RELATIONSHIP BETWEEN THE KINETICS AND KINEMATICS OF A UNILATERAL HORIZONTAL DROP JUMP TO SPRINT PERFORMANCE

DAVID JONSSON HOLM,[1] **MARKUS STÅLBOM,**[1] **JUSTIN W. L. KEOGH,**[1] **AND JOHN CRONIN**[1,2]

[1]Institute of Sport and Recreation Research New Zealand, School of Sport and Recreation, AUT University, Auckland, New Zealand; and [2]School of Exercise, Biomedical and Health Sciences, Edith Cowan University, Joondalup, Western Australia

ABSTRACT

Jonsson Holm, D, Stålbom, M, Keogh, JWL, and Cronin, J. Relationship between the kinetics and kinematics of a unilateral horizontal drop jump to sprint performance. *J Strength Cond Res* 22(5): 1589–1596, 2008—The aim of this study was to investigate the relationship between the kinematics and kinetics of a single-leg horizontal drop jump (SLDJ) to sprint performance. Twenty regional-level male team-sport athletes gave informed consent to participate in this study. All subjects performed a series of 25-m sprints (measured by dual-beam infrared timing lights) and SLDJ (with both legs) in randomized block order during the same testing session. The SLDJ required the subjects to step downwards off a 20-cm box, land on the force plate (operating at 500 Hz) with the specified foot, and jump for maximal horizontal distance while minimizing ground-contact time. Jump distance, particularly when normalized to a subject's height, was the strongest correlate to sprinting time for all three (5, 10, and 25 m) distances ($-0.44 < r < -0.65$). Multiple linear regression analyses indicated that the SLDJ could account for a high level of variance in sprint time ($0.49 < r^2 < 0.68$) and that these predictions had a relatively low standard error of estimate (0.02–0.10 seconds). These results further support the contention that jump (particularly horizontal) and sprint ability for short distances are highly related. Whereas practitioners should consider using more horizontal than vertical jumps in the training and testing of most team-sport athletes, additional research into the kinetic determinants of jumping and sprinting may allow a more specific and individualized exercise prescription for improving certain aspects of sprinting such as step length or step rate or the vertical vs. horizontal contributions to propulsion.

KEY WORDS ground-reaction force, prediction, running, stretch-shorten cycle

INTRODUCTION

Because sprinting speed is such a critical factor for performance in many team sports, strength and conditioning trainers spend considerable time trying to improve their athletes' sprinting ability. General weight training, Olympic weightlifting, plyometrics, and resisted sprinting can all be used to improve sprinting speed (2,20,31,33,39). Unfortunately, without a strong understanding of the determinants of sprinting speed and how these forms of exercise may improve each of these determinants, it is unlikely that the conditioner will prescribe the optimal training program to each athlete.

Sprinting speed is the product of step length and step rate (frequency) (11). Thus, to improve sprinting speed, athletes need to improve (at least) one of these factors (step length or rate) while the other factor remains unchanged or reduces to a lesser extent than the gain in the former. The interactions between step length and step rate and their influence on sprinting performance have been widely investigated (13,23,36). Although not universally accepted, Hunter et al. (13) and Weyand et al. (36) have proposed that the greatest determinant of sprinting speed is step length or flight distance, which, in turn, is most highly related to the magnitude of the horizontal ground-reaction impulse or vertical ground-reaction impulse/time, respectively.

Another approach used by sports scientists to gain an insight into the determinants of sprinting speed is to examine the relationship between sprinting speed, strength, and power. Such studies have typically shown moderate to moderately high correlations between sprinting speed and that of strength (mass lifted) and/or jump distance (1,15,24,37,38). Although such results are interesting and have some relevance to conditioning practice, these studies do not indicate what aspect(s) underlying performance in the strength or jump test was most related to sprinting speed. Because kinetics are, by definition, the causes (determinants) of motion, kinetic analyses of the strength or jump tests may provide further insight into those variables that better relate to sprinting speed than the more commonly assessed performance measures of mass lifted or distance jumped. This assertion is supported by a number of relatively recent studies (1,7,17)

Address correspondence to Justin Keogh, justin.keogh@aut.ac.nz.

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of elite rugby league players, elite age-group soccer players, and subelite sprinters, respectively.

