63 cm for RLL and 20.03 ± 2.86 cm for LLL.

With the My Jump2 application, we observe an average height of 20.49 ± 4.41 cm for RLL and 21.26 ± 3.22 cm for LLL in the SJ, while for the CMJ, we found an average height of 22.02 ± 3.04 cm for RLL and 23.03 ± 3.27 cm for LLL.

High levels of agreement were observed in one-legged jumping between the My Jump2 app and the OptoGait device for jump height and flight time in SJ and CMJ (Figure 1). However, we found an overestimation between 7% and 15% in single-leg jumping performance when the measurement was performed with the My Jump 2 application.

Table 1. Body composition and jumping performance of the study sample.

		Mean ± SD	**CI 95%**
Weight (Kg)		68.92 ± 8.41	65.36 — 72.47
Size (cm)		176.29 ± 7.86	172.29 — 179.97
BMI (Kg/m2)		22.11 ± 1.4	21.52 — 22.7
Lower Limb Length (cm)		104.02 ± 6.12	101.43 — 106.6
Jumping performance obtained with OptoGait	Flight time, RLL in SJ (ms)	376.52 ± 35.76	361.41 — 391.62
	Flight time, LLL in SJ (ms)	382.89 ± 31.29	369.68 — 396.11
	Jump height, RLL in SJ (cm)	17.53 ± 3.29	16.14 — 18.93
	Jump height, LLL in SJ (cm)	18.09 ± 2.94	16.85 — 19.33
	Flight time, RLL in CMJ (ms)	392.08 ± 27.14	380.62 — 403.54
	Flight time, LLL in CMJ (ms)	403.14 ± 28.8	390.98 — 415.31
	Jump height, RLL in CMJ (cm)	18.91 ± 2.63	17.8 — 20.02
	Jump height, LLL in CMJ (cm)	20.03 ± 2.86	18.82 — 21.23
Jumping performance obtained with MyJump2	Flight time, RLL in SJ (ms)	406.16 ± 44.1	387.54 — 424.79
	Flight time, LLL in SJ (ms)	415.08 ± 31.64	401.72 — 428.44
	Jump height, RLL in SJ (cm)	20.49 ± 4.41	18.63 — 22.36
	Jump height, LLL in SJ (cm)	21.26 ± 3.22	19.9 — 22.62
	Flight time, RLL in CMJ (ms)	422.43 ± 29.48	409.98 — 434.88
	Flight time, LLL in CMJ (ms)	432.12 ± 30.76	419.13 — 445.11
	Jump height, RLL in CMJ (cm)	22.02 ± 3.04	20.73 — 23.31
	Jump height, LLL in CMJ (cm)	23.03 ± 3.27	21.64 — 24.41

Kg: kilograms, cm: centimeters, SD: standard deviation, ms: milliseconds, CI 95%: 95% confidence interval, SJ: Squat Jump, CMJ: Countermovement Jump, RLL: Right Lower Limb, LLL: Left Lower Limb

Journal of Sport and Health Research 2024, 16(3):373-384

Table 2 describes the statistical correlations for flight time and jump height in one-legged hopping between the Optogait device and the My Jump 2 application for both SJ and CMJ. The correlation coefficients showed significant positive correlations between 0.92 and 0.94 for flight time and jump height correspondingly ($p < 0.05$), indicating good agreement between the two measurement tools

Table 3 details the analysis of repeatability and reproducibility of the My Jump2 application in the evaluation of one-legged jumping performance for the SJ and the CMJ. We found moderate to high concordance values (0.591-0.835) between the eval-uators and observed differences in their results corresponding to percentages of the variation coefficient between 2.87 to 10.72%.

