RELIABILITY OF COUNTERMOVEMENT JUMP PERFORMANCE ON CHRONOJUMP-BOSCOSYSTEM IN MALE AND FEMALE ATHLETES

Jeffrey C. Pagaduan[1] & Xavier De Blas[2]
[1]*College of Human Kinetics, University of the Philippines – Diliman*
[2]*Facultat de Psicologia, Cičncies de l'Educació i de l'Esport Blanquerna, Universitat Ramon*

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Abstract
The countermovement jump protocol is a common test for measuring leg power. In the recent decade, open source technology has been introduced to measure performance. The purpose of this study was to establish the relative and absolute reliability of the hands-on-waist countermovement jump protocol (CMJ) using the Chronojump-Boscosystem. 11 male (age, 31.0 ± 5.97 years; height, 174.3 ± 5.17 cm; body mass, 77.5 ± 8.3 kg; percentage body fat (%BF), 12.4 ± 2.42) and 9 female (age: 27.1 ± 3.17 years; height, 162.9 ± 3.25; body mass: 67.1 ± 6.15; %BF, 28.6 ± 4.56) national dragonboat athletes from the Philippines participated in the study. They performed two CMJ trials for two sessions separated by 7 days. Intraclass correlation coefficient with 95% confidence interval displayed as ICC (95% CI), standard error of measurement (SEM), minimal detectable change at 95% confidence interval ($MDC_{95\%}$) and smallest worthwhile change (SWC) were utilized in the study. Data revealed that males demonstrated ICC (95% CI) = 0.86 (0.54 – 0.96), SEM = 1.72, $MDC_{95\%}$ = 4.77, and SWC = 0.92. On the other hand, females showed ICC (95% CI) = 0.93 (0.74 – 0.99), SEM = 0.69, $MDC_{95\%}$ = 1.91, SWC = 0.52. In conclusion, CMJ performance on the Chronojump-Boscoystem displayed moderate relative reliability for males and high relative reliability for females. Absolute reliabilities of the CMJ performance were marginal for both groups.

Keywords: *countermovement jump, open source technology, Chronojump-Boscosystem*

INTRODUCTION

The countermovement jump is a common test for measuring jump performance which requires lower loading ground reaction forces and lower loading rates in the lower extremities (Wu, Chang, Liu, & Wang, 2010). The hands-on-waist countermovement jump (CMJ) is one variation of the countermovement jump protocols. It reduces the lower extremity stretch shortening cycle (SSC) capability contributed by armswing, thereby being more reflective of leg performance (Hara, Shibayama, Takeshita, Hay, & Fukashiro, 2008). Equipment using electronic mat system have been developed to acquire jump height values from CMJ performance (Bosco, Luthanen, & Komi, 1983). Contact mat system estimates lower body performance from flight time which is initiated from liftoff and deactivated from landing. Studies establishing the reliability of contact mat technologies are presented. For example, Miller and Callister (2009) tested the reliability of CMJ on male and female participants using a contact platform and found out an intraclass correlation coefficients (ICC) of 0.98. In another study, Slinde, Suber, Suber, Edwén, and Svantesson, (2008) found out that the reliability of CMJ performance on a contact platform of males and females was ICC = 0.80 and ICC = 0.88 respectively. Moir,

Button, Glaister, and Stone (2004) observed an ICC of 0.93 among male recreational athletes who performed CMJ. Markovic, Dizdar, Jukic, and Cardinale, (2004) also identified the reliability of CMJ on a contact mat system and reported an ICC = 0.98.

In the recent decade, open source technology in quantifying human performance in sports has been introduced. An open source technology provides accessibility to technology design and allows the end user to distribute the technology to other people (González, González, & Gómez-Arribas, 2003). One open source technology that can measure CMJ performance using contact mat system is the Chronojump-Boscosystem (De Blas, Padullés, López del Amo, & Guerra-Balic, 2012). The Chronojump-Boscosystem consists of a free software which can be downloaded on the internet, an open hardware, and a contact time mechanism. In measuring vertical jump values, Chronojump-Boscosystem use the kinematic equation proposed by Newton. The introduction of this technology provided greater opportunity to coaches, sports science practitioners and students for monitoring performance. The purpose of this study was to determine the relative and absolute reliability of a countermovement jump protocol using the Chronojump-Boscosystem on male and female national athletes.

METHODS

Participants

Participants of the study were 11 male (age, 31.0 ± 5.97 years; height, 174.3 ± 5.17 cm; body mass, 77.5 ± 8.3 kg; %BF, 12.4 ± 2.42) and 9 female (age: 27.1 ± 3.17 years; height, 162.9 ± 3.25; body mass: 67.1 ± 6.15; %BF, 28.6 ± 4.56) national dragonboat athletes from the Philippines. The athletes were asked to refrain from any strenuous activity 24 hours before experimentation. No dietary recommendation was administered to the athletes. Informed consent was requested from the athletes prior to further experimentation. The procedures of the experimentation followed the Declaration of Helsinki Ethical Guidelines for human studies.