To gain a more complete picture of the kinetic profiles of these "predictor" jump or strength tests, numerous dependent variables such as mean and peak force and impulse in both the vertical and anterior-posterior (horizontal) directions should be obtained. However, to minimize the number of statistical comparisons and, hence, the chance for false-positives, it may be recommended that such studies include only one predictor test. As a result, these studies would need to select a predictor test that possesses high levels of face validity to sprinting performance. One such test could be the horizontal single-leg drop jump (SLDJ), a test that has recently been shown to be a reliable measure of unilateral lower-body power (32). As described previously, the SLDJ involves high levels of unilateral horizontal and vertical force production and the imposition of relatively high stretch-shorten cycle (SSC) loads (32). Thus, the SLDJ was chosen because it seems to possess higher levels of face validity to sprinting (10,13,22) than the majority of bilateral and/or vertical jump tests commonly used in the literature (7,15–18,24).

The present study was conducted to examine the relationship between jumping and sprinting performance (over multiple distances) using the SLDJ. It was hypothesized that SLDJ and sprint performance would be highly related, with the strength of this relationship greater for short than long sprints and when using the jump kinetics rather than the kinematic (jump distance) measures. These data have considerable relevance to conditioning practice because only by increasing our understanding of the determinants of sprinting ability can practitioners systematically assess and develop conditioning programs that specifically address each physical/technical constraint that limits sprinting ability.

METHODS

Experimental Approach to the Problem

The present study used a cross-sectional approach to further examine the relationship between jumping and sprinting performance in team-sport athletes. Specifically, correlational and multiple linear regression analyses were conducted to determine the relationship between sprint time and a number of SLDJ kinematic and kinetic measures.

Subjects

Twenty men (mean ± *SD*; age 22 ± 3 years, height 180 ± 7 cm, mass 80 ± 9 kg) from different team sports (primarily touch football, rugby, and basketball) competing at the regional level in New Zealand signed an informed consent form before participation in this study. The athletes were in the late preseason or early in-season phase at the time of testing, had been participating in their chosen sport for at least 3 years, and often had some general (but not extensive) weight training experience. None of these athletes reported any current lower-limb injuries that could affect their performance or leave them prone to injury as a result of the testing procedures. Ethical approval for this study was granted by the Auckland University of Technology ethics committee.

Design

All subjects completed the sprint and jump tests within the same testing session. A 5-minute rest period was given to the subjects between the sprints and jumps. The jump and sprint tests were performed in block randomized order to negate order and fatigue effects. As a result of this design, it was felt unlikely that a significant order effect would occur for any of the dependent variables.

Although the subjects would often perform vertical and horizontal unilateral and bilateral jumps in training and competition, none of them had any previous formal testing experience with the SLDJ. Therefore, the subjects were shown the technique of the SLDJ by one of the researchers and were required to practice this jump in two supervised familiarization sessions before their testing session. Subjects were instructed not to perform any other heavy leg training during the 2 days before the testing session.

Procedures

At the beginning of the test session, the subjects performed a warm-up, consisting of 5–10 minutes of jogging, followed by a number of dynamic lower-body stretches and submaximal sprints and/or jumps. The sprints and SLDJ were all performed on an indoor, multipurpose sports hall.

Sprint Assessment. All sprints were performed for 25 m, with 5-, 10-, and 25-m splits recorded by dual-beam infrared timing lights (Swift Performance Technologies, Australia). Each sprint began from a two-footed parallel position 0.5 m behind the first timing light. All sprints were initiated by the subject, with time commencing when the first pair of infrared beams was broken by the athlete's body. The subjects were instructed to make their first step forward; that is, no backward step was allowed. This was to ensure standardized starts between all subjects across all trials. Subjects performed a minimum of three and a maximum of six (mode = 4) sprint trials, so that performance in the sprint would reach a plateau. The rest period between each sprint was 4 minutes.

