The validity and reliability of the my jump 2 app for measuring the reactive strength index and drop jump performance

Tom Haynes[1], Chris Bishop[2], Mark Antrobus[3] and Jon Brazier[1*]

[1]Centre of Applied Science, City and Islington College, London, United Kingdom, [2] London Sport Institute, Middlesex University, United Kingdom, [3] Sport, Exercise and Life Sciences, University of Northampton, United Kingdom.

* Jon Brazier, City and Islington College,311-321 Goswell Road, London, EC1V 7DD, United Kingdom. Jonnybrazier@hotmail.com

ABSTRACT

BACKGROUND: This is the first study to independently assess the concurrent validity and reliability of the My Jump 2 app for measuring drop jump performance. It is also the first to evaluate the app's ability to measure the reactive strength index (RSI).

METHODS: Fourteen male sport science students (age: 29.5 ± 9.9 years) performed three drop jumps from 20 cm and 40 cm (totalling 84 jumps), assessed via a force platform and the My Jump 2 app. Reported metrics included reactive strength index, jump height, ground contact time, and mean power. Measurements from both devices were compared using the intraclass correlation coefficient (ICC), Pearson product moment correlation coefficient (*r*), Cronbach's alpha (α), coefficient of variation (CV) and Bland-Altman plots.

RESULTS: Near perfect agreement was seen between devices at 20 cm for RSI (ICC = 0.95) and contact time (ICC = 0.99) and at 40 cm for RSI (ICC = 0.98), jump height (ICC = 0.96) and contact time (ICC = 0.92); with very strong agreement seen at 20 cm for jump height (ICC = 0.80). In comparison with the force plate the app showed good validity for RSI (20 cm: *r* = 0.94*;* 40 cm; *r* = 0.97), jump height (20 cm: *r* = 0.80; 40 cm; *r* = 0.96) and contact time (20 cm = 0.96; 40 cm; *r* = 0.98).

CONCLUSIONS: The results of the present study show that the My Jump 2 app is a valid and reliable tool for assessing drop jump performance.

Key words: Physical Performance; Drop Jumps; Plyometrics; Testing

Introduction

The use of vertical jump testing has been used for a variety of reasons such as to evaluate lower limb power [1], identify talent [2], and monitor fatigue [3]. The main vertical jump tests include the squat jump (SJ), counter movement jump (CMJ) and drop jumps. The SJ has been used in professional rugby union to monitor changes in lower limb power throughout a season [4], while in sports which rely heavily on maximal jumps, like basketball, CMJ's have been used to estimate peak power [5]. Vertical jump tests have also been used to provide an indication of fatigue for athletes during in-season periods [6], with the CMJ commonly used. However, Hamilton[3] suggested that due to the increased eccentric and stretch-shortening cycle (SSC) demands of a test like the drop jump (DJ), it may have an enhanced capacity to identify an athlete's 'readiness to train'. DJ tests can be used to determine the intensity of plyometric exercises, measure lower body reactive strength, monitor neuromuscular fatigue and test lower extremity stiffness [7]. The Reactive Strength Index (RSI) is one metric commonly analysed from DJ. It identifies an athlete's ability to quickly switch from an eccentric to a concentric contraction, and how much force the athlete is able to produce in the shortest possible time. More than one calculation to quantify RSI exists, but the most widely used is jump height (metres) ÷ ground contact time (seconds) [8]. RSI has also been correlated to change of direction speed (r = -0.645, P = 0.001) [9], attacking agility (r = 0.625, P = 0.004) and defensive agility (r = 0.731, P < 0.001) [10], making the DJ a useful performance test to help evaluate an athletes' potential ability in athletic tasks.

There are multiple methods that have been created to measure vertical jump performance including force platforms, accelerometer based systems and professional high-speed cameras. The Optojump photoelectric cells system (Optojump photocell system; Microgate, Italy) is an infrared platform which has been shown to estimate vertical jump height with strong concurrent validity compared with a force platform (ICC = 0.99, 95% CI: 0.97-0.99; $P < 0.001$) [11]. The myotest accelerometric system has also been shown to be a reliable field based test to measure vertical jump height and RSI when compared with measures from a force platform. However, slightly lower reliability has been noted in the CMJ (ICC = 0.74-0.96) [12]. Balsalobre-Fernández, Tejero-González[13] used a low-cost, high speed camera (240 frames per second) to measure flight time (later converted to jump height) in vertical jumps compared with an infrared platform. They observed a near perfect correlation between the high speed camera measurement of flight time and that seen by the infrared platform ($r = 0.997$; $P < 0.0001$), with excellent ICC's between two observers (ICC = 0.997; 95% CI: 0.995-0.998, $P < 0.0001$). These results show that using a smartphone application (app) is a reliable, field-based method for measuring vertical jump performance.