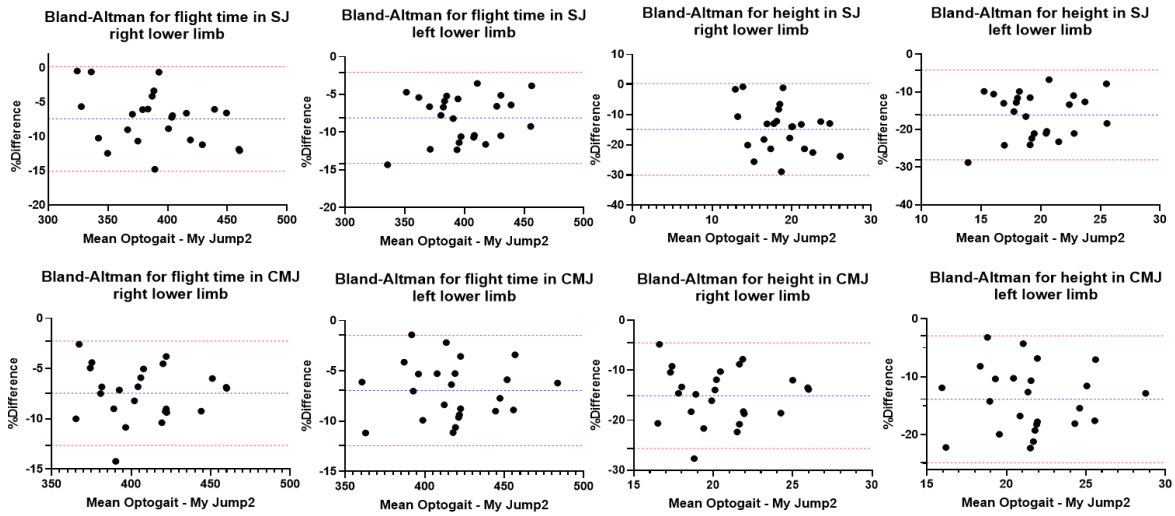

Figure 1. Concordance analysis between OptoGait and the My Jump2 application **(a)** Bland-Altman plot for the flight time variable; **(b)** Bland-Altman plot for the altitude variable

Journal of Sport and Health Research 2024, 16(3):373-384

Table 2. Correlation of jump assessment between OptoGait and My Jump2 application.

OptoGait versus MyJump2	ICC	CI 95%	r	P value	Diff (%)
Flight time, RLL in SJ	0.919	0.823 — 0.964	0.940	<0,01	-7.43
Jump height, RLL in SJ	0.902	0.788 — 0.957	0.941	<0,01	-14.84
Flight time, LLL in SJ	0.929	0.843 — 0.969	0.929	<0,01	-8.10
Jump height, LLL in SJ	0.926	0.837 — 0.967	0.930	<0,01	-16.14
Flight time, RLL in CMJ	0.928	0.841 — 0.968	0.931	<0,01	-7.44
Jump height, RLL in CMJ	0.921	0.827 — 0.965	0.931	<0,01	-15.08
Flight time, LLL in CMJ	0.923	0.831 — 0.966	0.925	<0,01	-6.93
Jump height, LLL in CMJ	0.918	0.820 — 0.964	0.926	<0,01	-13.88

ICC: intraclass correlation coefficient, CI 95%: 95% confidence interval, r: Pearson correlation coefficient, SJ: Squat Jump, CMJ: Countermovement Jump, RLL: Right Lower Limb, LLL: Left Lower Limb, Diff: differences between assessment tools

Discussion

The SJ and CMJ vertical jump variants are recommended for measuring explosive strength in athletes whose performance is highly influenced by the power generated in their lower extremities (Samozino et al., 2008). In this sense, one-legged jumping power in both SJ and CMJ is a good predictor of explosive strength and functionality of each limb and, consequently, of the symmetry that may exist between the lower limbs (Heishman et al., 2019). The present study analyzed the concurrent validity of the My Jump2 application installed on an Android device versus the OptoGait device for the measurement of vertical jump performance for one-legged jumping in the SJ and CMJ variants in elite under-20 soccer players belonging to the Club Deportivo Pereira professional team. We found that the My Jump2 application provides a reliable estimation of flight time and jump height for the SJ and CMJ jumping variants for one-legged jumping. Our results indicate that the data provided by the My Jump 2 application are remarkably close to the values re-ported by the OptoGait device. Therefore, the My Jump2 application is a practical and helpful instrument for measuring explosive and elastic explosive strength in elite un-der-20 soccer players.

OptoGait has shown estimation differences in vertical jump height of as little as 1.0 cm when compared to technologies such as force platforms with 1000 Hz acquisi-tion rates. (Glatthorn et al., 2011). We found in this study that compared to the OptoGait, the My Jump 2 application achieved strong correlation and concordance indicators for flight time and jump height. Our findings are consistent with the reports of Gallardo-Fuentes et al., 2016, who determined high correlation coefficients between the My Jump 2 application with the contact platform (0.97-0.99) in both male and female athletes during the exe-cution of SJ, CMJ, and Drop Jump (DJ) variants.