Jump Assessment. The SLDJ was performed with both the right and the left legs. The jumps were performed off a box (height, 20 cm) placed on the long edge of a force plate (Type 9287 B; Kistler, Winterthur, Switzerland) sampling at 500 Hz. This box height has been used safely for unilateral vertical drop jumps in normal patients as well as patients with a reconstructed anterior cruciate ligament (27). Further, this height was selected as the kinetic energy needing to be absorbed (and, hence, injury potential) on landing on one leg from 20 cm would be virtually identical to that acting on each leg in a bilateral drop jump from 40 cm, a drop height commonly used in training and research (14,33,34). Subjects stepped down from the box with their hands on their hips, landed on the specified leg, and, thereafter, jumped for maximum horizontal displacement and landed on two feet (see Figure 1). The instructions were to "minimize contact time and maximize horizontal displacement." The horizontal displacement (to the nearest 1 cm) was measured with a floor-mounted tape measure. This displacement was calculated as the difference in position between the toe-off position on the force plate to the heel of the foot closest to the force plate on landing on two feet after the jump. If a subject fell backward when landing, the jump was repeated. A rest period of 1 minute took place between each of the jumps. The order of jumps was randomized in block fashion, with all the jumps completed by one (e.g., left) leg before performing the jumps with the remaining (e.g., right) leg.

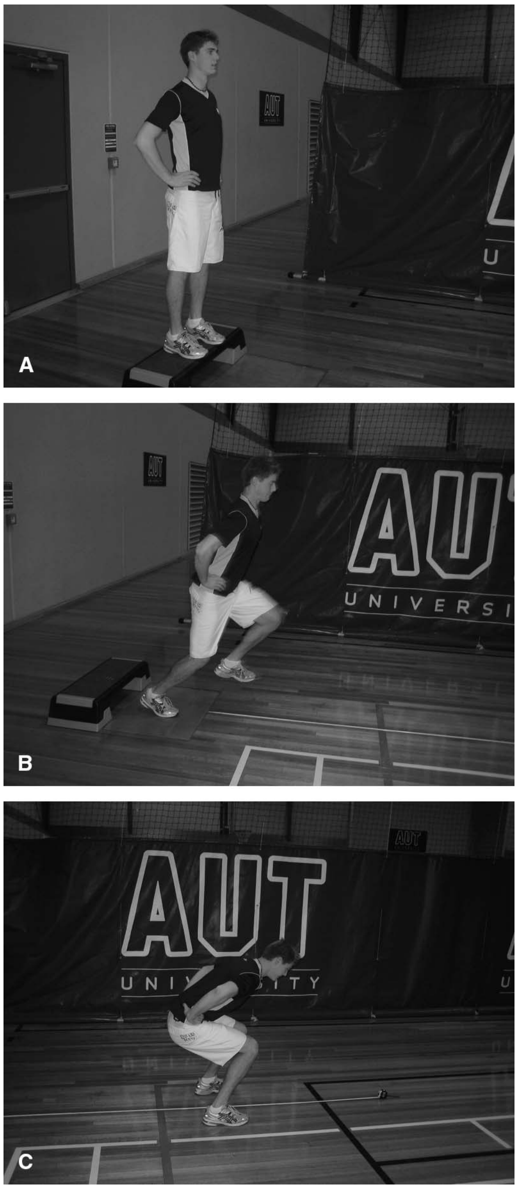

Figure 1. Starting, mid and final position of the single-leg drop jump (SLDJ).

To maximize the reliability of the SLDJ, we followed the recommendations of Booher et al. (4), with the jump test (for each leg) considered completed when the subject's performance began to plateau. This typically took four to six (mode = 5) trials. The intraday (coefficient of variation = 1.2–4.3%) and interday (test-retest) reliability (coefficient of variation = 2.3–8.3%; intraclass correlation coefficient = 0.74–0.96) of the kinematics and kinetics of SLDJ have been shown to be high to very high (32). Similarly, high levels of reliability for other unilateral horizontal jump tests involving relatively high SSC loads have also been reported (3,25,29).

Data Analyses

All kinetic data from the SLDJ were filtered using a low-pass second-order reverse-pass Butterworth filter at 6 Hz, similar to the procedures of Hunter et al. (13). The following dependent variables were calculated for each SLDJ: jump distance, jump distance/height, reactivity coefficient (RC), ground-contact time (CT), anterior-posterior impulse (impulse AP), vertical impulse (impulse V), mean anterior-posterior ground-reaction force (mean APGRF), mean APGRF/CT, mean vertical ground-reaction force (mean VGRF), mean VGRF/CT, peak anterior-posterior ground-reaction force (peak APGRF), peak APGRF/CT, peak vertical ground-reaction force (peak VGRF), and peak VGRF/CT.

