Modification of the Standing Long Jump Test Enhances Ability to Predict Anaerobic Performance

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Abstract

Almuzaini, KS and Flect, SJ. Modification of the standing long jump test enhances ability to predict anaerobic performance. *J Strength Cond Res* 22: 1265–1272, 2008–The purpose of this study was to investigate whether modifying the standing long jump test would enhance its ability to be a better predictor of anaerobic performance compared to other common anaerobic power tests. Three modified box long jump (MBLJ) tests were performed using 1, 2, or 3 boxes. Subjects consisted of 38 healthy males (age, 21.7 ± 1.7 years) who performed all the testing procedures. All 3 variations of the MBLJ test showed significant correlations ($p < 0.05$) with the vertical jump (VJ); standing long jump (SLJ); 50-, 100-, 200-, 400-m runs; long jump; triple jump; and shot put ability ($r = 0.362–0.891$). All 3 variations of the MBLJ test also showed significant correlations with isokinetic peak torque knee extension and flexion, Wingate mean power (W), and Wingate mean power per kilogram (W/kg) ($r = 0.357–0.504$). Generally, correlations of the 3 MBLJ tests were stronger than correlations between VJ and SLJ ability to the same measure of power. Generally, the 3-box MBLJ tests showed stronger correlations with measures of power than the 1- and 2-box MBLJ tests. Multiple linear regression models indicated that the 3-box MBLJ test is a major predictor of the track and field performances compared to the other tests of anaerobic power. Along with other independent variables, the 3-box MBLJ test explained 55%, 44%, 51%, 61%, 52%, and 72% of the variance of 50-, 100-, 200-, and 400-m runs; long jump; and triple jump performance, respectively. In conclusion, due to the significant correlations between the MBLJ tests, especially the 3-box version, and other measures of power, these tests are appropriate for testing lower body power.

Key Words anaerobic power, Wingate, vertical jump, standing long jump, peak torque, isokinetic strength

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Introduction

Field- and laboratory-based tests are used to determine and monitor during training power capabilities of both fitness enthusiasts and athletes. Additionally, anecdotal evidence suggests that it is becoming popular to test athletes before a weight training session as an indication of the ability to perform a particular type of session (i.e., strength, power-oriented session) at near-maximum power outputs. When testing athletes when sprint and jumping ability are required for success and to monitor the effects of a training program, very sport-specific tests may be used to determine and monitor power output specific to the tasks performed in the sport in which the athlete competes. For fitness enthusiasts, more general nonsport-specific tasks may be tested. In all the above testing situations, a test that correlated significantly with a wide variety of other power-oriented tests would be of value because using such a test gives a more total evaluation of fitness than a test that correlated to only a few other fitness parameters. Additionally, a test that is of short duration and none fatiguing would also be desirable, especially when testing before or during any type of training session because such a test would minimally interfere with performance of the training program.

Countermovement vertical jump tests have been used as field tests for testing athletes and fitness enthusiasts. These tests have been used because they are easy to administer, require little equipment, and have shown significant correlations with other power-oriented tasks. Countermovement jump performance has shown significant correlations with maximal sprint speed (20), maximal sprint speed between 15 and 30 m of a 30-m sprint (15), and time to sprint 30, 100, and 300 m (11). Short running sprints have also been used to test general fitness as well as sport-specific running speed. In addition to the correlations with countermovement jump ability, time to perform a short sprint (100 m) has shown significant correlations with maximal power and total work during a 30-second Wingate test (16). Thus, short running sprint ability has shown significant correlations with a field-based test (i.e., vertical jump ability) and laboratory-based test (i.e., Wingate test).

Tests to determine vertical jump and short running sprint ability are perhaps the most popular tests used to evaluate lower body power. Horizontal jumping ability, such as the standing long jump, although similar in terms of ease of administration and equipment required anecdotally appears to be a less popular testing modality. Standing long jump ability has, however, shown significant correlations with ski jump distance while countermovement vertical jump ability has shown nonsignificant correlations with ski jump distance (10). Indicating that horizontal jumping ability may be a better modality than vertical jump ability when training for and tracking training progress for some types of power-oriented athletic performances.