Procedures

Experimentation occurred for 2 sessions administered at the field located at Rizal Memorial Stadium during the regular morning training sessions (0600 – 0800 AM). Inter-session rest interval was set at 7 days. On day 1, the athletes performed a standardised warm-up which consisted of a light intensity jogging (rate of perceived exertion < 11) for 5 minutes followed by 4 dynamic-static stretching exercises for the lower body (Borg, 1982). The dynamic-static exercises were performed for two sets involving 5 repetitions per limb. The dynamic-static exercises included the: 1. lunge and reach; 2. reverse lunge and twist; 3. front leg swing to leg crossover; and, 4. knee hug to quadstretch. A dynamic-static stretch involves completing a movement task following a 1 second pause at the end of the movement. After the warm-up, athletes rested for two minutes. This was succeeded two trials of CMJ performance. Each trial was separated by a 10-15 second interval. In CMJ, the athletes began in an upright position with their hands on the waist. Upon hearing the 'as you go' signal from the tester, the athletes explosively perform a countermovement jump as high as possible while maintaining the position of the arms on the waist all throughout the jump. A trial is considered valid if full hip, knee and plantar flexion are observed at the peak of the jump. The athletes should be able to maintain this position until landing. During landing, the toes should land softly on the contact mats while absorbing the jump right by hip and knee flexion right after the foot contact. Additional trials were requested if the tester evaluated faulty jump execution from the athletes or technical error was observed. On day 2, the same warm-up and CMJ jump trials were executed. The average CMJ scores for both sessions were recorded for further analysis. CMJ trials were performed with the athletes positioned on two parallel home-made contact platforms (30.5 x 30.5 cm) attached to a hardware (Chronopic 3, Chronojump Boscosystem, Spain). The hardware is connected to a computer which displays the vertical jump values (cm) from a free software (Chronojump Boscosystem Software, Spain).

Statistical Analyses

Measures of central tendency and spread of the data were displayed as means and standard deviations. Kolmogorov-Smirnov test was utilized to determine the normality of data. Relative reliability was computed using the intraclass correlation coefficient (ICC) from two-way random effects and absolute agreement definition. 95% confidence intervals for ICC values were also identified. An ICC of above .90 is considered high, while between .80 and .90 is moderate and below .80 is regarded as low (Vincent, 1995). Absolute reliability was identified using the standard error of measurement (SEM) calculated at SD $\sqrt{1\text{-ICC}}$ (Weir, 2005). SEM allowed the calculation of minimal detectable change ($MDC_{95\%}$) which displayed the 95% confidence interval of the difference in score between paired observations (Haley & Fragala-Pinkham, 2006). $MDC_{95\%}$ was computed using the formula: $MDC_{95\%} = SEM \times \sqrt{2} \times 1.96$. Lastly, smallest worthwhile change (SWC) was calculated as .2 x between-subject standard deviation of CMJ Test. Researchers suggested that a test is rated as "good" is SEM is lower than SWC (Impellizzeri, & Marcora, 2009; Pyne, 2003). If SEM is greater than SWC, the test is considered as "marginal". When SEM is the same as SWC, the test is viewed as "satisfactory". Lastly, percentage of the coefficient of variation was measured using the standard deviation divided by the mean multiplied by 100. Analyses were performed using a commercial statistical software (SPSS for Windows, ver 18.0, SPSS Inc., Chicago, Il). Significance was set at .05 level.

RESULTS

The CMJ measures in the study showed normal distribution as confirmed by the Kolmogorov-Smirnov Test. Table 1 displays the mean and standard deviation of CMJ performance in both sessions, ICC, SEM, $MDC_{95\%}$ and SWC. For males, CMJ performance demonstrated the following measures: ICC (95% CI) = 0.86 (0.54 – 0.96); SEM

= 1.72; $MDC_{95\%}$ = 4.77, and SWC = 0.92. For females, ICC (95% CI) was 0.93 (0.74 – 0.99), SEM = 0.69, $MDC_{95\%}$ = 1.91, and SWC = 0.52.

Table 1. Mean and Standad Deviations of CMJ Performance, ICC, SEM, $MDC_{95\%}$, and SWC of Athletes

Athletes	Mean ± SD (cm)					
	Session 1	Session 2	ICC (95% CI)	SEM	$MDC_{95\%}$	SWC
Males	40.7 ± 1.1	40.9 ± 4.2	0.86 (.54 - .96)	1.72	4.77	0.92
Females	27.5 ± 0.9	27.6 ± 2.6	0.93 (.74 - .99)	0.69	1.91	0.52

DISCUSSION

The purpose of this study was to determine the reliability of the hands-on-waist countermovement jump performance using the Chronojump-Boscosystem in male and female national dragonboat athletes in the Philippines. Researchers recommend the use of ICC and SEM to identify relative and absolute reliability respectively (Atkinson, G., & Neville, 1998; Chinn, 1991; Weir, 2005). In this study, the relative reliability values for males and females were moderate and high respectively. These results were consistent with the ICC findings in CMJ performance using contact mat mechanism (Markovic, et al., 2004; Miller & Callister, 2009; Moir et al., 2004; Slinde et al., 2008). On the other hand, the absolute reliabilities as measured by SEM in both groups were “marginal”. Other findings include the $MDC_{95\%}$ for male athletes which indicates that 95% of the outcomes of the CMJ performance will demonstrate a random variation as a result of measurement error of less than 4.77 cm for the CMJ performance. The $MDC_{95\%}$ for female athletes shows that 95% of the outcomes of the CMJ performance will post a random variation as a result of measurement error of less than 1.91 cm for the CMJ performance.