The four kinetic variables that were normalized to ground-contact time (mean and peak APGRF/CT, mean and peak VGRF/CT) were analogous to rate of force-development measures in that they gave an indication of the amount of force produced during ground contact. However, because the variables were merely calculated by dividing the respective mean or peak force by the contact time, it was not felt appropriate to refer to them as a true rate of force-development measure. The RC (also referred to as the reactive strength index) is equal to the jump distance divided by the contact time (21). For all calculations, the contact time was defined as the period of time in which the vertical ground-reaction force was greater than 10 N (18).

With the exception of jump distance, the "rate of force-development type" measures, and the RC, all of the SLDJ variables were calculated using custom-designed Labview software (Labview 6, National Instruments). For each subject, the two longest SLDJ were identified, and the mean values for all dependent variables were calculated from these two trials. The two SLDJ trials with the highest RC for each subject were identified, and the mean values were calculated from these two trials. In addition, the two best times for every subject for each sprint distance (0–5, 0–10, 0–25, 5–10, and 10–25 m) were identified, with the mean of these values calculated and used for analysis.

Statistical Analyses

Descriptive statistics for all variables were presented as means and standard deviations to indicate centrality and spread of results among subjects. Although the SLDJ was performed on both the right and the left leg, a t-test showed that there were no significant ($p = 0.559$) differences between the legs in jump distance. Consequently, it was felt appropriate to pool the data from the right and left legs for all dependent variables (18).

Pearson product-moment correlations were used to determine the strength of the relationship between the sprint times and the jump kinetics and kinematics. To identify factors that are important in predicting sprint performance (for 0–5, 0–10, 0–25, 5–10, and 10–25 m), multiple linear stepwise regression analyses were conducted using all jump kinetic/kinematics measures (jump distance, jump distance/height, RC, CT, AP and V impulse, mean and peak vertical and anterior-posterior GRF, and mean and peak vertical and anterior-posterior GRF/CT). From this analysis, the best multiple-predictor model for each of the sprint distances was derived. Because data from at least five subjects are required for every predictor variable entered into a multiple regression analysis (5), a maximum of four predictor variables could be entered into each analysis. Regression diagnostics were used to determine whether any outliers were present, whether the data were normally distributed, and whether there were any issues with multicollinearity (9,26). In accordance with the recommendations of Garson (9) for testing multicollinearity, all variables entered into the regression analyses had to have tolerance, variance-inflation factors, and condition index values of >0.20, <4.0, and <30, respectively. All statistical analyses were conducted using Statistical Package for the Social Sciences (SPSS version 14.0) with significance set at a value of $p < 0.05$.

A power analysis was performed to determine the number of subjects required. According to Hopkins (12), a correlation of $r = 0.5$ is considered high and equates to an effect size of 1.2. Twenty-two subjects would, therefore, be required for a correlation coefficient of $r = 0.5$ to be significant with 80% power and a risk of type I error of 5%.

RESULTS

All subjects completed the familiarization and testing sessions without any incidents or injuries. The group means for all sprint and jump variables are presented in Table 1. The relationship between sprint times and the kinetics and kinematics of the jumps is displayed in Tables 2 and 3, respectively. Jump distance was significantly correlated to sprint time across all assessed (0–5, 0–10, 0–25, 5–10, and 10–25 m) distances. Normalization of the jump distance by the subjects' height led to small increases in the strength of these correlations. The strongest correlations were found between 10-m sprint time and jump distance/height ($r = -0.64$ to -0.65).

TABLE 1. Group means for all sprint and jump variables.