Although both maximal vertical and horizontal jump tests share the characteristics of ease of administration, are generally nonfatiguing, and have shown correlations with other power-oriented tests, there is evidence that horizontal jumping ability does show stronger correlations with some types of power-oriented activities. Therefore, the purpose of the present study was to investigate whether modifications of the standing long jump test would be a better predictor of anaerobic performance compared to other common anaerobic power tests. Correlations of performance in 3 modifications of the standing long jump test with other common tests of power were examined. The 3 modified long jump tests were performed by stepping off 1 box and immediately performing a long jump upon hitting the ground, after stepping off 1 box immediately jumping up onto a second box, stepping off this box and performing a long jump, and performing a long jump in the same manner as described for performing the test with 2 boxes except a third box was added. It was hypothesized that performance in the modified long jump tests would show stronger correlations than vertical jump and standing long jump ability to other power-oriented field- (i.e., short sprints, shot put, long jump, triple jump) and laboratory-based tests (i.e., Wingate test, isokinetic torque).

Methods

Experimental Approach to the Problem

All tests were preceded by a standardized intermittent warm-up, test instructions, and equipment familiarization. Verbal encouragement was standardized for all tests and subjects. During the first testing session, each subject performed a series of tests starting with anthropometric measurements. Then the subject performed a vertical jump test and isokinetic strength measurements. The subject then rested for at least 30 minutes before performing the Wingate anaerobic power test. The following week, the subjects performed track and field tests. The track tests (50-, 100-, 200-, and 400-m runs) were performed first with the 50- and 400-m test performed on 1 day followed by the 100 and 200 m on the following day. The field tests (shot put, long jump, triple jump) were performed 2 days after the second day of track tests. The track and field testing followed the competition rules of the International Association of Athletics Federations (IAAF) (13). After the field tests and on a separate day, subjects performed a standing long jump test and the 3 forms of the modified long jump, which consisted of performing a long jump after dropping to the floor from 1 box, after dropping from 1 box jumping onto a second box, dropping to the floor and performing a long jump, and performing a long jump in the same manner as described for performing the test with 2 boxes except a third box was added. Pearson correlation coefficients and stepwise multiple linear regression analyses were then performed to determine possible associations between performance of the modified long jump tests and the other power tests performed.

Subjects

Thirty-eight physical education students volunteered to participate in this study. The physical characteristics of the subjects are presented in Table 1. All subjects were healthy and had no history of musculoskeletal disease or knee joint surgery. The project was approved by an institutional review board, and all subjects were informed about the nature of the project before obtaining their written consent to participate in the project.

Anthropometric Measurements

Body weight (kg) and height (cm) were measured using a digital scale calibrated against known weights to ensure its validity and reliability. Subscapular, triceps, thigh, and calf skinfolds were measured on the right side of the subject using a Harpenden caliper (British Indicators Ltd., London, England). All measurements were obtained according to previously described procedures (8) and used to calculate the percentage of body fat (4).

Vertical Jump

Vertical jump height was determined in the laboratory using a measuring board (Taki & Company, Ltd., Japan). Subjects performed the vertical jump according to previously described procedures (1). The subjects were given 3 trials, and the best value (in centimeters) of the 3 jumps was used as the test score for statistical analysis. The test-retest reliability of this test have been reported to be high ($r = 0.93$) when using the technique described above (1).

Isokinetic Strength Measurements

In preparation for the test, subjects performed a standardized warm-up that consisted of 2 minutes of pedaling (50 rpm at 50 W) on a cycle ergometer (model 824 E, Monark, Varberg, Sweden). Then the subject stretched the quadriceps (grasping the foot and pulling the heel toward the buttocks) and hamstring (seated toe touch). Using an isokinetic dynamometer (Cybex Norm, CYBEX International, Inc., Ronkonkoma, NY), knee extensor and flexor peak torque in newton-meters (Nm) (the highest torque value recorded at any point in the range of motion) was recorded at angular velocities of 60, 180, and $300°\cdot s^{-1}$ during maximal knee extension and flexion concentric muscle actions for the dominant leg (the preferred

Table 1. Descriptive statistics of the healthy physical education major subjects ($N = 38$).

