Speed, Force, and Power Values Produced From Nonmotorized Treadmill Test Are Related to Sprinting Performance

Gerald T. Mangine, Jay R. Hoffman, Adam M. Gonzalez, Adam J. Wells, Jeremy R. Townsend, Adam R. Jajtner, William P. McCormack, Edward H. Robinson, Maren S. Fragala, David H. Fukuda, and Jeffrey R. Stout

Institute of Exercise Physiology and Wellness, Sport and Exercise Science, University of Central Florida, Orlando, Florida

Abstract

Mangine, GT, Hoffman, JR, Gonzalez, AM, Wells, AJ, Townsend, JR, Jajtner, AR, McCormack, WP, Robinson, EH, Fragala, MS, Fukuda, DH, and Stout, JR. Speed, force, and power values produced from nonmotorized treadmill test are related to sprinting performance. *J Strength Cond Res* 28(7): 1812–1819, 2014—The relationships between 30-m sprint time and performance on a nonmotorized treadmill (TM) test and a vertical jump test were determined in this investigation. Seventy-eight physically active men and women (22.9 ± 2.7 years; 73.0 ± 14.7 kg; 170.7 ± 10.4 cm) performed a 30-second maximal sprint on the curve nonmotorized TM after 1 familiarization trial. Pearson product-moment correlation coefficients produced significant ($p \leq 0.05$) moderate to very strong relationships between 30-m sprint time and body mass ($r = -0.37$), %fat ($r = 0.79$), peak power (PP) ($r = -0.59$), relative PP ($r = -0.42$), time to peak velocity ($r = -0.23$) and TM sprint times at 10 m ($r = 0.48$), 20 m ($r = 0.59$), 30 m ($r = 0.67$), 40 m ($r = 0.71$), and 50 m ($r = 0.75$). Strong relationships between 30-m sprint time and peak ($r = -0.479$) and mean vertical jump power ($r = -0.559$) were also observed. Subsequently, stepwise regression was used to produce two 30-m sprint time prediction models from TM performance (TM1: body mass + TM data and TM2: body composition + TM data) in a validation group ($n = 39$), and then crossvalidated against another group ($n = 39$). As no significant differences were observed between these groups, data were combined ($n = 72$) and used to create the final prediction models (TM1: $r^2 = 0.75$, standard error of the estimate (SEE) = 0.27 seconds; TM2: $r^2 = 0.84$, SEE = 0.22 seconds). These final movement-specific models seem to be more accurate in predicting 30-m sprint time than derived peak ($r^2 = 0.23$, SEE = 0.48 seconds) and mean vertical jump power ($r^2 = 0.31$, SEE = 0.45 seconds) equations. Consequently, sprinting performance on the TM can significantly predict short-distance sprint time. It, therefore, may be used to obtain movement-specific measures of sprinting force, velocity, and power in a controlled environment from a single 30-second maximal sprinting test.

Key Words sprint assessment, cross-validation, vertical jump, validity

Introduction

Maximal sprinting speed and power are both important measures for anaerobic performance (22). In developing an exercise prescription and/or setting training goals, athletes are subjected to a variety of laboratory and field assessments that include measures of speed and power. Short distance sprints (<50 m) and vertical jump height are often used as field assessments of speed and power (11), whereas the Wingate anaerobic power test (WAnT) on the cycle ergometer is considered the "gold standard" for laboratory power measurement (7,11). However, there are limitations associated with the use of these measures. Short distance sprints do not provide a measure of power and comparisons between athletes, or testing periods may be affected by differences in track surface and possibly human error associated with timing (different timer, etc.). Power output can be measured directly from the WAnT and calculated through vertical jump performance, however, neither of these tests are movement-specific for many sports. Although power output from vertical jump testing is moderately correlated to short distance sprinting speeds (4,14,15,19), it alone cannot account for all of the variation when predicting sprinting speed. Consequently, these tests are often performed independently (8,11,21,22,24,26), increasing the time and equipment/facilities/expertise needed for athlete assessment. This could be an issue if there are time constraints associated with team or player assessments. Thus, it would seem to be beneficial to determine a movement-specific speed and power assessment in a single test.

Address correspondence to Jay R. Hoffman, jay.hoffman@ucf.edu.