	Mean	*SD*
Sprints		
0–5 m (s)	1.13	0.05
0–10 m (s)	1.87	0.07
0–25 m (s)	3.78	0.15
5–10 m (s)	0.74	0.03
10–25 m (s)	1.90	0.08
Jumps		
Jump distance (cm)	171	15
Jump distance/height	0.95	0.07
RC ($cm \cdot s^{-1}$)	430	79
CT (s)	0.41	0.06
Anterior-posterior impulse (N·s)	1257	458
Vertical impulse (N·s)	4556	986
Mean APGRF (N)	−334	117
Mean APGRF/CT ($N \cdot s^{-1}$)	−831	333
Mean VGRF (N)	1135	156
Mean VGRF/CT ($N \cdot s^{-1}$)	2843	525
Peak APGRF (N)	−573	203
Peak APGRF/CT ($N \cdot s^{-1}$)	−1433	595
Peak VGRF (N)	1871	253
Peak VGRF/CT ($N \cdot s^{-1}$)	4766	1166

Only data for the mean of the two longest jumps are presented here because the data for the jumps with the highest RC were very similar. RC = reactivity coefficient; CT = contact time; APGRF = anterior-posterior ground-reaction force; VGRF = vertical ground-reaction force.

Multiple linear stepwise regression analyses were performed to determine the ability of the SLDJ kinetics/kinematics to predict sprint performance. The results, including the r^2 value, the standard error of the estimate in seconds (SEE), and the percent standard error of the estimate (%SEE), are presented in Tables 4 and 5, respectively. The strongest overall model was found for the prediction of the 5- to 10-m sprint time using the mean of the best two RC jumps; this explained 68% of the performance variability. Regardless of sprint distance, jump distance/height was the first variable selected by all regression analyses, with the peak or mean APGRF/CT typically being the other variable.

DISCUSSION

Results of the present study were somewhat consistent with the initial hypotheses, with jump distance exhibiting moderate to high negative correlations to sprint time ($r = -0.44$ to -0.65) regardless of whether the mean of the two longest jumps or the mean of the two jumps with the highest RC was used. These correlations were slightly higher in the following cases: 1) when jump distance was normalized to the athletes' height, and 2) for the first 10 m and then the remaining 15 m of the 25-m sprint. Because the correlations did not differ according to whether the longest jumps or the

TABLE 2. Correlations between sprint times and the jump kinematics (mean of two longest jumps).

	Sprint distance (m)				
	0–5	0–10	0–25	5–10	10–25
Body mass (kg)	0.11	0.21	0.24	0.34*	0.24
Height (cm)	−0.05	−0.03	0.02	0.01	0.03
Jump distance (cm)	−0.55**	−0.61**	−0.51**	−0.54**	−0.40*
Jump distance/height	−0.57**	−0.65**	−0.56**	−0.59**	−0.44**
RC (cm/s)	−0.14	−0.16	−0.11	−0.07	−0.07
CT (s)	−0.11	−0.11	−0.12	−0.17	−0.12
Anterior-posterior impulse (N·s)	0.00	−0.06	−0.17	−0.14	−0.25
Vertical impulse (N·s)	−0.36*	−0.33*	−0.32*	−0.30	−0.27
Mean APGRF (N)	−0.09	−0.17	−0.28	−0.28	−0.35*
Mean APGRF/CT ($N \cdot s^{-1}$)	−0.17	−0.24	−0.33*	−0.36*	−0.39*
Mean VGRF (N)	−0.43**	−0.37*	−0.32*	−0.22	−0.24
Mean VGRF/CT ($N \cdot s^{-1}$)	−0.14	−0.07	−0.04	0.09	0.01
Peak APGRF (N)	−0.16	−0.20	−0.29	−0.25	−0.35*
Peak APGRF/CT ($N \cdot s^{-1}$)	−0.22	−0.26	−0.33*	−0.33*	−0.37*
Peak VGRF (N)	−0.37*	−0.33*	−0.24	−0.18	−0.14
Peak VGRF/CT ($N \cdot s^{-1}$)	−0.10	−0.03	0.01	0.11	0.06

*Correlation is significant at the 0.05 level (two tailed).
**Correlation is significant at the 0.01 level (two tailed).
RC = reactivity coefficient; CT = contact time; APGRF = anterior-posterior ground-reaction force; VGRF = vertical ground-reaction force.

jumps with the greatest RC were used, it seems that the additional calculation required for the RC offers little advantage over just using the longest jumps to predict sprinting performance.