Variable	Mean ± *SD*
Age (y)	21.66 ± 1.66
Height (cm)	169.89 ± 6.34
Body mass (kg)	62.92 ± 8.68
% Body fat	17.06 ± 6.26
VJ (cm)	51.84 ± 6.68
PT KF 60°·s^{-1} (Nm)	90.42 ± 19.43
PT KF 180°·s^{-1} (Nm)	71.13 ± 18.17
PT KF 300°·s^{-1} (Nm)	49.58 ± 15.96
PT KE 60°·s^{-1} (Nm)	159.05 ± 33.71
PT KE 180°·s^{-1} (Nm)	113.92 ± 22.12
PT KE 300°·s^{-1} (Nm)	80.87 ± 16.31
Wingate 5 s PP (W)	556.71 ± 110.17
Wingate 5 s PP per kg (W·kg^{-1})	8.92 ± 1.50
Wingate MP (W)	407.42 ± 70.41
Wingate MP/kg (W·kg^{-1})	6.53 ± 0.93
50 m (s)	7.12 ± 0.41
100 m (s)	13.54 ± 0.83
200 m (s)	28.81 ± 1.93
400 m (s)	72.86 ± 7.50
LJ (m)	4.17 ± 0.40
TJ (m)	9.03 ± 0.63
SP (m)	9.43 ± 1.40
SLJ (cm)	213.70 ± 19.19
Modified 1-box jump (cm)	210.08 ± 22.02
Modified 2-box jump (cm)	209.62 ± 23.15
Modified 3-box jump (cm)	213.47 ± 22.73
Total distance modified 3-box jump (cm)	316.07 ± 40.32
Time modified 3-box jump (s)	3.61 ± 0.34

VJ = vertical jump; PT KF = peak torque knee flexion; PT KE = peak torque knee extension; PP = peak power; MP = mean power; LJ = long jump; TJ = triple jump; SP = shot put; SLJ = standing long jump.

kicking leg). Gravity correction for knee extension and flexion was performed as described by the manufacturer before testing. Testing of maximal knee extension and flexion concentric peak torque was done in a seated position following the procedures recommended by the manufacturer (9). The test procedure consisted of 4 consecutive maximal extension-flexion repetitions at each velocity, performed with a 1-minute rest between velocities. The highest torque at each velocity was recorded. The order of trial velocities was randomized in a counterbalanced manner. The subjects were verbally encouraged to produce maximal effort during all test velocities. After testing, the subjects completed a 2-minute standardized cool-down period on the same cycle ergometer used during the warm-up. The test-retest reliability of isokinetic dynamometry has generally been reported to be high with correlation coefficients ranging from 0.93 to 0.99 (6).

Wingate Test

In preparation for the test, each subject performed a warm-up that consisted of 3 minutes (50 rpm at 50 W) of pedaling a cycle ergometer (model 824 E, Monark) interspersed with 2 all-out sprints, each lasting 5 seconds performed during the second and third minutes of the warm-up. The subject then rested for 5 minutes. Before the start of the test, the seat was adjusted according to the leg length of each subject so that with the midfoot in contact with the pedal, there was a slight knee bend. Toe clips were used during the warm-up and testing procedures. All subjects were given standardized instructions to pedal as fast as possible from the beginning of the test and to maintain the maximum rpm throughout the 30-second period. On the command "start," subjects pedaled as fast as possible against only the resistance of the weight basket until they reached their maximum rpm (approximately 3–4 seconds) at which time the test resistance was applied. This was done to overcome the inertial and frictional resistance of the flywheel and to shorten the acceleration phase once the resistance used during the test was applied. The test resistance was 0.075 kp·kg^{-1} body mass (12). Pedal revolution during the 30-second test were sensed by photoelectric cells interfaced with a computer and used in conjunction with the test resistance to calculate peak and mean power using standard software (Sp-6 Wingate Power Testing Software; Cranlea & Co., Birmingham, UK). Verbal encouragement was given during all tests. Following the test, a cool-down was performed consisting of pedaling for 2 minutes against a light resistance. Peak power (PP) was considered to be the highest mechanical power produced during any 5-second period, and mean power (MP) was defined as the average power sustained throughout the 30-second period. The test-retest reliability of this test is reported to have correlation coefficients ranging between 0.89 and 0.98 (12).

