Comparison of Vertical Jump Height Using the Force Platform and the Vertec

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Abstract — Vertical jump height is often being measured in many ways to evaluate the ability of an individual to jump, and to provide an estimation of lower limb muscle power. The various jump tests and apparatus each have their advantages and disadvantages. The main purpose of this study was to compare and explore the relationship between the two more popular test apparatus - the force platform and the Vertec. Sixty-nine university students, 32 females and 37 males between the ages of 20 to 23 (M age 22.04±0.66 years) were recruited to participate in this study. They were required to perform countermovement jumps on the force platform and using the Vertec. Both jump tests were run on the same day, with a 10-minute interval between tests. Results showed that the jump height values obtained from the force platform were significantly lower compared to jumping with the Vertec. The mean jump height for the force platform was 0.36m ± 0.094 and for the Vertec was 0.55m ± 0.120 respectively. Although the mean jump height of the force platform and Vertec displayed a significant correlation (r = 0.826, p < 0.01). It was concluded that both devices are suitable to be used to measure jump height because those who obtained a high jump height at the Vertec also obtained a high value of jump height on the force platform. An important difference between both devices was the presence of a target of achievement for the Vertec.

Keywords — Jump height, Vertec, Force Platform, Countermovement Jump

I. INTRODUCTION

Generally, every individual has the ability to jump as it is one of the fundamental motor skills that is acquired at a very young age. However, there are many factors that influence the capability of an individual to jump and attain the maximum jump height. The vertical jump test is frequently used to assess athletic skill by comparing the jump performance of starters vs. non-starters [1] and to measure lower body power [2]. It also appeared to be a valuable measurement in identifying lower-limb functionality for the non-athletic population [3, 4]. While there are many types of devices that can be used to measure vertical jump height, two types of devices, the force platform and the Vertec, was investigated in this study.

A force platform is a rectangular metal plate with a piezoelectric or strain gauge transducer attached at each corner to give an electric output that is proportional to the force on the plate. It is a device that measures the force applied by an individual onto the force plate. There are few methods that can be used to measure the jump height using the force platform, including the flight time method, impulse-momentum method and the work-energy method [5]. Linthorne [5] found that both flight time and impulse momentum methods obtained via the force platform are able to provide a good estimation of jump height.

Alternately, the Vertec consists of several plastic swivel vanes arranged in half inch (0.0127m) increments which are attached to a telescopic metal pole that can be adjusted to a participants’ standing reach. The test requires participants to use their hand to displace the vanes with an overhead swinging motion at the peak of their vertical jump. The highest displaced horizontal swivel vane determines the maximum jump height. Vertical jump height is calculated by taking the difference between the fully extended standing reach measurement and the highest displaced horizontal swivel vane [6]. The Vertec is relatively inexpensive, require minimal training for operation, do not require extensive data analysis, and provide immediate results [3].

In previous studies, jump height has been measured using Just Jump, contact mat, and Myotest accelerometers [2, 3, 7, 8, 9, 10, 11]. One study by Erich and colleagues [11] found 27% higher jump height when assessed by the Vertec, compared to the force platform. Another study conducted by Isaacs [7] compared the Vertec to the Just Jump system (VJM) in children aged 7 to 11 years old and found a significant difference (r = 0.83, p < 0.001) between vertical jump height scores measured with the VJM and the Vertec. Jump height in the VJM is determined by measuring flight time [3], and the flight time is subsequently determined by microswitches located within the mat, which are sensitive to the lift-off of the feet from the mat and to the landing of the feet back on to the mat [6]. Participants jumping on the mat focuses purely on the jump and do not have the knowledge of results about the height of jump. Meanwhile, jumping using the Vertec would involve the coordination of jumping and swiping the vanes simultaneously as participants have a target to aim and reach. However, previous research has yet to investigate the relationship between the Vertec and the force platform on jump performance. Thus, the purpose of this study is to compare jump height and determine the relationship between the force platform and the Vertec.
II. METHODS

A. Participants

Sixty nine university students, 32 females and 37 males between the ages of 20 to 23 (M age 22.01±0.66 years), from the University of Malaya were recruited to participate in this study. All the participants were healthy and had no injuries during the data collection period. They were briefed on the procedures of the study and required to sign an informed consent form. The study was approved by the University of Malaya Research Ethics Committee (UM.TNC2/RC/H&E/UMREC – 116) and procedures of this study were carried out in accordance with the guidelines regarding the use of human participants.

B. Instruments

The force platform was a rectangle metal piece (0.5m x 0.5m). It was set to 1200Hz for the capture rate. Gen 5 AMTI-NetForce (Watertown, MA, USA) was used in this study. According to Linthorpe [5], jump height can be calculated using the flight time method where;

\[ v_{to} = \frac{gt_{flight}}{2} \]

\[ y_{flight} = \frac{v_{to}^2}{2g} \]

Where \( V_{to} \) is the vertical take-off velocity, \( t_{flight} \) is the duration of participant in air and \( y_{flight} \) is the jump height of the participant.

The Vertec (Sports Imports, Columbus, OH, USA) consists of 48 plastic vanes with three colours (white, blue and red). Every red vane indicates 6 inch, blue indicates 1 inch and white indicates 0.5 inch. The difference between standing height and the highest displaced vane measurement is the value of the jump height.

C. Procedures

Participants were required to perform countermovement jumps on two jumping test apparatus, which were carried out in a laboratory on the same day. The rest period between tests was 10 minutes. Height and weight of the participants were recorded. They were briefed on the procedures and the protocols of the tests. Prior to testing, participants warmed up by cycling on an ergometer at an average of 60 RPM for five minutes. Participants then proceeded to either jumping on the force platform followed by jumping with the Vertec, or vice-versa, the order by which was determined randomly. Three trials were given for each jumping device and the highest score for each was used for analysis. Only countermovement jumps were recorded, and trials with the wrong technique were repeated. A countermovement jump, starts from a standing position, followed by a squat with arms swinging backwards and then taking off the ground with the arms swinging up forward and upwards (see Figure 1 for an illustration).

