11º CONGRESSO NACIONAL DE BIOMECÂNICA
A. P. G. Castro, C. Pina, P. R. Fernandes, C. Santos, J. Folgado & A. Amaro (Eds)
Sesimbra, Portugal, 21-22 de Fevereiro, 2025

JUMP HEIGHT DIFFERENCES DUE TO THE COMPUTATION METHOD USED DURING THE COUNTERMOVEMENT JUMP

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KEYWORDS: Flight Time, Impulse, Center of Mass Displacement, Vertical Jump Performance.

1 INTRODUCTION

Vertical Jump tests are essential for evaluating lower limb power in strength training programs [1][2]. These tests are frequently implemented in sports that require explosive movements, and jump height is one of the most evaluated metrics. Jump height can be computed in different ways, such as, using the measured flight time (FT) (obtained with a contact mat or a force plate), through the vertical impulse produced on the floor (computed from the force plate data) or by measuring the displacement of the center of mass (CoM) (obtained with cameras).

As so, the results vary according with the calculation method and/or equipment used [3][4]. Xu *et al.* [4] concluded that FT offers average reliability and is relatively accessible with fewer error factors. Impulse and motion capture systems provide excellent reliability, being the impulse method easier to use compared with motion capture, which involves more complex data processing.

Because studies have shown discrepancies between methods, with no consensus on their interchangeability [2][5], this study aimed to verify the differences in jump height obtained with the 3 previously mentioned methods in healthy and active adults.

2 MATERIAL AND METHODS

The study, was conducted as part of a summer internship at the Biomechanics and Functional Morphology Laboratory, Faculdade de Motricidade Humana, ULisboa

The inclusion criteria were: (1) age 18 or above, (2) practice at least 30 minutes of exercise 3 times a week, (3) able to perform CMJs correctly. Participants were excluded if they: (1) were professional/federated athletes, (2) have suffered an injury within 6 months, (3) had symptoms (pain/discomfort) in the lower limbs that may affect their performance, (4) were pregnant, (5) had any clinical/pathological diagnosed.

First, they were informed about all study procedures and ethical considerations and then participants signed an Informed Consent.

After a warmup, participants were invited to jump with a marker placed on the sacrum. They stood with feet flat and hands on hips to eliminate arm movement [6], squatted to a self-selected depth and jumped as high as possible, landing in a similar posture. Three CMJs were performed on the force plate, with a 1-minute rest between trials. The best jump was used for the study, with no performance feedback provided during the test.

The displacement of the marker with record using 5 Arqus A9 cameras and 5 Miqus M3 cameras from Qualisys, synchronized in space and time with 2 Bertec force platforms, to measure the Ground reaction force. The software used for data treatment included: Qualisys Track Manager and Visual 3D.

The jump height was calculated using the FT and the impulse, with the values from the force plate, and with the displacement of the CoM, with kinetic data, with only one marker. The sacrum marker was chosen to simplify the marker setup protocol, based on Chiu and Salem study [5].

3 RESULTS AND DISCUSSION

Seven physically active adults (4 females and 3 males; aged=29.4 ± 8.2 years; height=1.71 ± 0.09 m; weight=67.4 ± 8.3 kg) performed 3 CMJs.

The jump height calculated the displacement of sacrum marker resulted in the lowest value, while the height calculated by time of flight was the highest (Table 1), which agrees with Montalvo et al [2].

Table 1 – CMJ jump height computed by impulse, flight time and marker kinematic data

Variables	
Jump Height calculated by Impulse (cm)	27.6 ± 8.6
Jump height calculated by Flight Time (cm)	28.5 ± 9.8
Jump height calculated by Displacement of sacrum marker (cm)	24.6 ± 8.2

The FT method often overestimates jump height due to variations in center of mass height between takeoff and landing as observed by Montalvo *et al*. [2]. Indeed, in this study, the difference between the FT method and the impulse method was higher for the participants who showed a higher difference in sacrum position between takeoff and landing.

In this study, the impulse method also showed significant differences from motion capture data, contrary to the small differences noted by Chiu *et al*. [5]. While the impulse method is generally accurate, errors in body weight measurement can lead to inaccuracies, and explain the discrepancies. On the other hand, it could be that the marker placed on the sacrum is not an accurate representation of COM height during the jump.

4 CONCLUSIONS

The results indicate that the different methods produce significant variations, which can affect the accuracy of the assessment. Time of flight can be more feasible in the field, as it only requires a contact mat to perform the assessment, but the impulse method provides greater accuracy. Because this study involved a small sample size, and a specific sample, these results should not be generalized for other contexts. However, sports professionals should be aware of these differences when assessing performance and prescribing training.

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