COMPARISON OF JUMP HEIGHT VALUES DERIVED FROM A FORCE PLATFORM AND VERTEC

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This study simultaneously assessed jump heights derived from a force platform and a Vertec as well as the reliability of each instrument. Twenty-one recreationally active adults performed 3 maximal countermovement jumps reaching to a Vertec that was placed above the force platform. A repeated measures ANOVA was used to assess differences between Vertec jump height and force platform derived jump height. Results revealed a 27% higher jump height when assessed by the Vertec, compared to the force platform. Intra-class correlations were used to assess trial-to-trial reliability. Both instruments displayed excellent reliability. Practitioners could use the following regression equation to interpret measurements from the force platform: Vertec jump height = force platform height (1.024) + 0.142m.

KEYWORDS: countermovement jump, instrumentation, athlete testing, power, reliability

INTRODUCTION: The countermovement jump is performed in a variety of sports. Practitioners and sport scientists also use the countermovement jump to assess lower body power and the effectiveness of training protocols (Ham et al., 2007; Klavora, 2000).
A variety of instruments are used to evaluate countermovement jump performance including a measuring tape, Vertec, contact mat, motion analysis and force platform (Klavora, 2000; Leard et al., 2007). Jump height assessed by measuring tape and Vertec is determined by subtracting the standing height or reach height by the maximum jumping height or reach height using procedures such as Sargent's, Abalakov's, and Starosta's, jump tests (Klavora, 2000; Starosta & Radzinska, 2001). Jump height assessed by the force platform and contact mat can be determined by the time in air (Markovic et al., 2004; Moir, 2008). Jump height assessed by the aforementioned instruments have been shown to be reliable, however, significant jump height differences ranging from 7.9 to 36% have been reported (Isaacs, 1998; Leard et al., 2007; Markovic et al., 2004; Starosta & Radzinska, 2001). Practitioners must be able to interpret and compare results obtained by scientists that use laboratory equipment such as a force platform to a more inexpensive and convenient field test such as a Vertec.
Force platforms have been used to assess jump performance because of their precision based on high sampling frequencies, and accuracy when compared to motion analysis data (Baca, 1999; Mori, 2008). The Vertec measuring device is widely used because of its simplicity. This device requires the athlete to maximally reach for an object which closely replicates many common sport movements. This device is composed of 48 vanes spaced 1.27 cm apart which can be displaced by the hand when jumping and reaching to a maximum height. Jump heights assessed via Vertec have been shown to be 7.9 and 11% lower when compared to contact mats (Isaacs, 1998; Leard et al., 2007). However, previous research has yet to assess the differences in countermovement jump height obtained from a Vertec and a force platform. Thus, the purpose of this study is to assess the difference between Vertec and force platform derived jump heights, and to assess the reliability of each of the testing instruments.

METHODS: Twenty one recreationally active adults (six female and fifteen male; mean ± SD; age = 22.4 ± 5.1 years; height = 176.4 ± 9.1 cm; body mass = 78.6 ± 11.5 kg) volunteered to serve as subjects for the study. Inclusion criteria included subjects who were 18-45 years old, participated in high school or college sports, without orthopedic lower limb pathology that restricts functioning or known cardiovascular pathology. All subjects provided informed written consent and the study was approved by the institution review board.

Warm-up prior to the test consisted of three minutes of low intensity rope jumping followed by dynamic stretching including one exercise for each major muscle group. Three minutes rest was provided prior to beginning the test. The test consisted of three maximum countermovement jumps with arm swing, since this technique is sport specific and has been shown to maximize jump performance (Hara et al., 2008). Subjects were instructed to jump and reach maximally to a Vertec (Sports Imports, Columbus, OH, USA) which were performed on a force platform (BP6001200, AMTI, Watertown, MA, USA), thus enabling simultaneous recording of results by both methods. One minute rest was provided between each trial.
Jump height derived from the Vertec was assessed by the distance between the height of the highest vane touched during the standing vertical reach with one hand and the vane touched at the highest point of the jump with one hand measured to the nearest 1.27 cm (Harman & Garhammer, 2008). The time in air (TIA) method was used for calculating jump height derived from the force platform (Aragón–Vargas, 2000). Time in air was defined as the period between takeoff and contact after flight (Moir, 2008).