With the release of the iPhone 5s (Apple Inc. [USA]) which included an improved camera capable of recording at 120 Hz, the iPhone has the potential to film at high speeds, enabling it to be used to measure flight-time in vertical jumps. The app, My Jump 2, was developed as a mobile tool that could accurately measure jump performance. Balsalobre-Fernández, Tejero-González[13] tested the app's ability to measure CMJ performance against a 1000 Hz force plate using male sports science students. The results showed near perfect agreement for CMJ jump height when comparing methods ($r = 0.995$; $P < 0.001$) and near perfect reliability between observers (ICC = 0.997; 95% CI: 0.996-0.998; $P < 0.001$). However, the My Jump 2 app did significantly underestimate jump height compared with the force platform ($P < 0.05$), reporting on average 1.2 cm lower jump heights. Gallardo-Fuentes, Gallardo-Fuentes[14] looked at both male and female athletes who performed SJ's, CMJ's and DJ's (from a 40 cm box) on two days, 48 hours apart. They also found near perfect correlation between all jumps between the My Jump 2 app measurement and that from the contact platform, SJ (r = 0.96-

0.99; $P < 0.001$), CMJ ($r = 0.97$-0.99; $P < 0.001$), 40-cm DJ ($r = 0.97$-0.99; $P < 0.001$); in addition to excellent agreement between observers SJ (ICC = 0.97-0.99; $P < 0.001$), CMJ (ICC = 0.98-0.99; $P < 0.001$) 40-cm DJ (ICC = 0.98-0.99; $P < 0.001$). There was no significant difference between jump heights from the app to the contact platform with a mean of 0.2 cm difference between measurements. However, it is important to note that a contact platform was used in this study, which is potentially less sensitive than force platforms; thus, accuracy could be questioned. The aforementioned evidence suggests that the My Jump 2 app is a valid tool for measuring jump height performance when compared with a force plate or contact platform.

Whilst previous studies have looked at the My Jump 2 app for measuring jump height; to the authors' knowledge no other studies have assessed the reliability of additional DJ metrics. Therefore, the aim of the present study was to analyse the validity and reliability of the My Jump 2 app for measuring the RSI and DJ performance. We hypothesised that the My Jump 2 app would show high concurrent validity and reliability when measuring RSI and DJ performance from two different jump heights.

Materials and methods

Subjects

Fourteen active and healthy, male sports science students (N = 14, age = 29.5 ± 9.9 years, height = 178 ± 10 cm, body mass = 81.4 ± 14.1 kg, leg length = 112.3 ± 9.2 cm) were recruited for this study, all participants had at least one year of jump training experience (inclusive of the DJ). Leg length was recorded as the My Jump 2 app uses it to calculate power and force using the equations by Samozino, Morin[15]. Subjects were excluded from the present study if they were experiencing any current injury or had been injured in the 4-week build up to the study's commencement. Written informed consent was obtained from all subjects and the study was approved by London Metropolitan University Ethics Committee.

Procedures

The participants carried out a standardised warm-up prior to testing (Table 1.) Each participant then performed three DJ onto a force platform (FP) (Force Platform FP8, Hurlab, Finland) whilst simultaneously being recorded with a smartphone (iPhone 6) using the My Jump 2 app. A 3-minute passive rest separated each jump, drop heights of 20cm and 40cm were used, with testing of the different heights carried out seven days apart. The app required the tester to manually select the initial contact frame, the take-off frame from the floor and the final landing frame. A number of variables were recorded from both devices including, jump height (cm), contact time (m/s), mean power (W) and RSI. The force platform, with a sampling frequency of 1200 Hz, calculated jump height through flight time, using the following equation: $h = g.\Delta t^2/8$, with h being the jump height in metres and Δt the time in the air in seconds. RSI was calculated on the force platform and the My Jump 2 app using the same equation: RSI = Flight time/Ground contact time.