Although favorable relative reliability values of CMJ performance in male and female athletes were displayed, marginal absolute reliability values were also discovered. These may be attributed to various sources of errors during experimentation (Rikli, 2000). Future studies addressing mechanisms to reduce errors are warranted. In conclusion the CMJ test using the Chronojump-Boscosystem displayed moderate relative reliability for males and high relative reliability for females. Also, absolute reliabilities were found to be marginal for both groups.

REFERENCES

1. Atkinson, G., & Nevill, A.M. (1998). Statistical methods for assessing measurement error (reliability) in variables relevant to sports medicine. *Sports Medicine, 26*, 217-238.
2. Borg, G.A. (1982). Psychophysical bases of perceived exertion. *Medicine and Science in Sports and Exercise, 14*(5), 377-381.
3. Bosco, C., Luhtanen, P., & Komi, P.V. (1983). A simple method for measurement of mechanical power in jumping. *European Journal of Applied Physiology,50*, 273-282
4. Chinn, S. (1991). Repeatability and method comparison. *Thorax, 46*, 454-456.
5. De Blas, X., Padullés, J. M., López del Amo, J.L., & Guerra-Balic, M. (2012). Creation and validation of Chronojump-Boscosystem: A free tool to measure vertical jumps. *International Journal of Sports Science, 30*(8), 334-356. Retrieved from http://dx.doi.org/10.5232/ricyde2012.03004
6. González, I., González, J., & Gómez-Arribas, F. (2003). *Free Hardware: Classification and development of hardware reconfigurable on GNU/Linux*. VI Hispalinux Congress, Madrid, Spain.
7. Haley, S.M., & Fragala-Pinkham, M.A. (2006). Interpreting change scores of tests and measures used in physical therapy. *Physical Therapy, 86*, 735-743.
8. Hara, M., Shibayama A., Takeshita, D., Hay, D., & Fukashiro, S. (2008). A comparison of the mechanical effect of arm swing and countermovement on the lower extremities in vertical jumping. *Human Movement Science, 27*(4), 636-648.
9. Impellizzeri, F.M., & Marcora, S.M. (2009). Test validation in sport physiology: Lessons learned from Clinimetrics. *International Journal of Sports Physiology and Performance, 4*, 269-277.
10. Markovic, G., Dizdar, D., Jukic, I., & Cardinale, M. (2004). Reliability and factorial validity of squat and

countermovement jump tests. *Journal of Strength and Conditioning Research,18*(3), 551-555.
11. Miller, A., & Callister, R. (2009). Reliable lower limb musculoskeletal profiling using easily operated, portable equipment. *Physical Therapy in Sport,10*(1), 30-37.
12. Moir, G., Button, C., Glaister, M., & Stone, M.H.(2004) Influence of familiarization on the reliability of vertical Jump and acceleration sprinting performance in physically active men. *Journal of Strength and Conditioning Research,18*(2), 276-280.
13. Pyne, D.B. (2003). *Interpreting the results of fitness testing*. International Science and Football Symposium. Victorian Institute of Sport, Melbourne, Victoria, Australia.
14. Rikli, R.E. (2000). Reliability, validity, and methodological issues in assessing physical activity in older adults. *Research Quarterly for Exercise and Sport, 71*(2), 89-96.
15. Slinde, F., Suber, C., Suber, L., Edwén, C., & Svantesson, U. (2008). Test-retest reliability of three different countermovement jump tests. *Journal of Strength and Conditioning Research, 22*(2), 640- 644.
16. Vincent, W.J. (1995). *Statistics in Kinesiology*. Human Kinetics, Champaign, IL.
17. Weir, J.P. (2005). Quantifying test-retest reliability using the intraclass correlation coefficient and SEM. *Journal of Strength and Conditioning Research, 19*(1), 231-240.
18. Wu, H., Chang Y., Liu, C., & Wang, L. (2010). Biomechanical analysis of landing from countermovement jump and vertical jump with run-up in the individuals with functional ankle instability. *International Journal of Sport and Exercise Science, 2*,43-48.

Corresponding author:
Jeffrey C. Pagaduan
College of Human Kinetics,
University of the Philippines – Diliman
Diliman, Quezon City, Philippines 1101
Phone: 63 915 860 8976
E-mail: jcpagaduan@gmail.com

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