$$\text{TIA jump height} = \tfrac{1}{2}\, g(t / 2)^2, \text{ where } g = 9.81 \text{ m} \cdot \text{sec}^{-2},\ t = \text{time in air}$$

Data were evaluated using SPSS © (Version 16.0). A repeated measures ANOVA was used to assess differences between Vertec jump height and force platform derived jump height. Trial-to-trial reliability analysis of recorded variables used both single (ICC_{single}) and average (ICC_{ave}) measures intra-class correlations. The ICC classifications of Fleiss (1986) (less than 0.4 was poor, between 0.4 and 0.75 was fair to good, and greater than 0.75 was excellent) were used to describe the range of ICC values. A repeated measures ANOVA was also used to assess the differences between the three trials for each instrument. Significant main effects between trials were further analyzed using a Bonferroni-adjusted pairwise comparison. Effect size classifications of Hopkins (2002) (less than 0.04 was trivial, between 0.041 and 0.249 was small, between 0.25 and 0.549 was medium, between 0.55 and 0.799 was large, and greater than 0.80 was very large) were used to interpret the effect sizes. The *a priori* alpha level was set at $p \leq 0.05$ with power and effect size represented by d and η_p^2, respectively. Linear regression analysis was used to develop a prediction equation to estimate Vertec jump height from force platform derived jump height. Assumptions for linearity of statistics were tested and met.

RESULTS: Analysis of the data revealed jump heights derived from the Vertec and force platform were 0.554 ± 0.10 m and 0.402 ± 0.09 m, respectively, which were statistically different ($p < 0.01$). Despite the differences in jump height, reliability was demonstrated by the Vertec (ICC_{single} 0.990; ICC_{ave} 0.997) and force platform (ICC_{single} 0.978; ICC_{ave} 0.992). Repeated measures ANOVA results revealed no significant difference between trials for the force platform ($p = 0.436$; $d = 0.185$; $\eta_p^2 = 0.041$) but a significant difference between trials for the Vertec ($p = 0.031$; $d = 0.660$; $\eta_p^2 = 0.160$). Bonferroni-adjusted post hoc analysis revealed no significant differences between any of the trials for the Vertec. Results of the regression analysis indicated that the force platform was a significant predictor of Vertec jump height ($R^2 = 0.735$, standard error of estimate [SEE] = 0.054 m). Thus, the following regression equation was developed: Vertec jump height = force platform height (1.024) + 0.142 m (Figure 1).