**********************Table 1 somewhere near here**********************

Statistical Analysis

Statistical analysis was undertaken to test the reliability and validity of DJ performance using the app. A two-way random intraclass correlation coefficient (ICC) with absolute agreement was used to look at the reliability of the app compared to the force plate for RSI, jump height, contact time and mean power; in all jumps measured. To supplement the ICC analyses, Bland-Altman plots [16] were created to show the agreement between the two testing methods. To test the concurrent validity of the app, Pearson's product moment correlation coefficient (r) was performed on normally distributed data, where data was skewed or not normally distributed Spearman's rank correlation coefficient (r) was utilised. To measure the stability of the app for all jumps performed at both heights, Cronbach's α and the coefficient of variation (CV) were used. IBM SPSS Statistics 24 for Mac (IBM Co., Armonk, NY, USA) was used to carry out all calculations.

Results

All data was deemed normally distributed ($P > 0.05$) with the exception of RSI at 20cm, RSI at 40cm, contact time at 20cm, contact time at 40cm and mean power at 20cm ($p < 0.05$). Near perfect levels of agreement were seen between the My Jump 2 app and force platform measures of RSI at 20cm (ICC = 0.95; 95% CI: 0.91-0.96; $P < 0.001$) and at 40cm (ICC = 0.98; 95% CI: 0.97-0.99; $P < 0.001$) (Figures 1a and 1b). Furthermore, near perfect agreement was seen in measures of jump height (ICC = 0.96; 95% CI: 0.96-0.99; $P < 0.001$) and contact time (ICC = 0.92; 95% CI: 0.92-0.98; $P < 0.001$) at 40 cm (Table 2), although mean power in both tests had weaker agreement (ICC = 0.67; 95% CI: 0.39-0.82; $P < 0.001$).

Near perfect correlations were seen in RSI measures at 20cm ($r = 0.94$; $P < 0.001$) and at 40cm ($r = 0.97$; $P < 0.001$), between the My Jump 2 app and the force platform. Figures 2a and 2b show near perfect correlations in both jump height and contact time between the measuring devices ($r = 0.96$; $P < 0.001$ and $r = 0.98$; $P < 0.001$ respectively). Conversely, mean power showed weaker correlations ($r = 0.66$; $P < 0.01$) at 20 cm.

The My Jump 2 App showed good intra-session reliability when measuring RSI at 20 cm (α = 0.98; CV = 6.71%) and at 40cm (α = 0.99; CV = 10.32%). However, the CV value for the 40cm jump was bordering on unacceptable; previous studies reported that for biomechanical variables a CV of ≤10% is reliable (Cormack et al., 2008; Hunter et al., 2004). Good intra-session reliability was seen in the other variables measured in both tests (Table 3).

******************************Figure 1 somewhere near here***************

******************************Table 2 somewhere near here***************

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Discussion

The purpose of this study was to test the concurrent validity and reliability of the My Jump 2 app to measure DJ performance. The app was found to be both valid and reliable at measuring multiple metrics for DJ performance.

The near perfect agreement seen between the My Jump 2 app and the force platform, in RSI measures, jump height and contact time; all support the validity of the app as a valid tool for measuring drop jump performance. This is reinforced by the Bland-Altman plots (Figures 1a and 1b) which also portray strong agreement, along with the near perfect correlations seen between the two devices measurements of RSI, jump height and contact time. These findings suggest that even though the take-off and landing frames are manually selected, the app can still accurately measure contact time and jump height. Mean power was the only variable which did not correlate well between the two devices. Compared with the other variables measured at 20cm, mean power showed relatively weaker intraclass correlation coefficient (ICC = 0.67) and a weaker correlation (r = 0.65). A possible explanation for this could be due to the possible increased errors in the app's calculations of power. Whilst the force plate measures force directly, the app uses contact time, flight time and mass to estimate power. With the DJ, the app only records mass when creating a user profile, whereas the force platform measures mass before each jump, so potential fluctuations in an athlete's mass could affect the accuracy of this measure. The My Jump 2 app is not the only device which has not measured power as accurately as the force platform. Choukou, Laffaye[12] reported greater inconsistency in reliability (ICC = 0.29-0.79) when comparing the Myotest accelerometer base system to a force platform. This could support the idea that to measure force and power accurately and reliably, direct measurements are needed instead of calculating them through other means.

The My Jump 2 app also showed consistent measures between the three jumps performed. From the jumps measured, good to excellent Cronbach's α scores were seen in all variables, showing high internal consistency between jumps (Table 3). The CV between all variables measured was low, with the exception of RSI at 40cm (10.32%) which neared previously reported unacceptable levels [17]. This slightly larger variation in RSI measurements could be down to the fact that RSI is multi-factorial, with the error on flight time being compounded by error on contact time.