28(7)/1812–1819

Journal of Strength and Conditioning Research

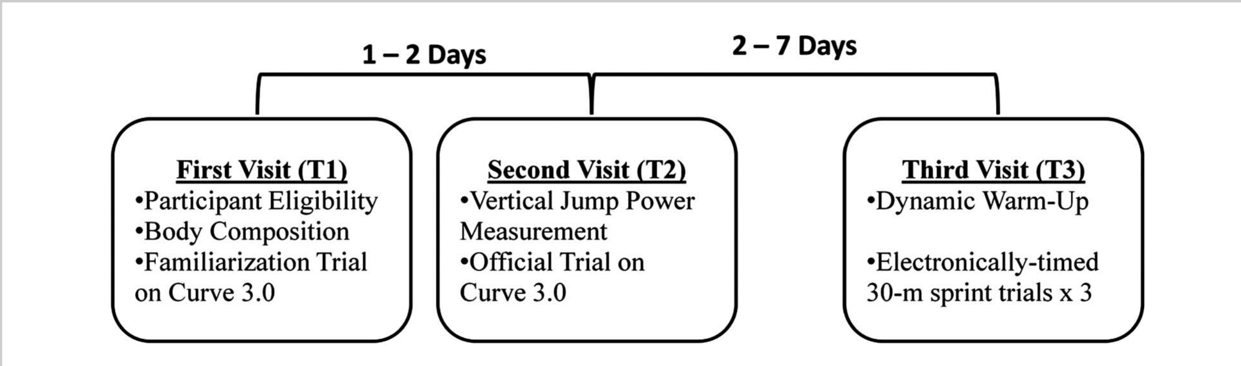

Figure 1. Order of testing.

Recently, the Woodway Curve 3.0 nonmotorized treadmill (TM; Woodway, Inc., Waukesha, WI, USA) was developed to simulate sprinting performance in a laboratory setting. The TM has a curved platform, which permits the runner to reach full running velocity using techniques similar to flat surface running. In addition to its ability to measure speed, the TM has built-in force transducers allowing for measurement of lower-body force and power during the sprint. The reliability of a 30-second sprint assessment on the TM to assess power performance in recreationally active men and women has been established, and has also been demonstrated to be significantly correlated ($r = 0.56$, $p < 0.001$) to the WAnT (7). Although the reliability of power performance on the TM has been established, the

Table 1. Performance characteristics of the validation and cross-validation groups, mean ± *SD* (range).*

	Validation ($n = 39$)	Cross-validation ($n = 39$)	p
Descriptive measures			
Age (y)	22.7 ± 2.3 (18.8–31.1)	23.1 ± 3.1 (18.4–30.3)	0.498
Weight (kg)	73.3 ± 13.7 (42.5–97.9)	72.8 ± 15.8 (50.6–105.1)	0.887
Height (cm)	172.2 ± 9 (145–195)	169.2 ± 11.6 (147–192.5)	0.217
%Fat	18.0 ± 7.4 (6.2–33.6)	17.3 ± 7.8 (5.4–37.5)	0.658
LBM (kg)	60.2 ± 13 (34.6–86.9)	60.5 ± 15.4 (36.2–96.3)	0.935
Running power on curve			
Peak power (W)	1137 ± 319 (649–2,079)	1110 ± 280 (525–1,995)	0.685
RMP ($W \cdot kg^{-1}$)	3.9 ± 0.7 (2.2–5.6)	3.9 ± 0.7 (2.3–5.2)	0.741
RPP ($W \cdot kg^{-1}$)	15.5 ± 3.3 (8.8–21.8)	15.4 ± 2.7 (8.9–24.0)	0.822
Running force on curve			
PHF (N)	283 ± 38 (183–352)	285 ± 36 (220–358)	0.841
PVF (N)	10,886 ± 3,574 (2,412–14,244)	9,982 ± 4,091 (2,338–14,087)	0.302
Running speed on curve (s)			
TPV	7.79 ± 4.45 (1.47–18.57)	6.65 ± 2.9 (3.4–25.71)	0.185
TPP	1.97 ± 1.33 (0.07–3.68)	1.96 ± 0.95 (0.09–8.25)	0.970
10 m	2.48 ± 0.3 (1.58–3.1)	2.51 ± 0.23 (1.94–3.15)	0.650
20 m	4.21 ± 0.51 (3.19–5.59)	4.22 ± 0.42 (3.21–5.5)	0.922
30 m	5.85 ± 0.71 (4.82–7.94)	5.84 ± 0.63 (4.42–7.75)	0.937
40 m	7.48 ± 0.94 (6.17–10.29)	7.46 ± 0.86 (5.65–9.87)	0.917
50 m	9.12 ± 1.18 (7.57–12.73)	9.12 ± 1.11 (6.88–12.00)	0.997
Dependent performance variables			
PVJP (W)	2,081 ± 931 (1,106–5,566)	1,979 ± 733 (938–4,199)	0.593
MVJP (W)	1,148 ± 446 (593–2,937)	1,064 ± 311 (554–2,081)	0.341
30-m sprint (s)	4.86 ± 0.59 (4.19–6.21)	4.95 ± 0.49 (4.20–6.14)	0.485

*%Fat = body fat percentage; LBM = lean body mass; RMP = relative mean power; RPP = relative peak power; PHF = peak horizontal force; PVF = peak vertical force; TPV = time to peak velocity; TPP = time to peak power; PVJP = peak vertical jump power; MVJP = mean vertical jump power.

Figure 2. Maximal sprinting on the Woodway Curve 3.0 nonmotorized treadmill.

design of the TM requires a kinematic change in locomotion, which becomes more pronounced as the user progresses from a walk, to a jog, and finally to a run compared with this progression on a flat surface (23). It is unknown whether this kinematic change would affect the ability to relate sprint speeds on the TM to those performed on athletic surfaces (i.e., track, field, or court).