Track and Field Tests

Facilities meeting IAAF specifications were used when testing subjects in the 50-, 100-, 200-, and 400-m runs; shot put; long jump; and triple jump. All track and field tests were performed following the IAAF (13) competition rules with a standardized warm-up consisting of stretching and running. The track tests were performed on 2 consecutive days with the 50- and 400-m runs performed on the first day and the 100- and 200-m runs on the second day. Track tests performed on the same day were separated by at least 1 hour and timed with a stopwatch. Reliability of hand timing of short sprints (40 yd, 36.6 m) has been shown to be high with correlation coefficients ranging between 0.92 and 0.97 (17). One trial of each track test was performed. The field tests were performed 2 days after the second day of track tests. The order of the field tests was shot put (4-kg shot), long jump, and triple jump with at least 30 minutes of rest between tests. Each subject was given 3 trials in each of the field tests, and the best value was used as the test score.

Standing Long Jump

All subjects were instructed to perform a long jump from a standing position. Standardized instructions were given to subjects that permitted them to begin the jump with bent knees and swing their arms to assist in the jump. A line drawn on a hard surface served as the starting line. The length of the jump was determined using a tape measure, which was affixed to the floor. Each subject was given 3 trials, and the distance of the best jump was measured, to the nearest 1 cm, from the line to the point where the heel closest to the starting line landed. If the subject fell backward, the distance where the body part closest to the starting line touched the ground was measured as the jump's length. Each subject performed 3 jumps, whether or not a subject fell backward during an attempt. The longest jump was used as the test score.

Modified Long Jump

Subjects were instructed to perform a modified long jump in 3 ways: stepping off 1 box and immediately performing a long jump upon hitting the ground, after stepping off 1 box immediately jumping up onto a second box, stepping off of this box and performing a long jump, and performing a long jump in the same manner as described for performing the test with 2 boxes except a third box was added. The height of the box was chosen using previously described procedures (7) to perform a pilot study in which subjects (5 subjects selected from the subject pool: age, 21.4 years; height, 169.8 cm; and weight, 64.9 kg) performed a vertical jump after dropping from different box heights. The box height that elicited the highest vertical jump height was 50 cm, which was the height chosen for all boxes used in the modified long jump tests. The length and width of the boxes were 50 and 60 cm, respectively. The test order of the modified long jump tests progressed from the 1-, 2- and 3-box modified long jump tests. A 10-minute rest was allowed between trials of each of the modified long jump tests and at least a 30-minute rest was allowed between the 1-, 2- and 3-box jump tests. Before performing each test, the subject stood in a chalk box. The subject then stood on a box with feet close together and his toes at the edge of the box; the subject then stepped off the box, landed on both feet, and performed a long jump. The length of the jump was determined using a tape measure to determine the distance from the heel closest to the front edge of the box upon landing (as indicated by the powder mark). Each subject performed 3 trials of the 1-box modified long jump.

The subject then performed 3 trials of the 2-box modified long jump test. For this test, a second box was aligned with the first box with 90-cm distance between the 2 boxes. The only difference between the 2-box modified long jump and the 1-box modified long jump was that the subject dropped from the first box and immediately (no rest) jumped, with both feet, onto the second box, immediately stepped off the second box (no rest), and performed a maximal distance long jump. For the 3-box modified long jump, 3 boxes were aligned with a 90-cm distance between the boxes. For the 3-box modified long jump, the subject dropped from the first box and immediately jumped, with both feet, on to the second box, dropped from it, and jumped, with both feet, onto the third box and immediately dropped and performed a long jump. Three trials of the 3-box modified long jump test were performed. The distance jumped in the 2- and 3-box modified long jump was determined in the same manner as described for the 1-box modified long jump test. In the 3-box modified long jump, in addition to the distance of the final long jump, the distance from the front edge of the first box to the heel mark of the long jump was also measured in centimeters. In the 3-box modified long jump test, the time it took the subject to perform the entire test was recorded to the nearest 0.01 second using a stop watch as the time from leaving the first box to the landing of the long jump.