The magnitude of the correlations observed in the present study between sprint and SLDJ performance seemed greater than most of the literature for bilateral vertical jumps (7,15–18,24). This result was expected because of the similarities

TABLE 3. Correlations between sprint times and the jump kinematics (mean of two highest RC jumps).

	Sprint distance (m)				
	0–5	0–10	0–25	5–10	10–25
Body mass (kg)	0.11	0.21	0.24	0.34*	0.24
Height (cm)	−0.05	−0.03	0.02	0.01	0.03
Jump distance (cm)	−0.54**	−0.61**	−0.51**	−0.54**	−0.40*
Jump distance/height	−0.56**	−0.64**	−0.56**	−0.59**	−0.44**
RC ($cm \cdot s^{-1}$)	−0.14	−0.15	−0.12	−0.07	−0.09
CT (s)	−0.15	−0.17	−0.17	−0.23	−0.15
Anterior-posterior impulse (N·s)	0.01	−0.03	−0.14	−0.10	−0.22
Vertical impulse (N·s)	−0.42**	−0.41**	−0.38*	−0.37*	−0.32*
Mean APGRF (N)	−0.10	−0.17	−0.27	−0.27	−0.33*
Mean APGRF/CT ($N \cdot s^{-1}$)	−0.19	−0.27	−0.35*	−0.39*	−0.40*
Mean VGRF (N)	−0.42**	−0.37*	−0.33*	−0.23	−0.26
Mean VGRF/CT ($N \cdot s^{-1}$)	−0.16	−0.10	−0.09	0.04	−0.06
Peak APGRF (N)	−0.16	−0.21	−0.29	−0.26	−0.35*
Peak APGRF/CT ($N \cdot s^{-1}$)	−0.24	−0.30	−0.36*	−0.37*	−0.40*
Peak VGRF (N)	−0.36*	−0.31*	−0.24	−0.17	−0.16
Peak VGRF/CT ($N \cdot s^{-1}$)	−0.12	−0.07	−0.04	0.05	−0.01

*Correlation is significant at the 0.05 level (two tailed).
**Correlation is significant at the 0.01 level (two tailed).
RC = reactivity coefficient; CT = contact time; APGRF = anterior-posterior ground-reaction force; VGRF = vertical ground-reaction force.

TABLE 4. Prediction equations using the best jump method.

	Sprint distance (m)				
	0–5	0–10	0–25	5–10	10–25
Jump distance/height	−0.434	−0.793	−1.498	−0.320	−0.699
Peak APGRF/CT	−0.030	−0.057	−0.130		
Mean APGRF/CT				−0.052	−0.136
Constant	1.488	2.519	4.951	0.983	2.411
R^2	0.49	0.65	0.60	0.67	0.49
SEE (s)	0.03	0.05	0.10	0.02	0.06
SEE (%)	3.20	2.42	2.69	2.54	3.33

CT = contact time; APGRF = anterior-posterior ground-reaction force; SEE = standard error of the estimate.

between sprinting and the SLDJ with both activities involving unilateral ground contacts, high SSC loads, and the production of horizontal as well as vertical forces (10,13). When compared with the horizontal jump literature, the correlations observed in the present study were somewhat lower than those of Maulder and Cronin (18) and Nesser et al. (24) but considerably higher than those of Maulder et al. (17). The relative inconsistency of these findings was surprising, but it may reflect interstudy differences in a number of factors including subject characteristics (e.g., sprinting ability), sprinting distance, sprint start position (block vs. standing start), and type of horizontal jump performed. Nevertheless, the results of the study and that of the vertical and horizontal jump literature suggest that horizontal jump may better predict sprinting ability than vertical jumps. On this basis, the astute strength and conditioning trainer may use more horizontal jumps in the training and testing of team-sport athletes. Although some conditioners may question the reliability of such horizontal jumps for testing, recent research has indicated that the SLDJ and other horizontal tests possess similar levels of reliability to that of the more common bilateral vertical jumps such as the squat jump and countermovement jump (3,25,29,32).