Assessing sprint and power performance on the TM may prove to be beneficial for both strength coaches and sport scientists if it can be established that performance output from the TM is related to traditionally measured sprint performance. Thus, the purpose of this investigation was to determine the relationship between force, velocity, and power measures on the TM and 30-m sprint time. A second purpose of this study was to develop a prediction equation using sprinting speed and power values generated from the 30-second maximal sprint on the TM to estimate 30-m sprint performance.

Methods

Experimental Approach to the Problem

The ability of the Curve 3.0 nonmotorized TM to predict 30-m sprinting performance was assessed in physically active men and women. Participants reported to the human performance laboratory (HPL) on 3 separate occasions. On the first visit (T1), eligible participants were advised of the purpose, risks, and benefits associated with the study, followed by a familiarization trial on the TM. Previous research in our lab has indicated that 1 familiarization trial on the TM was necessary to obtain reliable measurements of peak power (PP) and force (7). Within 1–2 days of T1, participants returned to the HPL. On this second visit (T2), participants completed a vertical jump assessment followed by another 30-second maximal sprint on the TM. The final visit (T3) occurred within 1 week from T2 in the gymnasium located immediately next door to the HPL, where participants completed three 30-m sprint trials. Figure 1 depicts the timeline for testing during this investigation.

Subjects

Seventy-eight physically active men and women (22.9 ± 2.7 years [18.4–31.1]; 73.0 ± 14.7 kg [42.4–105.1]; 170.7 ± 10.4 cm [145.0–195.0]) volunteered to participate in this study. Before participation, all subjects were asked to complete a health and activity questionnaire, PAR-Q, and an informed consent after explanation. The Institutional Review Board of the University approved this research protocol, and the approval included a waiver of written documentation of consent. All subjects were free of any physical limitations

Table 2. Comparison between derived and cross-validated equations for 30-m sprinting speed (seconds).*

	Mean ± *SD*	*p*	*r*	SEE
TM1 ($n = 39$)				
Validation	4.90 ± 0.49	0.985	1.00	0.04
Cross-validation	4.90 ± 0.45			
TM2 ($n = 39$)				
Validation	4.90 ± 0.54	0.924	0.98	0.12
Cross-validation	4.91 ± 0.46			

*TM1 = body mass and TM-derived data; TM2 = body composition and TM-derived data.

(determined by health and activity questionnaire) and had been recreationally active (exercised 2–3 times per week). Subsequently, the participants were randomly assigned to either a validation (n = 39; men = 24; women = 15) or cross-validation (n = 39; men = 21; women = 18) group with no significant differences between the 2 groups in the mean values of all measured variables (Table 1).

Descriptive Measures

Before physical exertion during T1, anthropometric measurements, including height, body mass, and body fat percentage, were collected. Body mass (±0.1 kg) and height (±0.1 cm) were measured using a Health-o-meter Professional scale (Patient Weighing Scale, Model 500 KL; Pelstar, Alsip, IL, USA). All body composition measures were performed with a skinfold caliper (Caliper-Skinfold-Baseline, Model #MDSP121110; Medline, Mundelein, IL, USA) by the same investigator using standardized procedures previously described for collecting skinfold measurements from the triceps, suprailiac, abdomen, and thigh (11), and previously published formulas for calculating body fat percentage (%FAT) (13).

Maximal Treadmill Sprint Testing

Figure 2 illustrates sprinting on the TM. Participants performed a 30-second TM sprint at T1 and T2, which were separated by 1–2 days. Before the sprint, participants performed a 10-minute warm-up consisting of 5 minutes on a cycle ergometer, followed by a 5-minute walk (1.8 $m \cdot s^{-1}$) on the TM interspersed with 3–5 maximal sprints lasting 5 seconds. After a 2-minute rest, participants began one 30-second maximum effort sprint on the TM. The study investigator provided a 5-second countdown and "Go" command. At "Go," participants began a maximal effort sprint for 30 seconds. Participants were verbally encouraged throughout the sprint. Performance data from the 30-second maximal sprint were recorded from force transducers constructed into the TM's platform and analyzed by the manufacturer's computer software (Pacer Performance System XPV7 2.1.07, Innervations, Joondalup WA, Australia). As a determinant of a valid trial, analysis was performed only on trials for which PP was achieved within the first 8 seconds. From each valid trial, time to peak velocity (TPV), PP, peak horizontal force, peak vertical force (PVF), and 10-m time splits for the first 50 m, previously determined to be reliable after 1 familiarization trial (7), were used for statistical analysis.