Reliability Study

Twenty-five of the subjects in the present study participated in determining the test-retest reliability of the standard standing long jump and the 3-box jump test. The 2 trials of each test were administered 2 days apart. Results of intraclass correlation coefficient (ICC) indicated that distance jumped for both the standard standing long jump (ICC = 0.97) and the 3-box jump test (ICC = 0.92) were reliable.

Statistical Analyses

An SPSS statistical package (Version 13) was used to analyze the data. Descriptive statistics were computed for subjects. Pearson correlation coefficients were calculated to evaluate the correlations among variables tested in the present study. Stepwise multiple linear regression analysis models were used to assess how well the dependent variables (50-, 100-, 200-, and 400-m runs; long jump; triple jump; and shot put) could be explained by the values of the independent variables (skinfolds, modified box jump tests, isokinetic tests, Wingate test). The level of significance was set at $p \leq 0.05$.

Results

Descriptive characteristics (age, height, body mass, and percentage of body fat) of the subjects and performance measures in all tests including the modified box jump tests are given in Table 1. Significant correlations were shown between performance of all 3 modified box jump tests including total distance and total time for the modified 3-box jump test between vertical jump and standing long jump performance (Table 2). The distance jumped in the modified 1-box jump (4 of 6 correlations), 2-box jump (5 of 6 correlations), and 3-box jump tests (5 of 6 correlations) showed significant correlations with peak torque of knee flexion and extension at the velocities tested. Total distance (5 of 6 correlations) in the modified 3-box jump test also showed significant correlations with peak torque during knee extension and flexion.

Five-second peak power during the Wingate test showed significant correlations with the distance jumped in the modified 2- and 3-box jump tests as well as total distance in the modified 3-box jump test (Table 2), while 5-second peak power relative to body mass only demonstrated a significant correlation with performance of the modified 2-box jump test. Wingate mean power and mean power relative to body

Table 2. Correlation matrix for modified box jump, vertical jump, standing long jump, isokinetic, and Wingate tests.

	VJ (cm)	SLJ (cm)	PT KF $60°\cdot s^{-1}$ (Nm)	PT KF $180°\cdot s^{-1}$ (Nm)	PT KF $300°\cdot s^{-1}$ (Nm)	PT KE $60°\cdot s^{-1}$ (Nm)	PT KE $180°\cdot s^{-1}$ (Nm)	PT KE $300°\cdot s^{-1}$ (Nm)	Wingate 5 s PP (W)	Wingate 5 s PP/kg ($W\cdot kg^{-1}$)	Wingate MP (W)	Wingate MP/kg ($W\cdot kg^{-1}$)
Modified 1-box jump (cm)	0.642*	0.891*	0.300*†	0.213	0.105	0.463*	0.390*	0.388*	0.250	0.187	0.402*	0.371†
Modified 2-box jump (cm)	0.580*	0.865*	0.357*	0.277†	0.193	0.498*	0.418*	0.439*	0.309†	0.292†	0.417*	0.426*
Modified 3-box jump (cm)	0.623*	0.857*	0.377*	0.271†	0.190	0.504*	0.4398	0.445*	0.300†	0.266	0.466*	0.470*
Total distance modified 3-box jump (cm)	0.385*	0.557*	0.335†	0.259	0.315†	0.354†	0.326†	0.321†	0.338†	0.170	0.426*	0.258
Time modified 3-box jump (s)	−0.369†	0.335†	−0.113	−0.039	0.171	−0.221	−0.264	−0.164	−0.131	0.007	−0.295†	−0.186
SLJ	0.691*	1.00	0.356†	0.250	0.130	0.503*	0.460*	0.440*	0.334†	0.235	0.499*	0.433*
VJ	1.00	0.691*	−0.056	0.001	−0.059	0.363†	0.333†	0.221	0.069	0.073	0.351†	0.429*

VJ = vertical jump, SLJ = standing long jump; PT KF = peak torque knee flexion; PT KE = peak torque knee extension; PP = peak power; MP = mean power.
*Significant correlation at the 0.01 level (1 tailed).
†Significant correlation at the 0.05 level (1 tailed).

mass demonstrated significant correlations with distance jumped in all 3 modified box jump tests, while only mean power demonstrated significant correlations with total distance jumped and time of the modified 3-box jump test.

