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DIFFERENCES IN RSI AND PEAK GROUND REACTION FORCE FOR DROP REBOUND JUMPS FROM A HANG AND BOX FOR FEMALE SUBJECTS

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The aim of this study was to examine differences between drop jump rebound from a box (DJB) and hanging position (DJH). The volunteers were 14 college aged women who were healthy and physically active. Jumps were assessed from a 30 cm drop onto a force platform. Jump height, contact time, reactive strength index, and peak vertical ground reaction force were compared for the two jumps using a Paired T-test. There were no significant differences in peak ground reaction force or jump height between the DJB and DJH ($p > 0.05$). Contact time was found to be less ($p = 0.033$) and RSI higher ($p = 0.012$) for the DJB. Thus, the DJB would be recommended for power training over the DJH. The results of the current study may aid coaches to prescribe the optimal drop rebound jump position for the training of their athletes.

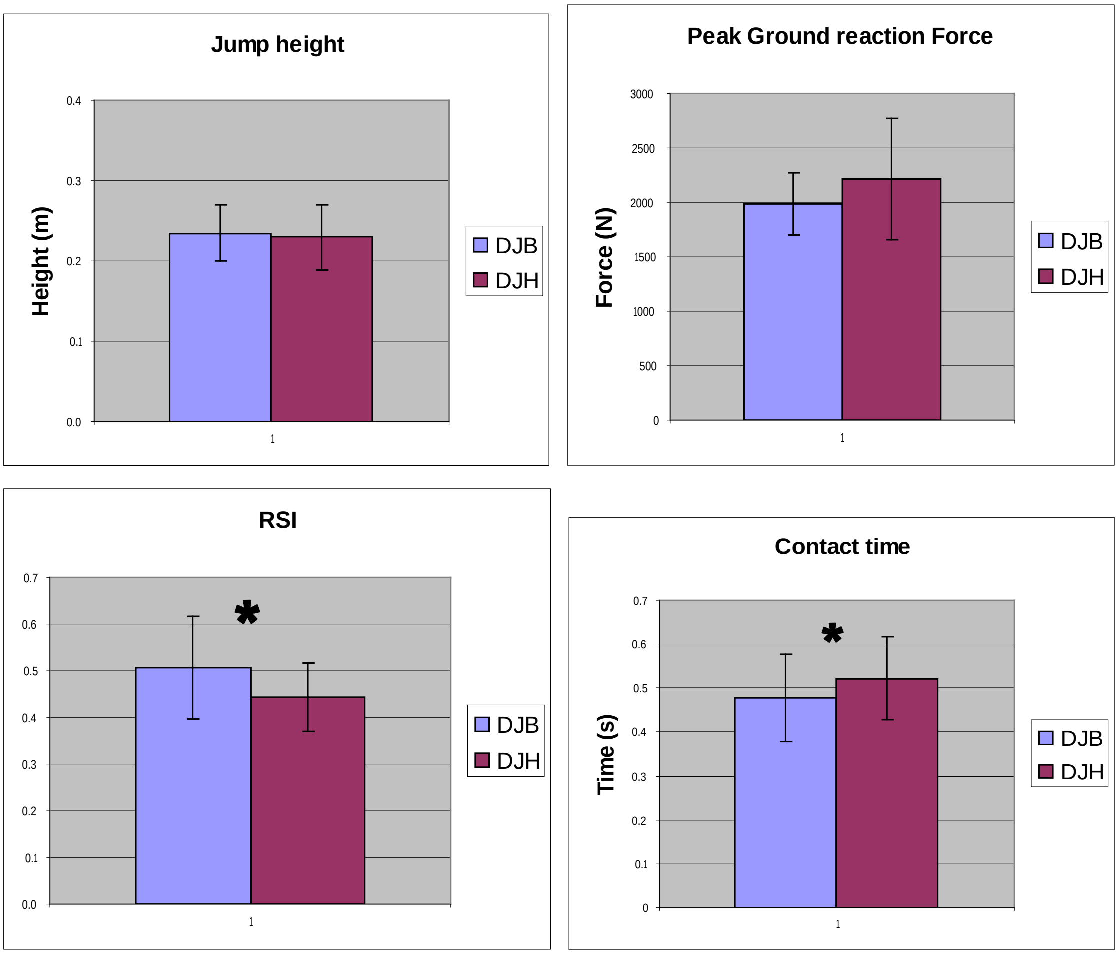
KEYWORDS: plyometrics, stretch shorten cycle, reactive strength index, contact time

INTRODUCTION: Plyometrics is a common training method used to increase power and jumping performance (Ebben, 2010). Rebound jumps initiated with a drop from a box are commonly used for training and assessment of plyometric performance. However, the drop from a box often may involve a hop/shuffle forward off the box, thus altering the actual drop position to the landing surface. A drop that takes place while hanging from a support would eliminate the hop/shuffle and any associated horizontal impact. Difference in jump height and ground reaction forces have been previously investigated during loaded and unloaded drop jumps (Tsarouchas 1994). Thus, this study will investigate the differences between drop jump rebound from a box (DJB) and drop jump rebound from a hang (DJH). Differences in jump height, contact time and thus reactive strength index (RSI) and vertical peak ground reaction forces (VGRF) during take off will be compared between the two jump positions. Anecdotally the hypothesis would be that jump height may be greater for the drop from hang as the efforts may be more easily focused up and not slightly forward.