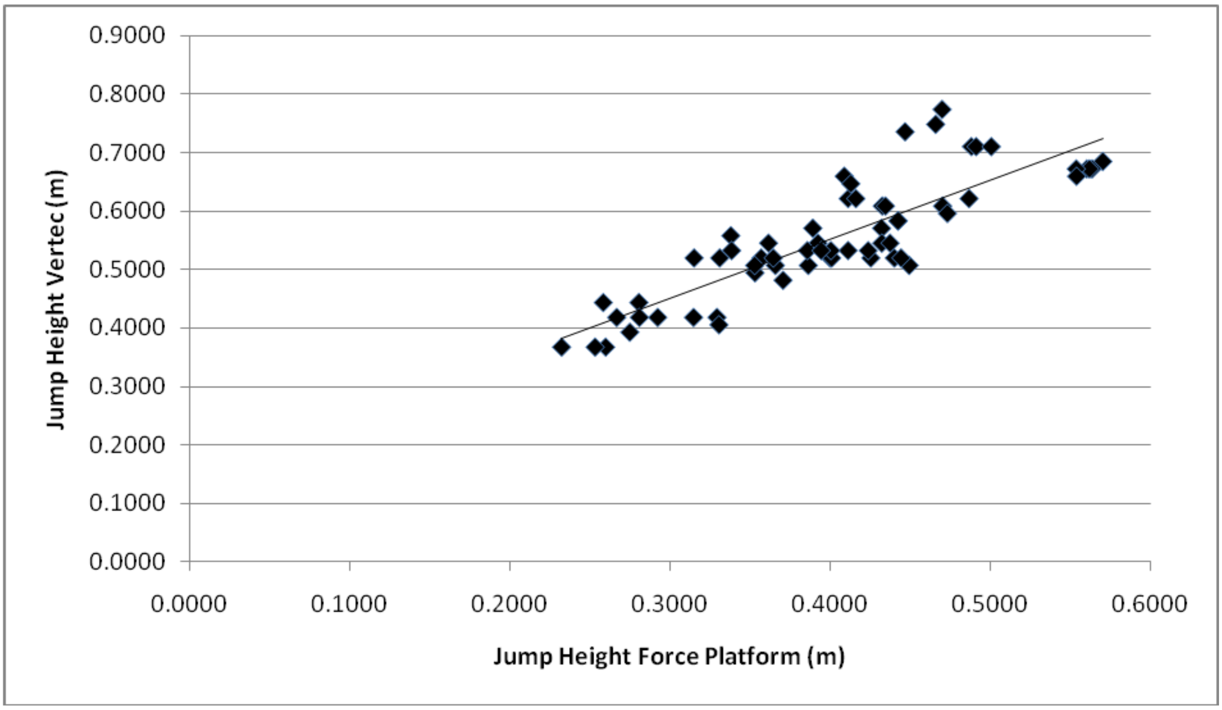

Figure 1. Regression analysis of Vertec and force platform derived jump heights.

DISCUSSION: This is the first study to simultaneously assess differences in Vertec and force platform derived jump heights. Results suggest a 27% higher jump height when assessed by the Vertec, compared to the force platform. The present differences are in contrast to previous reports of lower jump heights obtained from the Vertec compared to contact mats, which use the same calculations to determine jump height as the force platform (Isaacs, 1998; Leard et al., 2007). Details for the procedures and methods for determining Vertec jump height were not explained by Leard and colleagues (2007), thus interpretation of the differences between past and present results remains equivocal. Issacs et al., (1998) however, employed a two arm jump and reach technique and included children, whose motor skills are less developed, which may have influenced the capability of precisely contacting the vanes at the peak of the jump, deflating the Vertec jump height values. General differences between Vertec and force platform jump height assessment could be attributed to the subjects ability to influence initial and final reach height during Vertec testing by manipulating body and or shoulder position to contact the vanes. More specifically, if the subjects body and shoulder position were lower during the initial reach height measurement compared to the maximum jumping reach height, measured jump height would be inflated. Additionally, the number of limbs needed to contact the vanes (1 or 2) for initial and final reach height and the position of the lower body upon landing, could result in jump height discrepancies. Reach height, however, is valuable because of its application to many sports.

Trial-to-trial reliability was excellent for both the Vertec and force platform derived jump heights. These findings are consistent with past research regarding the reliability of force platform derived jump heights (Aragon-Vargas, 2000, Enoksen et al., 2009; Moir, 2008). However, previous research has yet to assess the reliability of Vertec derived jump height (Isaacs, 1998; Leard et al., 2007). Significant differences were found between trials for the Vertec, but post-hoc analysis didn't confirm any differences between trials thus leaving the possibility for type II error. Additionally, the effect size for the differences between Vertec trials was small, thus limiting the possibility for type I error. Nevertheless, the small differences between the trials for the Vertec are likely due to the large (1.27cm) measurement error of the vane spacing. Comparable ICC values were revealed with a device similar to a Vertec, though this device had vanes that were spaced 1.0 cm apart (Young et al., 1997). Results also indicated that Vertec derived jump height can be predicted from force platform data using the regression equation, which allows practitioners to interpret jump heights measured by different instruments.

CONCLUSION: Jump heights derived from a Vertec were 27% higher than heights derived from a force platform. Despite this difference, both instruments provided reliable measurements. Jump height assessment by means of a Vertec is common because of its practicality and external validity. Practitioners will now be able to interpret jump heights derived from force platforms and Vertec's by using the following regression equation: Vertec jump height = force platform height (1.024) + 0.142 m.

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