Table 3. Selected bivariate correlations between Woodway Curve 3.0 nonmotorized treadmill performance and 30-m maximal sprint (n = 78).*

	r	r^2	p
Measures of force (N)			
PHF	−0.25	0.06	0.026
PVF	−0.18	0.03	0.121
Measures of power			
PP (W)	−0.59	0.35	0.000
RMP ($W \cdot kg^{-1}$)	−0.31	0.10	0.005
RPP ($W \cdot kg^{-1}$)	−0.42	0.18	0.000
Measures of speed (s)			
TPV	−0.23	0.05	0.039
TPP	−0.12	0.01	0.307
10 m	0.48	0.23	0.000
20 m	0.59	0.34	0.000
30 m	0.67	0.44	0.000
40 m	0.71	0.51	0.000
50 m	0.75	0.56	0.000

*PHF = Peak Horizontal Force; PVF = Peak Vertical Force; PP = Peak Power; RMP = Relative Mean Power; RPP = Relative Peak Power; TPV = Time to Peak Velocity; TPP = Time to Peak Power.

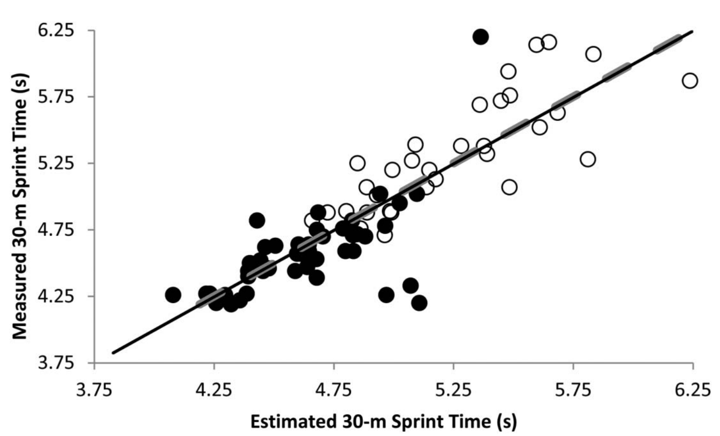

Figure 3. Regression line comparison between derived formula (TM1) and measured 30-m land sprinting performance. *Gray dashed line = line of identity (slope = 1); black solid line = line of best fit from linear regression (TM1); open circles = women; closed circles = men.

Vertical Jump Power Measurement

After the 5-minute warm-up on the cycle ergometer, participants performed a maximal vertical jump assessment (Uesaka Sport, Colorado Springs, CO). Before testing, each participant's standing vertical reach height was determined by colored squares located along the vertical neck of the device.

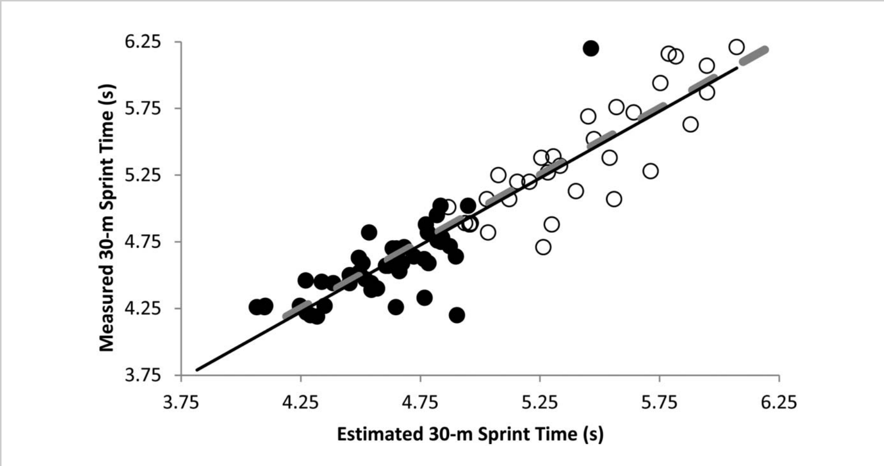

Figure 4. Regression line comparison between derived formula (TM2) and measured 30-m land sprinting performance. *Grey dashed line = line of identity (slope = 1); black solid line = line of best fit from linear regression (TM2); open circles = women; closed circles = men.

These squares corresponded with similarly colored markings on each horizontal tab, which indicated the vertical distance (in inches) from the associated square. Vertical jump height was determined by the indicated distance on the highest tab reached after 3 maximal countermovement jump attempts and in accordance with previously described procedures (11). Peak (PVJP) and mean (MVJP) vertical jump power was determined from a Tendo Power Output Unit (Tendo Sports Machines, Trencin, Slovakia) that was attached to the waist of each participant during the vertical jump assessment. The Tendo unit consists of a transducer attached to the end of the belt, which measured linear displacement and time. Subsequently, the velocity of each jump was calculated and power determined. Test-retest reliability for the Tendo unit in our laboratory has consistently shown $R > 0.90$.