The distance jumped in all 3 modified box jump tests demonstrated significant correlations with 50-, 100-, 200-, and 400-m run performance (Table 3). Total distance in the 3-box jump test demonstrated significant correlations with long jump, triple jump, and shot put performance, while time in the modified 3-box jump test demonstrated significant correlations with triple jump and shot put performance.

Both vertical jump and standing long jump performance demonstrated significant correlations with peak torque, Wingate measures, and the majority of track and field tests (Tables 2 and 3). The correlations between the standard jump test (vertical and standing long jump) performances and peak torque and Wingate measures were of the approximate same strength as those shown by the modified box jump performances. However, the correlations between the standard jump tests and the track and field tests were generally lower than the correlations shown between the distances jumped in the 3 modified box jump tests, especially for the modified 3-box jump test.

Stepwise linear regression analysis was performed between the independent variables and the anaerobic track and field performances. These analyses demonstrated the following as the best prediction equations for the track and field performances:

50-m time $= -0.01$(3-box jump distance) + 0.03 (subscapular skinfold) $-$ 0.08 (Wingate absolute PP) + 9.2

$(F_{3,36} = 15.8, p = 0.000, R = 0.77, R^2 = 0.59,$ adjusted $R^2 = 0.55$, and SEE $= 0.27)$.

100-m time $= -0.09$ (calf skinfold) -0.02 (3-box jump distance)+16.03

$(F_{2,36} = 15.3, p = 0.000, R = 0.69, R^2 = 0.47,$ adjusted $R^2 = 0.44$, and SEE $= 0.62)$.

200-m time $= 0.19$ (calf skinfold) -0.03 (3-box jump distance) -0.61 (Wingate absolute MP) + 36.9

$(F_{3,36} = 13.3, p = 0.000, R = 0.74, R^2 = 0.55,$ adjusted $R^2 = 0.51$, and SEE $= 1.36)$.

400-m time $= 1.01$ (subscapular skinfold) -0.14 (3-box jump distance) + 91.4

$(F_{2,36} = 29.2, p = 0.000, R = 0.79, R^2 = 0.63,$ adjusted R2 $= 0.61$, and SEE $= 4.7)$.

Table 3. Correlation matrix for modified box jumps and track and field tests.

	50 m	100 m	200 m	400 m	LJ	TJ	SP
Modified 1-box jump (cm)	−0.532*	0.434*	−0.400*	−0.362†	0.518*	0.595*	0.588*
Modified 2-box jump (cm)	−0.553*	−0.482*	−0.463*	−0.535*	0.617*	0.681*	0.600*
Modified 3-box jump (cm)	−0.559*	−0.509*	−0.521*	−0.496*	0.731*	0.763*	0.713*
Total distance modified 3-box jump (cm)	−0.124	−0.249	−0.142	−0.022	0.564*	0.464†	0.678*
Time modified 3-box jump (s)	0.118	−0.034	0.108	0.134	−0.164	−0.362†	−0.415*
SLJ	−0.450*	−0.422*	−0.374*	−0.353†	0.621*	0.729*	0.721*
VJ	−0.385*	−0.323†	−0.246	−0.320†	0.557*	0.577*	0.530*

LJ = long jump; TJ = triple jump; SP = shot put; SLJ = standing long jump; VJ = vertical jump.
*Significant correlation at the 0.01 level (1 tailed).
†Significant correlation at the 0.05 level (1 tailed).

Long jump distance = 0.012 (3-box jump distance) + 1.68

$(F_{1,26} = 28.7, p = 0.000, R = 0.73, R^2 = 0.54,$ adjusted $R^2 = 0.52$, and SEE = 0.28).

Triple jump distance = 0.02 (3-box jump distance) + 0.2 (Wingate absolute MP) + 0.03 (height) − 0.3

$(F_{3,23} = 21.1,\ p = 0.000,\ R = 0.87, R^2 = 0.76,$ adjusted $R^2 = 0.72$, and SEE = 0.33).

Shot put distance = 0.05 (standing long jump) + 0.05 (body mass) − 3.3

$(F_{2,25} = 20.4, p = 0.000, R = 0.80, R^2 = 0.64,$ adjusted $R^2 = 0.61$, and SEE = 0.88).