METHODS: Fourteen female volunteers (Mean ± SD; age = 20.00 ± 3.00 years; height = 1.73 ± 0.89m; body mass = 68.60 ± 10.40kg.) were recruited on a voluntary basis from a variety of sporting backgrounds. All were physically active (trained 3+ days a week) with no lower limb injuries in the previous six months, while experience of plyometric training was varied. Each signed an informed consent form and filled out a readiness for physical activity questioner. Ethic approval was granted by the university Human Subject's Research Review Committee (#HS10-321).
The volunteers abstained from intense training and resistance training for the previous 24 hours. They underwent a warm up on a cycle ergometer for 5 minutes at 60 rpm, which is equivalent to 90 watts. Dynamic stretching and squat jumps were performed followed by four familiarization drop rebound jumps from a 30cm box and four from a 30cm hanging position. A 5 minute rest was taken before measurement of the jumps. Volunteers performed three maximal DJB and DJH both from 30cm in random order. The hands were placed on the head to prevent arm swing after the release from the hanging and box positions. Instructions for the jumps were to jump as fast and as high as possible to ensure the highest RSI (Young et al, 1995).
Jumps were recorded on a force plate (OR6-5-2000, AMTI, Watertown, MA, USA) sampling at 1000Hz. Jump height was calculated using the time in air method (Komi & Bosco, 1978) that assumes the centre of mass was at the same height at take off as at

landing. This assumption seems safe to use as error was calculated to be less than 3% by Frick et al (1991).
Statistical analysis was done using a paired two tailed T-test on Microsoft Excel. The jumps using the highest RSI were considered the best performance and were the ones analysed for all dependent variables. The alpha level selected was $p \leq 0.05$.

RESULTS: T-test revealed no significant difference in VGRF between the DJH (2208 ± 558N) and DJB (1988.7 ± 282.3N) (p=0.18). There was also no significant difference found for height jumped (p=0.36) with mean height for DJH and DJB being 0.229 ± 0.041m and 0.234 ± 0.035m respectively. Significant differences were found for contact time for DJH 0.522 ± 0.095s to 0.477 ± 0.100s for DJB (p=0.03). RSI also differed between DJH and DJB (p=0.01) with means and SDs of 0.44 ± 0.07 and 0.51 ± 0.11 respectively. These are represented in graphic from as seen in Figure1.



*= Statistical significant difference p=0.01

*= Statistical significant difference p=0.03

Figure 1. Means for the jump height, VGRF, RSI, and contact time of the best jump for each subject. (n=14).

DISCUSSION: The major findings of this study reveal no significant difference between DJH and DJB for either height or VGRF. The fact that the jump height is the same for either drop jump position suggests they could be used interchangeably when training for or assessment of jump height. Because training specificity is important, in activities such as blocking in basketball/volleyball where height is most important, training with either type of drop jump would suffice.
With regards to training the stretch shortening cycle both types of rebound jumps were found to be slow stretch shortening cycle jumps as the contact time was >0.25s as noted

by Schmidtbleicher (1992). So unless attempting to improve rate of force development or reducing contact time then the use of either would suffice.
Use of RSI is agreed to be a better measure of power than height jumped alone (Komi, 2000; McClymont, 2007; Schmidtbleicher & Komi, 1992). As the RSI was significantly higher for the DJB than DJH it is a more powerful movement. In addition, Young (1995) suggested that DJB is a valuable performance measure and included it on the list of Strength Qualities Assessment Test battery. The fact that a drop jump causes the athlete to have to absorb their momentum first and then jump makes it a reactive type strength. Training to reduce contact time/increase tendon stiffness, e.g. for sprinters where running velocity is key, may be optimized by using the DJB (Harrison et al., 2004; Comyns et al., 2007).
In the current study, only verbal instruction followed by a demonstration was given, thus a lack of feedback may not have yielded a true maximum performance for the individual jumps. Young et al (1995) gave visual feedback on contact time and height jumped after each jump in addition to verbal instructions and found that the combined feedback resulted in better RSI compared to each feedback strategy separately.
Also the fact that arm swing was not allowed and hands were placed on the head may have lowered the outcome performance scores. Previous studies have shown that arm swing augments jump performance (Harrison & Maroney, 2007; Walsh et al., 2004). Because the current technique (keeping the hands on the head) was not regularly used by the subjects in typical jump performance, it may have affected the outcome as well. Nevertheless, this technique was used to allow the two jumps to be similar in arm use and centre of mass throughout the jump.

CONCLUSION: Both jump techniques yielded similar jump height and VGRF, however the DJB demonstrated significantly higher RSI and lower contact time. However, DJH required more time for set up and unique equipment (elevated hanging bar). In addition, because the DJB exhibited a higher RSI and lower contact times it would be optimal for power training, compared to the DJH. The DJH may ensure that the impact will be straight down and it may add variety to the training. In the field, very few if any sports require absorbing a force straight down, an example might be blocking in volleyball or rebounds in basketball; most other sports will have a horizontal aspect e.g. even a high jump take off has horizontal velocity. In conclusion, DJB seems to be a more practical and a more appropriate drop jump position.

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