Sprint Testing

An electronically timed 30-m sprint was used to determine maximal sprinting speed at T3. Before the sprint, all participants performed a dynamic warm-up that included light jogging for 5 minutes followed by several exercises that included body weight squats, walking lunges, walking knee hugs, and walking quadriceps stretch (1 set of 10 repetitions were performed for each exercise). Sprint times were measured using an infrared testing device (Speed Trap II; Brower Timing Systems, Draper, UT, USA) and performed on a hardwood indoor basketball court. Participants were instructed how to begin the sprint from a 3-point stance. Timing began on the participant's first movement and concluded when he/she sprinted past the infrared sensor located 30-m from the starting point. The best

Table 4. Sprinting speed predictive equations of 30 m from 30-second maximal sprint on Woodway Curve 3.0 nonmotorized treadmill.*

TM1	TM2
All Subjects ($n = 78$)	
3.441 + [(50–40 m) × 1.479] − (TPV × 0.042) − (RPP × 0.043)	2.619 + [(50–40 m) × 0.850] + (%fat × 3.254) − (TPV × 0.028) − (PVF × 0.00002) + (10 m × 0.299)
$R^2 = 0.75$	$R^2 = 0.84$
SEE = 0.27	SEE = 0.22
Validation ($n = 39$)	
3.211 + [(50–40 m) × 1.597] − (TPV × 0.040) − (RPP × 0.042)	2.326 + [(50–40 m) × 0.753] + (%fat × 3.817) − (TPV × 0.030) − (PVF × 0.00003) + (10 m × 0.479)
$R^2 = 0.73$	$R^2 = 0.84$
SEE = 0.32	SEE = 0.25
Cross-Validation ($n = 39$)	
3.662 + [(50–40 m) × 1.364] − (TPV × 0.047) − (RPP × 0.043)	3.274 + [(50–40 m) × 0.997] + (%fat × 2.724) − (TPV × 0.030) − (PVF × 0.00002) − (10 m × 0.024)
$R^2 = 0.80$	$R^2 = 0.87$
SEE = 0.23	SEE = 0.19

*50–40 m = difference between 40-m sprint time and 50-m sprint time on TM (seconds); TM1 = body mass and TM-derived data; TM2 = body composition and TM-derived data; TPV = time to peak velocity (seconds); RPP = relative peak power ($W \cdot kg^{-1}$); %fat = 4 site body fat percentage (in decimals); 10 m = 10-m sprint time on TM (seconds); PVF = peak vertical force (N).

of 3 attempts, separated by 2–3 minutes, was recorded as the participant's fastest time.

Statistical Analyses

All data are reported as mean ± *SD*. Pearson product-moment correlation coefficients were used to examine the relationships between measurements recorded from the 30-second sprint on the TM, vertical jump performance, and the 30-m sprint. Stepwise regression analysis was then employed to develop 30-m sprint prediction models in the validation and cross-validation groups using (1) body mass and TM-derived data (TM1) and (2) body composition and TM-derived data (TM2). Additionally, a prediction model from the collected vertical jump assessment was created for comparison with the TM-derived equations. In the validation group, it was confirmed whether the regression slope and intercept in the relationship between the estimated and measured sprinting speed values were significantly different from 1 and 0, respectively. To evaluate the accuracy of the equations, a new set of equations was developed using the same variables in the cross-validation group. Once the equations were cross-validated and no significant differences between the slope and intercept values of regression lines for the validation and cross-validation groups in the relationships between the estimated and measured 30-m sprint values were confirmed (Table 2), the data from the 2 groups were pooled to generate the final prediction equations. A criterion alpha level of $p \leq 0.05$ was used to determine statistical significance. Statistical Software (V. 20.0; SPSS Inc., Chicago, IL, USA) was used for all analyses.