The multiple linear regression models indicate the 3-box jump test is a major predictor of the track and field performance compared to the other tests of anaerobic power used in the present study. The only track and field test where the 3-box jump test was not indicated as a major predictor was the shot put, for which the standing long jump was indicated as a major predictor of performance. Along with other independent variables as indicated in the equations, the 3-box jump test could explain 55%, 44%, 51%, 61%, 52%, and 72% of the variance of the performance in the 50-, 100-, 200-, and 400-m runs; long jump; and triple jump, respectively.

Discussion

The major finding of the present study was that the distance jumped in the 3 variations of the modified box long jump test showed significant correlations with short sprint, long jump, triple jump, shot put, standing long jump, and vertical jump ability. Additionally, the modified box long jump tests also showed significant correlations with isokinetic peak torque of knee extension and flexion, peak power, mean power, and mean power per kilogram of body mass in a Wingate test. Generally, the correlations with the performance of other tests followed a pattern of increasing strength in the order of the 1-, 2-, and 3-box modified box long jump tests. The results of the single correlations are supported by the stepwise linear regression analysis that also indicated that the 3-box modified long jump test is a major predictor of track and field performance than other tests performed except for the shot put where standing long jump performance was indicated as a major predictor of performance. These results indicate that performance in the modified box long jump tests, especially the 3-box test, correlate well with a wide variety of other power-oriented physical performance tasks and is a valid indicator of power capabilities. The modified box long jump tests, therefore, would be appropriate to measure power capability changes due to training and before a training session to indicate ability to perform a session at near-maximum power outputs.

The significant correlations of the 3 variations of the modified box long jump test to 50-, 100-, 200-, and 400-m sprint ability are in agreement with previous data demonstrating significant correlations of countermovement vertical jump ability to 30-, 100-, and 300-m sprint ability (11), maximum sprint speed (20), maximum sprint speed between 15 and 30 m of a 30-meter sprint (15), and both sprint acceleration and sprint velocity (18). The present results are also in agreement with those of a previous study showing significant correlations between standing long jump ability with both sprint acceleration and sprint velocity (18). Thus, both horizontal and vertical jump ability significantly correlate with short-term sprint ability. However, the present study's results indicate that the distance jumped in the modified long jump tests shows greater correlations with short-term sprint ability than both standing long jump and vertical jump ability, while the stepwise linear correlation results indicate that the 3-box modified long jump test is a major predictor of performance in sprint ability from 50 to 400 m. These findings are in partial disagreement with previous data on female college athletes (18) participating in a variety of sports showing no difference in correlations between vertical jump versus sprint acceleration ($r = 0.614$) and sprint velocity ($r = 0.622$) and standing long jump ability versus sprint acceleration ($r = 0.612$) and sprint velocity ($r = 0.668$). The present study's finding that standing long jump ability shows higher correlations than vertical jump ability to short sprint ability is in disagreement with previous data on male college athletes (18) participating in a variety of sports showing greater correlations between vertical jump versus sprint acceleration ($r = 0.632$) and sprint velocity ($r = 0.646$) compared to standing long jump ability versus sprint acceleration ($r = 0.484$) and sprint velocity ($r = 0.424$). In the present study, male college sports science students served as subjects, and in the previous study (18), college athletes served as subjects; thus, it is possible that training history and/or level of athletic ability may in part account for this apparent contradiction between studies.

The distance jumped in the modified long jump tests also showed significant correlations with long jump, triple jump, and shot put ability. The significant correlations of the distance jumped in the modified long jump tests with long jump and triple jump ability are probably due to all these tests involving a jumping task. The significant correlations with shot put ability are probably related to the need for lower body power to successfully perform the shot put. However, the stepwise linear correlations indicated that the standing long jump test is a better predictor of shot ability than any of the 3 modified box jump tests, while the 3-box jump modified long jump test was a major predictor of long jump and triple jump ability. Thus, standing long jump ability may be more appropriate to monitor power output in shot putters compared to any version of the modified box long jump test.