Recent studies have looked at how the My Jump 2 App compared with force platform and contact platform measurements on a number of different jumps [13, 14]. Balsalobre-Fernández, Tejero-González[13] when testing the CMJ, showed a near perfect correlation (*r* = 0.995) and intraclass correlation (ICC = 0.997) between the app and a force platform. Gallardo-Fuentes, Gallardo-Fuentes[14] also saw a near perfect correlation (*r* = 0.97-0.99) in jump height between the app and the force platform, along with very strong levels of agreement (ICC = 0.98-0.99) and small mean difference between devices (0.1 ± 0.8 cm); when testing CMJ, SJ and drop jump in both male and female athletes. The similar findings seen in both studies and the current study, suggest the My Jump 2 App is able to reliably measure DJ performance in a wide range of populations, from elite athletes to more recreational athletes, with varied ability in jumping technique.

The findings in this study also compare well to other methods of measuring jump height, such as infrared platforms, accelerometric systems and professional high-speed cameras. When looking at vertical jump heights, a difference of ~1cm was seen between the Optojump measuring system and a force platform [11]; and 3.6cm difference was seen between an accelerometer based system and a force plate [12]. Balsalobre-Fernández, Tejero-González[13] showed professional high speed cameras have measured jump height with an average difference of just 0.31cm; however, this study was compared against Optojump instead of a force platform, but is still thought to be an accurate measure of jump height [18]. Although these studies mostly looked at CMJ and SJ tests, the errors in jump height from the current study, at only 0.45cm (20cm) and 0.68cm (40cm), relate closest to that seen from professional high speed cameras. From this it could be concluded that the My Jump 2 App is a valid and reliable tool for measuring jump height in the DJ compared with both lab (force platform) and other field based protocols.

There are a number of potential limitations of using the My Jump 2 app to measure drop jump performance. The key limiting factor to the accuracy of the app is the frame rate of the iPhone 6 camera, at 240 fps it is better than the iPhone 5 camera (120 fps) which made a big improvement in the apps performance, but it is still possible that the exact landing and take-off frames could be missed. Furthermore, a greater number of observers were needed to compare results measured and to account for possible human error which could have occurred. Another possible limitation is the varied drop jump experience of the participants used, whilst previous research was conducted on elite athletes [13, 14] with greater experience performing DJ's. However, the strong agreement and near perfect correlations seen in this study suggests the My Jump 2 app is a valid and reliable tool for measuring drop jump performance in not only elite athletes but also the general population.

Further research is needed to assess the reliability and validity of using the My Jump 2 app as a field based tool. Research needs to be done on the mean power measurement of the My Jump 2 app to identify and correct the differences in agreement, correlation and mean difference between the app and a force platform. This would allow the app to reliably measure a wider number of variables, making it a more useful tool to practitioners. To the authors knowledge the app has been tested for CMJ, SJ and drop jump measurements, but no research has been conducted on the app's ability to measure limb asymmetry or lower extremity stiffness. If the app was shown to be a reliable tool for measuring limb asymmetry and stiffness, it could aid practitioners in further performance parameters as well as in an injury screening and management capacity. As a final thought, with the recent release of My Jump 2 on Android smartphones, future research should be conducted to assess the validity and reliability of the app utilising a variety of smart phone technology. This would ensure that results pertaining to the app's usefulness are spread to a wider practitioner market.

Conclusions

The ability to measure jump performance and reactive strength is important for strength and conditioning coaches and sports scientists, for the monitoring of physical components, adaptations to training and neuromuscular fatigue. The results of this study show that the My Jump 2 app is a valid and reliable tool for measuring DJ performance at both 20 cm and 40 cm in sports science students. These findings along with previous evidence on elite athletes, shows the My Jump 2 app can reliably measure DJ performance on a wide-ranging population, making the app a useful field test for practitioners, working in both performance and with general populations.

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Table 1. Standardised warm-up protocol for all subjects

Table 2. Mean drop jump performance data (± standard deviation) measured with the My Jump 2 app and the force platform

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Figure 1. Bland-Altman plots for the My Jump 2 app and the force platform (A) RSI at 20 cm (B) RSI at 40 cm. Middle line shows the absolute average difference between devices, with the upper and lower lines showing ±1.96 SD.