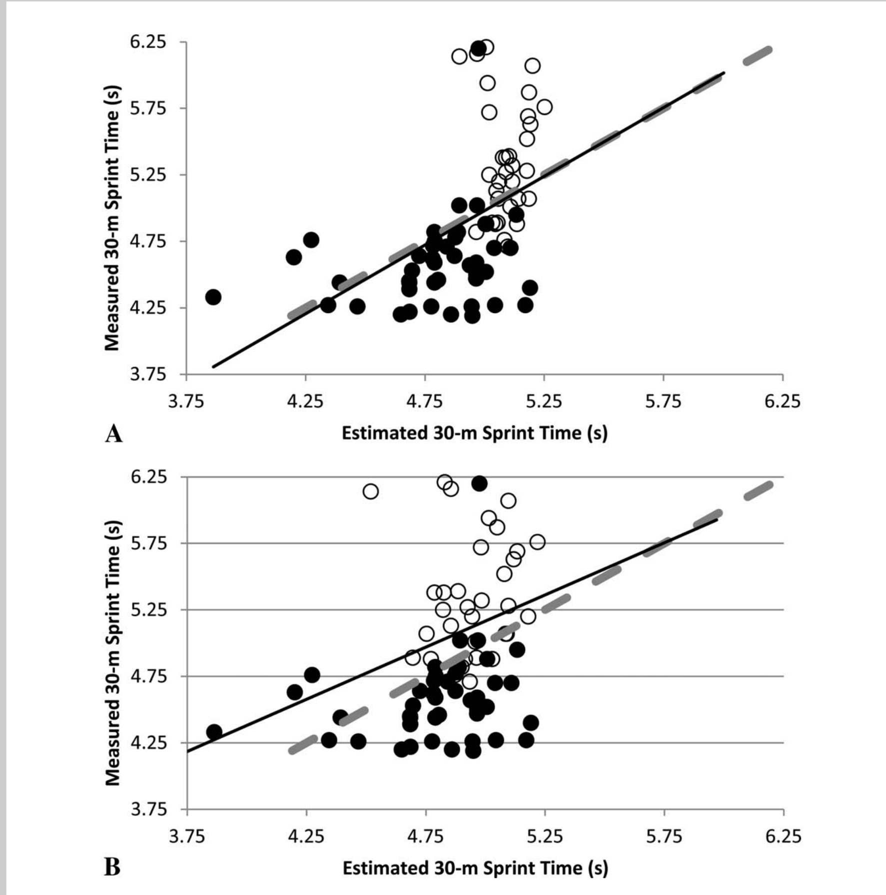

Figure 5. Regression line comparison between vertical jump derived formula and measured 30-m land sprinting performance. A) Peak vertical jump power and (B) mean vertical jump power. A) *Grey dashed line = measured 30-m sprint time; black solid line = estimated 30-m sprint time (PVJP); open circles = women; closed circles = men. B) *Grey dashed line = measured 30-m sprint time; black solid line = estimated 30-m sprint time (MVJP); open circles = women; closed circles = men.

Results

Selected bivariate correlations between TM performance and 30-m maximal sprint can be observed in Table 3. In respect to anthropometric measures; body mass ($r = -0.369$; $p < 0.001$), height ($r = -0.501$; $p < 0.001$), lean body mass (LBM) ($r = -0.629$; $p < 0.001$), and %fat ($r = 0.788$; $p < 0.001$) were all significantly related to 30-m sprint performance, whereas significant relationships were also observed with PVJP ($r = -0.479$; $p < 0.001$) and MVJP ($r = -0.559$; $p < 0.001$).

Stepwise regression indicated that the time spent covering the distance between 40 m and 50 m (TM40-50) on the TM was found to be the best predictor of 30-m sprint time ($R = 0.796$; SEE = 0.360 seconds). Therefore, this variable was present in both of the derived equations. The first equation (Figure 3) found significant contributions from TM40-50, TPV, and relative peak power (RPP). In relation to actual 30-m sprint, this model resulted in a 0.2% mean difference in sprint time with the ability to explain 75% of the variance. The second equation (Figure 4), which considered of all of the collected variables except vertical jump performance, differed from the actual 30-m sprint by 0.6% and improved the ability to predict sprinting time by 9%. In this final equation, the significant contributing variables included TM40-50, %fat, TPV, PVF, and 10-m sprint time. The final, cross-validated equations are expressed in Table 4.

TABLE 5. Comparison between derived models for predicting land sprinting speed ($n = 78$).*

	Mean ± *SD* (s)	%Difference	*r*	SEE
Actual	4.90 ± 0.54			
TM1	4.91 ± 0.47	0.2	0.87	0.27
TM2	4.93 ± 0.49	0.6	0.92	0.22
MVJP	4.67 ± 0.38	−4.7	0.56	0.45
PVJP	4.92 ± 0.25	0.4	0.48	0.48

*TM1 = body mass and TM-derived data; TM2 = body composition and TM-derived data; MVJP = mean vertical jump power; PVJP = peak vertical jump power.

Predictive equations were also derived from vertical jump power scores collected at T2. From these scores, 30-m sprint time could be calculated from peak vertical jump power: $5.533-(0.0003 \times \text{PVJP})$ and mean vertical jump power: $5.772-(0.001 \times \text{MVJP})$. These data indicated a difference of 0.4% and −4.7% in predicted mean scores from actual 30-m sprint time for the peak and mean power equations respectively. The relationship between vertical jump peak and mean power to 30-m sprint speed is depicted in Figure 5. The ability for these equations to explain variance was 23% for PVJP and 31% for MVJP with the *SE* for each estimate being 0.48 seconds and 0.45 seconds, respectively. The combination of both PVJP and MVJP did not significantly add to the prediction equation.

With the least SEE = 0.22 seconds and greatest relationship to 30-m sprint time ($R = 0.92$), TM2 is the most precise of the derived models, whereas TM1 was the second most precise model ($R = 0.87$; SEE = 0.27 seconds). Based on these criteria, both of the TM-derived models seem to be more accurate than the vertical jump models for predicting 30-m sprinting time (Table 5).