The only significant correlations found for total distance jumped in the 3-box modified long jump test (distance from the front edge of the first box to the landing point of long jump) were with long jump, triple jump, and shot put ability and the only significant correlations found for total time to perform the modified 3-box long jump test were with triple jump and shot put ability. This indicates that generally asking subjects to perform the 3-box modified long jump test as fast as possible is not warranted. Even though significant correlations were noted between total distance and total time of the 3-box modified long jump test were noted with long jump, triple jump, and shot put ability, these correlations were of a lower magnitude than those shown with distance jumped in all 3 modified long jump tests, indicating that distance jumped and not time to perform the modified long jump tests would be more appropriate when monitoring training for athletes involved in these disciplines.

Correlations between distance jumped in the modified long jump tests versus measures of vertical jump distance, standing long jump distance, and isokinetic peak torque and power during a Wingate test were included to validate that the modified long jump tests represent a measure of power. Due to collinearity, it might be expected that significant correlations would be shown between the modified box jump tests, which in part are dependent on power output, and other tests of power. However, generally all 3 modified box jump tests showed stronger correlations with other power tests than did the standard tests of vertical jump and standing long jump ability. The variations of the modified long jump test significantly correlated with vertical jump distance; standing long jump distance; peak torque during knee flexion at $60°\cdot s^{-1}$; peak torque during knee extension at 60, 180, and $300°\cdot s^{-1}$; Wingate mean power; and Wingate mean power per kilogram of body mass, while peak torque during knee flexion at $180°\cdot s^{-1}$ and Wingate peak power showed significant correlations with distance jumped in the 2- and 3-box modified long jump test; and Wingate peak power per kilogram of body mass showed a significant correlation with distance jumped in the 2-box modified long jump test. Although not all variables associated with isokinetic peak torque and Wingate peak power showed significant correlations with distance jumped in the 3 variations of the modified long jump test, the vast majority of the correlations with the results of other tests were significant (41 of 48).

The significant correlations shown between the modified box jump tests and measures of power are in agreement with previous research showing significant correlations between measures of strength and jump tests. Significant correlations between standing long jump ability and absolute 1 repetition maximum (1RM) back squat (3,14), 1RM half squat ability (19), and 1RM back squat relative to body mass (18) have been shown. Similarly significant correlations between vertical jump ability and various measures of strength and power, such as isokinetic squat ability (2), 1RM half squat ability (19), absolute 1RM squat ability (3,18), 1RM squat ability relative to body weight (18), clean and jerk and snatch ability (5), have been shown. However, nonsignificant correlations between absolute 1RM squat and standing long jump ability (18), 1RM knee extension and stranding long jump ability (3), and 1RM knee extension and vertical jump ability (3) have also been shown. Overall results of the present and previous studies indicate standing long jump ability as well the 3 variations of the modified box long jump test are valid measures of lower body power.

In conclusion, the 3 variations of the modified box long jump test show significant correlations with a variety of power measures including short sprints, vertical jump, standing long jump, long jump, triple jump, shot put, isokinetic knee extension, isokinetic knee flexion, and the Wingate test, indicating that the modified long jump tests are a valid indicator of power. The 3-box modified long jump test generally shows greater correlations with the above measures of power than the 1- and 2-box variations and is a major predictor of 50-, 100-, 200-, 400-m runs; long jump; and triple jump ability. The results of the present study indicate that the modified long jump tests would be appropriate for determining power output and monitoring power output during training.

Practical Applications

The results of the present study demonstrate that the 3 variations of the modified long jump tests show significant correlations with a variety of power measures including short sprints, vertical jump, standing long jump, long jump, triple jump, shot put, isokinetic knee extension, isokinetic knee flexion, and the Wingate test. The correlations of the 3 variations of the modified long jump test were generally stronger than correlations between vertical jump ability and standing long jump ability to the same measures of power. The 3-box modified long jump test generally showed stronger correlations with measures of power than the 1- and 2-box modified long jump tests and is a major predictor of 50-, 100-, 200-, and 400-m runs; long jump; and triple jump ability. Therefore, the results of the present study indicate that the modified long jump test, especially the 3-box modified long jump test, are appropriate test modalities to determine power output and to monitor changes in power output due to training and before a training session as an indicator of ability to perform a session at near-maximum power output.

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