In contrast to our initial hypothesis and that of the recent literature (7,16,17), the results of the present study reveal that the sprint-jump correlations were substantially greater when using SLDJ distance than the SLDJ kinetics. Nevertheless, significant negative correlations were still observed between sprint time (over most distances) and a number of vertical (impulse, peak force, and mean force) and anterior-posterior (peak and mean force) kinetic variables. Although such results only offer moderate support to the view that jump kinetics may be strong determinants of sprinting performance (13,36), future research should examine the relationship between jump kinetics and that of the two primary sprinting determinants: step length and step rate. Because the forces produced during ground contact may be more strongly related to step length (flight distance) than step rate (11,13,36), it is possible that the correlation between jump kinetics and step length would be stronger than that of

TABLE 5. Prediction equations using the best reactivity coefficient method.

	Sprint distance (m)				
	0–5	0–10	0–25	5–10	10–25
Jump distance/height	−0.327	−0.752	−1.415	−0.304	−0.656
Peak APGRF/CT		−0.058			−0.073
Mean APGRF/CT			−0.130	−0.051	
Vertical impulse	−0.022				
Constant	1.563	2.466	4.845	0.965	2.369
R^2	0.49	0.66	0.60	0.68	0.49
SEE (s)	0.03	0.05	0.10	0.02	0.06
SEE (%)	3.02	2.40	2.67	2.50	3.35

CT = contact time; APGRF = anterior-posterior ground-reaction force; SEE = standard error of the estimate.

jump kinetics and sprinting speed, as assessed in this and previous studies (7,16,17). Such an approach would further improve our understanding of the determinants of sprinting performance (13,23,30,36) and improve the ability of practitioners to individualize the exercise prescription so that athletes who need to increase their step length would perform a different program than those athletes who need to increase their step rate.

Regardless of using the mean of the two longest SLDJ or the two SLDJ with the highest RC, the stepwise linear regression analyses had r^2 values of between 0.49 and 0.68 across all five distances. This indicates that performance in the SLDJ explains about one-half to two-thirds of the variance in sprint times across these distances. The prediction error (SEE) of these equations ranged from 0.02 to 0.10 seconds (2.28–3.35%), values that seem consistent with the results of much more complicated and time-consuming metabolic modeling studies (6,35). Consistent with the trends observed for the correlations, a greater percentage of variance was explained for the short ($\leq$10 m) than longer (10–25 m) sprint distances. Such results further support the view that one of the primary determinants of short-distance sprinting performance is the ability of the lower-extremity musculature to produce high levels of force and impulse during ground contacts of short duration (1,15,18). Further support for this view can be found in several resistance training studies that have found that the training-related gains in sprinting speed were typically greater when assessed over short ($\leq$10 m) than longer (20–40 m) distances (2,20,33).

It must, however, be acknowledged that there are some limitations to the design of this study. The first is that although correlations describe the relationship between two variables, any association (regardless of its strength) does not necessarily imply causation. The second was the use of a mixed athletic group. By using a mixed sample, the heterogeneity of the sample will likely increase, thereby making it more difficult to find statistical significance. It is also possible that the 5- and 10-m split times from the 25-m sprint might have differed from what would have occurred if the athletes actually had performed 5- or 10-m sprints. However, because many studies have recorded short (5- and 10-m splits) from longer (20–50 m) sprints (8,19,28,39), and because the energetics of such short-duration high-intensity activity seem similar (6,35), we feel that the 5- and 10-m split sprint times from the 25-m sprint would be similar to that obtained from actual 5- and 10-m sprints.

PRACTICAL APPLICATIONS

The results of the present study further support the view that jumping and sprinting abilities are highly related and that sprint times can be accurately predicted by a number of jump kinematic and kinetic measures, particularly when the sprint distance is short ($<$10 m) and when assessed with horizontal rather than vertical jumps. Because the reliability of these horizontal jump measures can also be very high (given sufficient familiarization), it is recommended that practitioners strongly consider using horizontal rather than vertical jumps in the training and testing of athletes who perform the majority of their sprints over short distances. However, because it is still not clear whether the kinematics (e.g., jump distance) or kinetics of these jumps best predict sprint performance, future research should examine the relationship between these jump variables and the key determinants of sprinting speed such as step length and step rate. Such research would further our understanding of the determinants of sprinting and assist the practitioner in individualizing the prescription of training so that the exercises performed can be specifically tailored to improving the factors that limit each athlete's sprinting ability, such as step length or step rate.

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