DISCUSSION

This investigation set out to determine if maximal sprint performance on the TM was related to 30-m sprint performance. The results of our study indicate moderate-to-strong relationships between 30-m sprint time and several speed and power measures from the TM. Specifically, PP and RPP generated during the TM sprint were both significantly related to 30-m sprint performance. The strongest relationship to 30-m sprint time was found to be the time spent covering the distance between 40 m and 50 m during the 30-second maximal sprint on the TM. Additionally, body mass, height, and lean body mass were negatively related to sprint time, whereas %fat was positively related. Through stepwise regression, 2 prediction models were derived from these relationships. The first of the 2 models (TM1) was able to significantly predict 30-m sprint time using body mass and variables solely obtained from TM performance. The second model (TM2) included these variables in addition to those that described body composition.

Explosive power, as measured from a vertical jump assessment, has been previously shown to predict 10-m ($r = -0.77$, $p = 0.016$) (15), 20-m (-0.73, $p < 0.001$) (14), 30-m ($r = -0.56$, $p < 0.05$) (4), and 40-m ($r = -0.464$, $p < 0.05$) (19) sprint time. This investigation supported these findings with a similar relationship being observed between PVJP and 30-m sprint time ($r = -0.479$; $p < 0.001$). However, the lack of specificity in the movement does not allow it to account for all of the variation in the prediction of sprinting speed. Maulder and Cronin (14) reported that repeated horizontal jump is better correlated to 20-m sprint time ($r = -0.86$, $p < 0.001$) than a vertical countermovement jump ($r = -0.73$, $p < 0.001$) and a repetitive vertical jump ($r = -0.52$, $p < 0.026$) (14). Similarly, the derived TM models from this investigation included power measured in both the horizontal and vertical planes. Both of these models possessed stronger relationships to 30-m sprint time, with lesser SEEs, in comparison with the derived vertical jump models. Our results are in support of other investigations (12,16) that have indicated that power measured in a movement-specific fashion improves the accuracy of sprint time prediction. However, the relationship between power and sprint time after training on the TM remains unknown.

The ability to effectively accelerate on the TM seems to be an important factor in predicting performance to 30-m sprint time. The significant correlation between TPV and 30-m sprint time ($r = -0.23$) and TPV's inclusion in both prediction models demonstrates that TPV is essential for predicting 30-m sprint time. We found that peak velocity occurred immediately before (TPV = 7.22 ± 3.77 seconds), when the participants reached the 40-m distance (7.47 ± 0.89 seconds). This is consistent to the distance where peak velocity typically occurs (3,4). However, acceleration cannot be assumed to have been achieved similarly on the TM and 30-m sprint. In fact, the best predictor for 30-m sprint time was the time spent covering the 10-m distance that followed peak velocity achievement. Although we did not measure sprinting kinematics in this investigation, this may be related to acceleration difficulties, which have been shown to occur with speed progression on the TM (23). The inclusion of 10-m sprint time in TM2, along with TPV in both equations, seems to correct for variance in technical ability. Nevertheless, it remains unknown if greater TM familiarity would reduce the variability. Evidence does suggest that technical improvements in sprinting may occur through inclined TM training (17), despite differences in the mechanics of the 2 modalities (5,6,18,23,27); it is possible that training on the TM may have a similar effect.

The concept that lower-body mass and body composition are predictors for successful sprinting performance is supported directly (10,25) and indirectly (1,2,4,15,19,28) in the literature. In this investigation, significant relationships were found between 30-m sprint time and body mass ($r = -0.369$; $p < 0.001$) and body composition ($r = 0.788$; $p < 0.001$). Consequently, the derived models were developed based on these relationships. In the first model (TM1), which accounted for 75% of the variance in sprint time, body mass was incorporated through RPP. Although PP had a greater relationship ($r = -0.59$) to 30-m sprint time, the effect of body mass and/or weight moved must still be accounted for to accurately predict power and ultimately speed (1,2,4,9,15,19,28). Additionally, body composition also seems to be important during sprinting performance (25). The inclusion of %fat into the regression analysis culminated in a model that improved predictive ability by 9%. Nevertheless, 16% of variance remains unexplained. Although height was correlated to sprint performance, it did not significantly add to either of the prediction models. Likewise, the effect of leg length and the ratio of leg length to body height, which were not measured, may also play significant roles (20).

Practical Applications

In a controlled setting, a 30-second maximal sprint on a nonmotorized TM is capable of measuring speed, force, and power that is related to indoor 30-m sprint time. The relationships between these measures to actual sprint time seem to be stronger than the use of a vertical jump power test. The results of this study indicate that the Woodway Curve 3.0 nonmotorized TM can be an effective predictor of sprint speed and sport-specific power. Consequently, a single 30-second maximal sprint may be an alternative to several time-consuming field tests, once athletes are familiarized with the device.