Table 3. ICC and CV between evaluators of vertical jump with My Jump 2 application

	ICC	CI 95%	P value	CV (%)	CI 95% (%)
Flight time, RLL in SJ	0.833	0.647 — 0.926	<0,01	2.87	1.0 — 4.74
Flight time, LLL in SJ	0.627	0.288 — 0.826	<0,01	5.23	2.81 — 7.66
Jump height, RLL in SJ	0.835	0.650 — 0.926	<0,01	5.80	1.94 — 9.66
Jump height, LLL in SJ	0.596	0.242 — 0.810	<0,01	10.72	5.80 — 15.65

Journal of Sport and Health Research 2024, 16(3):373-384

Flight time, RLL in CMJ	0.634	0.309 — 0.829	<0,01	3.16	1.04 — 5.28
Flight time, LLL in CMJ	0.787	0.561 — 0.904	<0,01	6.65	5.18 — 8.12
Jump height, RLL in CMJ	0.591	0.245 — 0.803	<0,01	6.29	2.05 — 10.53
Jump height, LLL in CMJ	0.752	0.499 — 0.887	<0,01	5.14	1.85 — 8.43

ICC: intraclass correlation coefficient, CI 95%: 95% confidence interval, CV: Coefficient of variation, SJ: Squat Jump, CMJ: Countermovement Jump, RLL: Right Lower Limb, LLL: Left Lower Limb.

Similarly, Yingling et al., 2018 used a mechanical device called Vertec to evaluate jump height and estimated power calculated according to the Sayers et al., 1999 equation in the CMJ variant in healthy college students. They found moderate correlation values (0.81 - 0.92) when comparing this device with My Jump 2, thus determining the validity of this application to estimate jump height and power in this motor task. Additionally, Wee et al., 2018 evaluated the concurrent validity of several wearable devices against a contact platform, including the My Jump2 application, finding a very high correlation (0.99) in athletes practicing different sports, including volleyball, handball, and rugby. Others also found the same pattern of high correlation using different vertical jump variants when comparing The My Jump 2 application with contact mats (0.98-0.99) (Balsalobre-Fernández et al., 2015; Haynes et al., 2019).

This same pattern of statistical correlation between the My Jump2 application and the OptoJump device was reported by Bogataj, Pajek, Hadžić, et al., 2020 in children and adolescents. They examined the validity of My Jump 2 in a sample of children between 11 and 14 years of age, 22 females and 26 males, finding significant statistical correlations for both the SJ (0.97) and the CMJ (0.97). In the same way, Cruvinel-Cabral et al., 2018 showed high correlations between the My Jump 2 and contact mat (0.99) as well as a good agreement between observers in people over 60 years of age, which shows that the use of this application is valid and reliable in any context.

Regarding the specific assessment of one-legged jump height and muscle power, Barbalho et al., 2020 evaluated 11 soccer players simultaneously on a force plate and with the My Jump2 application in DJ, finding a high correlation between the devices ($r > 0.98$). Our results in one-legged jump also showed high levels of correlation between the OptoGait device and the My Jump2 application. Still, unlike the previous study, these correlations were for the SJ and CMJ in elite under-20 soccer players and a larger sample of athletes.

In practical terms, the validity shown by the My Jump2 application makes clear its capacity to estimate vertical jump height using mobile devices other than the IOS operating system, which has a high-speed camera system of up to 240 Hz (Balsalobre-Fernández et al., 2015; Haynes et al., 2019). The Android operating system used in the present study used a device with a low-speed camera of 30 Hz, providing a portable, easy-to-use, and cost-effective tool that does not require laboratory space or the expertise of the evaluators.

The limitations of this study include the absence of female athletes for comparison with the values obtained by males, which is a limiting factor in the concurrent validity regarding the use of the application (Bogataj, Pajek, Andrašić, et al., 2020). In addition, this study did not control for distance and camera position, which depend exclusively on the expertise and skill of the evaluators in capturing the video, which may

Journal of Sport and Health Research 2024, 16(3):373-384

have implications for the observed results. Therefore, these aspects must be considered in the design and implementation of future studies to complement the findings of this research

Conclusions

The results of this research suggest that the My Jump2 app is a practical, cost-effective and valid tool to measure jump height and flight time in elite youth soccer players. In addition, this application is simple and economical for sports professionals, being a tool suitable for the sports environment for measuring simple tests such as SJ and CMJ and thus estimating the muscular power of the lower extremities with only one leg.

Practical Applications

- The data presented in this study have shown that the My jump2 application is a reliable and valid tool for the evaluation of single leg jumping.
- Athletes, coaches, and researchers can rely on the use of this technology to assess and monitor vertical jump performance.
- We can conclude that this is a reliable tool that provides professionals and researchers with accurate information on changes in the physical performance of athletes.

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Journal of Sport and Health Research 2024, 16(3):373-384

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