![Figure 1. Countermovement Jump (Adapted from Linthorpe [5])]()

For the force platform jump test, participants stepped on the force platform when instructed and executed a countermovement jump. If they landed outside the platform on descend, the trial was repeated. Rest interval between trials was one minute.

For the Vertec jump test, the plastic vanes were adjusted according to the participants’ maximum standing reach by extending their arm straight over the head (standing height). The dominant side was closest to the vanes. Participants then performed a maximal countermovement jump and displaced the vanes with their dominant hand. The highest displaced vane was recorded.

D. Data Analyses

To compare the vertical jump height between jumping on the force platform and jumping with the Vertec, the highest score for each of the jumps on each jumping device was recorded. Data was analyzed using IBM Statistical Package for the Social Science (SPSS) software. Data distribution was assessed using Kolmogorov Smimov’s test for normality. Paired sample t-test was used to determine if there were significant differences between the two types of jump test apparatus with \( p \) level set at .01. Relationship between the two tests were analyzed using the Pearson product moment correlation coefficient. Means and standard deviations of jump height (m) were obtained using descriptive statistics.
III. RESULTS

The mean jump height on the force platform was 0.36 ± 0.094 m while for the Vertec, it was 0.55 ± 0.120 m. There were significant differences between jump height for the force platform and Vertec, t(68) = -23.414, p<0.01, whereby participants jumping on the force platform showed a significantly lower value compared to those jumping with the Vertec. In terms of relationship there was a significant positive correlation (r = 0.82, p<0.01). By convention, r = .70 to .90 is considered as a high positive correlation [12]. Figure 2 represented the relationship between the force platform and Vertec for jump height performance.

![Figure 2: Scatter plot of jump height between force platform and Vertec](image)

IV. DISCUSSION

The purpose of this present study was to compare the difference in jump height between the force platform and the Vertec, as well as to look at the relationship between the two devices.

From the results obtained, participants' jump height was varied between the Vertec and the force platform, with mean scores for the Vertec significantly higher than the force platform. A previous study by Magnúsdóttir and colleagues [9] comparing three devices to measure jump height showed similar results whereby jump height results from the contact mat and accelerometer results that relied on flight time calculation showed systematically lower values compared to the Vertec. Another study had also found 27% higher jump height values when assessed by the Vertec, compared to the force platform [11].

Higher values from the Vertec could probably be due to extraneous factors such as target of achievement, motivation, knowledge of results, technique of jumping, and coordination. Jump height is increased when performers are given an external focus of instructions, relative to an internal focus or no focus instructions [8]. As seen from the results, an external focus which is the Vertec vanes seem to influence and drive the participants to jump higher and break their previous record. Participants are constantly motivated to reach for a higher vane as the knowledge of results exist. On the other hand, participants jumping on the force platform are unable to obtain the knowledge of results or any feedback of their performance.

Different motor coordination needs of the two types of jumps could also play a role. On the force platform, participants will jump with both arms swinging simultaneously throughout the swing as they are only focused on the jump. There is no need to reach for a target. Some participants tend to tuck their legs in during the jump and some would have their legs fully extended. Motor coordination patterns using the Vertec is different whereby participants need to coordinate the timing of the hand to swat the vanes of the Vertec while jumping. In order to reach higher, participants would put more effort to explode off the ground and at the same time reach as high as possible to displace a higher vane on the Vertec.

Position and movement of the limbs could well affect the center of gravity position and indirectly affect the jump height. Raising both arms or both arms and both legs, moves the center of gravity closer to the head thus closer to the hands. Lifting of arms causes another body part to move downwards in order for the center of gravity to continue moving along the parabolic path [13]. When jumping on the force platform, participants may raise their arms and legs, therefore causing the head and the trunk to go lower in order to compensate for the jump movement. This causes the jump height to be lower compared to jumping with only one hand raised (as in the Vertec), or jumping without lifting of the legs. Figure 3 illustrates the height of jump when different limbs are raised during the jumping phase.

![Figure 3: Three different vertical jump techniques result in different jump heights but with the same height of the center of gravity. (Adapted from McGinnis [13])](image)
Despite having distinct differences in the jump height between the force platform and Vertec, both these devices showed a strong positive correlation. When the participant was able to obtain a very high jump height on the force platform, the value obtained using the Vertec appeared to be high as well. Conversely, when jump performance was low on the force platform, the scores obtained from the Vertec were also low. This outcome displays a consistency in the evaluation between two different types of test. Looking through the past studies, Leard and colleagues [10] had also found similar results to this present study, whereby the correlation between Just Jump (contact mat), Vertec (jump and reach) and the criterion reference (3-camera motion analysis system) was statistically significant, although the mean scores among the three devices measuring vertical jump height were significantly different.

These results of this study provide evidence that although both tests are distinctly different from one another because jumping on the force platform does not require the participant to reach a target and involve a different pattern of coordination, the jump heights between the two are closely related. Future research should possibly compare the differences between jumping on the force platform without a target and jumping on the force platform with a target that is specific to a sport skill.

V. CONCLUSION

The present study showed that the jump height on the force platform and Vertec were significantly different yet were strongly correlated. Previous studies with the same concept gave similar results as what was found. It appeared that either one of these tests are suitable and valid to be used as a jumping assessment for athletes as well as sedentary people. Depending on the availability of the test apparatus, both the Vertec and the force platform would provide researchers with valid results.

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CONFICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES


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