References

1. Baker, D and Nance, S. The relation between running speed and measures of strength and power in professional rugby league players. *J Strength Cond Res* 13: 230–235, 1999.
2. Berthoin, S, Dupont, G, Mary, P, and Gerbeaux, M. Predicting sprint kinematic parameters from anaerobic field tests in physical education students. *J Strength Cond Res* 15: 75–80, 2001.
3. Cissik, JM. Strength and conditioning considerations for the 100-m Sprinter. *Strength Cond J* 32: 89–94, 2010.
4. Cronin, JB and Hansen, KT. Strength and power predictors of sports speed. *J Strength Cond Res* 19: 349–357, 2005.
5. Elliott, B and Blanksby, B. A cinematographic analysis of overground and treadmill running by males and females. *Med Sci Sports* 8: 84–87, 1976.
6. Frishberg, BA. An analysis of overground and treadmill sprinting. *Med Sci Sports Exerc* 15: 478–485, 1983.
7. Gonzalez, AM, Wells, AJ, Hoffman, JR, Stout, JR, Fragala, MS, Mangine, GT, McCormack, WP, Townsend, JR, Jajtner, AR, and Emerson, NS. Reliability of the Woodway curve non-motorized treadmill for assessing anaerobic performance. *J Sports Sci Med* 12: 104–108, 2013.
8. Gutowski, AE and Rosene, JM. Preseason performance testing battery for men's lacrosse. *Strength Cond J* 33: 16, 2011.
9. Harman, EA, Rosenstein, MT, Frykman, PN, Rosenstein, RM, and Kraemer, WJ. Estimation of human power output from vertical jump. *J Appl Sport Sci Res* 5: 116–120, 1991.
10. Harris, NK, Cronin, JB, Hopkins, WG, and Hansen, KT. Relationship between sprint times and the strength/power outputs of a machine squat jump. *J Strength Cond Res* 22: 691–698, 2008.
11. Hoffman, J. *Norms for Fitness, Performance, and Health.* Champaign, IL: Human Kinetics, 2006.
12. Holm, DJ, Stålbom, M, Keogh, JW, and Cronin, J. Relationship between the kinetics and kinematics of a unilateral horizontal drop jump to sprint performance. *J Strength Cond Res* 22: 1589–1596, 2008.
13. Jackson, AS and Pollock, ML. Practical assessment of body composition. *Phys Sports Med* 13: 76–90, 1985.
14. Maulder, P and Cronin, J. Horizontal and vertical jump assessment: Reliability, symmetry, discriminative and predictive ability. *Phys Ther Sport* 6: 74–82, 2005.
15. Maulder, PS, Bradshaw, EJ, and Keogh, J. Jump kinetic determinants of sprint acceleration performance from starting blocks in male sprinters. *J Sports Sci Med* 5: 359–366, 2006.
16. Meylan, C, McMaster, T, Cronin, J, Mohammad, NI, and Rogers, C. Single-leg lateral, horizontal, and vertical jump assessment: Reliability, interrelationships, and ability to predict sprint and change-of-direction performance. *J Strength Cond Res* 23: 1140–1147, 2009.
17. Myer, GD, Ford, KR, Brent, JL, Divine, JG, and Hewett, TE. Predictors of sprint start speed: The effects of resistive ground-based vs. inclined treadmill training. *J Strength Cond Res* 21: 831–836, 2007.
18. Nelson, RC, Dillman, CJ, Lagasse, P, and Bickett, P. Biomechanics of overground versus treadmill running. *Med Sci Sports* 4: 233–240, 1972.
19. Nesser, TW, Latin, RW, Berg, K, and Prentice, E. Physiological determinants of 40-meter sprint performance in young male athletes. *J Strength Cond Res* 10: 263–267, 1996.
20. Paruzel-Dyja, M, Walaszczyk, A, and Iskra, J. Elite male and female sprinters' body build, stride length and stride frequency. *Stud Phys Cult Tourism* 13: 33–37, 2006.
21. Robbins, DW and Goodale, T. Evaluation of the physical test battery implemented at the National Football League Combine. *Strength Cond J* 34: 52–57, 2012.
22. Semenick, D. Anaerobic testing: Practical applications. *Strength Cond J* 6: 45–45, 1984.
23. Snyder, AC, Edlbeck, BP, Myatt, CJ, and Reynolds, KG. Foot pressures of walking, jogging, and running on non-motorized and motorized treadmills. Poster session presented at: American College of Sports Medicine 58th Annual Conference and 2nd World Conference on Exercise is Medicine, Denver, CO, June 2, 2011.
24. Spaniol, FJ. Baseball athletic test: A baseball-specific test battery. *Strength Cond J* 31: 26–29, 2009.
25. Thomas, T, Zebas, C, Bahrke, M, Araujo, J, and Etheridge, G. Physiological and psychological correlates of success in track and field athletes. *Br J Sports Med* 17: 102–109, 1983.
26. Walker, S and Turner, A. A one-day field test battery for the assessment of aerobic capacity, anaerobic capacity, speed, and agility of soccer players. *Strength Cond J* 31: 52, 2009.
27. Wank, V, Frick, U, and Schmidtbleicher, D. Kinematics and electromyography of lower limb muscles in overground and treadmill running. *Int J Sports Med* 19: 455–461, 1998.
28. Young, W, McLean, B, and Ardagna, J. Relationship between strength qualities and sprinting performance. *J Sports Med Phys Fitness* 35: 13, 1995.