Can experienced runners accurately estimate performance capabilities to derive the parameters of the critical velocity model?

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Abstract
This study examined the accuracy of estimated performance times to define the parameters of the critical velocity (CV) model. Twelve subjects provided an estimated time to complete (ET$_\text{com}$) maximal-effort runs at four different distances (400m, 800m, 1600m, and 3200m). The CV and anaerobic running capacity (ARC) were derived from the total distance (TD) versus ET$_\text{com}$ relationship. The equation: predicted time to completion ([PT$_\text{com}$] = ARC/(velocity - CV)) was used to determine the PT$_\text{com}$ for runs at three different distances (200m, 600m, and 1000m). The PT$_\text{com}$ was validated against the actual time to complete (AT$_\text{com}$) runs at the same three distances. The TD versus ET$_\text{com}$ relationship was highly linear and indicated a close relationship between running distance and time. The PT$_\text{com}$ overestimated the AT$_\text{com}$ at 200m, but there were no significant differences between the PT$_\text{com}$ and AT$_\text{com}$ at 600m and 1000m. There were, however, no significant relationships between PT$_\text{com}$ and AT$_\text{com}$ at any of the three distances. These findings indicated that the CV model could be applied to estimated running times to derive the CV and ARC parameters, but the parameters of the test could not be used to accurately estimate individual performance times above CV using the equation PT$_\text{com}$ = ARC / (V – CV).

Keywords: Fatigue Threshold, Performance Estimations, Aerobic Exercise, Anaerobic Exercise

1. Introduction
The critical velocity (CV) model was developed [1] as the treadmill analog to the critical power (CP) model for cycle ergometry. Running velocity and the time to exhaustion (T$_\text{lim}$) conform to the same hyperbolic relationship that had previously been shown for power output versus T$_\text{lim}$ during cycle ergometry [1]. The CV model provides estimates of two separate parameters, CV and anaerobic running capacity (ARC), that are defined as the slope and the y-intercept of the total distance (TD) and T$_\text{lim}$ relationship, respectively. It has been suggested [2] that CV represents the highest sustainable (at least 30 min) running velocity, where metabolic responses (VO$_2$ and blood lactate) reach steady state values. The ARC parameter reflects the total amount of work that can be performed using only the energy stores within the working muscle (phosphocreatine, adenosine triphosphate, glycogen, and the oxygen bound to myoglobin [3, 4], and is limited by the accumulation of metabolic byproducts and ions [5]. Thus, the CV model provides estimates of two separate parameters, CV and ARC, which reflect the aerobic and anaerobic capabilities, respectively.

One potential application of the CV model is the prediction of performance for intensities above the CV [5]. Currently, there are conflicting data regarding the ability of the CV model to accurately predict performances. For example, Pepper et al. [6] indicated the CV model accurately predicted the time to exhaustion at 115% of CV, but it was over predicted at 100 and 130%. During cycle ergometry, however, the time to exhaustion was accurately predicted at all power outputs above CP [7]. Thus, the results of previous studies [6, 7] indicated there is conflicting evidence regarding the ability of the CP/ CV model to provide an accurate estimate of the subjects’ performance capabilities at power loadings greater than CP or CV.

Typically, the CV test parameters are determined from multiple, constant power output or velocity work bouts, performed to exhaustion. The total distance (TD) is then plotted against the time to exhaustion (T$_\text{lim}$) to derive CV and ARC.
Recently, Black et al. [8] suggested that, in comparison with the conventional constant work rate protocol, a self-selected pacing, time-trial strategy could be used to estimate the CP and AWC during cycle ergometry. These findings [8] indicated performance variables (i.e., time trials), rather than times to exhaustion, may provide accurate estimates of the CP test parameters. No previous studies, however, have examined the validity of CV and ARC derived from estimated performance capabilities at predetermined distances during track running. The CV test is physically demanding, requiring multiple, exhaustive work bouts. To improve the applicability of the test, previous studies have examined the number of trials necessary to accurately estimate the test parameters. During cycle ergometry, it was reported that only two constant work rate tests are necessary to accurately estimate CP and AWC [4]. In addition, a single 3-minute all-out test has also been developed for cycling [4, 8, 9], rowing [11], swimming [12], and running [13]. Although a single, 3-min all-out test reduced the number of workout requirements to determine CV/CP and ARC/AWC, many athletes and coaches do not have access to the necessary equipment and may not be willing to alter training schedules to complete the test. A protocol that utilizes estimated performance times to determine the parameters of the CV test would improve the applicability of the test. Therefore, the purposes of this study were to: 1) determine if estimated performance times at four different distances can be used to accurately define the parameters of the CV test; and 2) if the CV test parameters could be used to accurately predict performance at intensities above CV. Based on previous studies [7, 8], we hypothesized that; 1) CV and ARC would be accurately estimated from estimated performance times; and 2) the estimated CV and ARC parameters could be used to predict performance above CV.

2. Materials and Methods

2.1 Experimental Design

The subjects completed a total of seven visits with a minimum of 24 hours between each visit. During the first visit, the subjects performed a graded treadmill test to exhaustion to determine maximal oxygen uptake ($\dot{V}O_{2peak}$) and the velocity associated with $\dot{V}O_{2peak}$ ($v\dot{V}O_{2peak}$). The subjects were asked to estimate their maximal-effort times to complete (ET$_{com}$) four different distances (400m, 800m, 1600m, and 3200m). The ET$_{com}$ was used to derive the CV and ARC from the linear-total distance versus T$_{lim}$ model. During the remaining six visits, the subjects performed maximal-effort runs at distances of 200m, 600m, and 1000m. Each distance was performed twice, in a randomized order, and the time to complete (AT$_{com}$) the run was recorded. The predicted time to complete (PT$_{com}$) three distances (200, 600, and 1000m) was derived using the CV and ARC estimates from the TD versus ET$_{com}$ relationship. The PT$_{com}$ and AT$_{com}$ for the maximal-effort runs were used to access the validity of the equation: PT$_{com} = ARC / (V - CV)$ for predicting performance, utilizing the CV parameters derived from the predicted times. In addition, the reliability of the performance at each distance (200, 600, and 1000m) was determined.

2.2 Subjects

Twelve (6 males, 6 females; age: 23.5 ± 3.6 years, height: 174.1 ± 8.0 cm, weight: 66.7 ± 9.0 kg) trained runners with experience in running distances, between 15 to 45 miles per week were recruited for this study. The study was approved by the University’s Institutional Review Board for Human Subjects. All subjects completed a medical history questionnaire and signed a written informed consent document prior to testing. Twelve runners completed the incremental treadmill test and provided estimates of their ET$_{com}$ for four distances (400m, 800m, 1600m, and 3200m). Two subjects, however, were removed from the analyses because they provided estimates of ET$_{com}$ that resulted in negative anaerobic running capacity (ARC) values derived from the total distance versus ET$_{com}$ relationship. Therefore, the analyses included 10 subjects (5 males, 5 females; age: 22.6 ± 3.2 years, height: 173.7 ± 8.7 cm, weight: 64.2 ± 7.4 kg).

2.3 Body Composition Assessments

Body composition assessments were conducted with Bioelectrical Impedance Analysis (BIA; Bodystat QuadScan 4000) prior to the exercise testing during visit 1. The BIA device was calibrated before measurements were taken and subjects were instructed to lay in a supine position on a non-conductive surface. The impedance at all frequencies provided (5, 50, 100 & 200 Hz), percent body fat, and total body water were determined from the manufacturer’s prediction equation and recorded for each subject.

2.4 Determination of peak values

During visit 1, the subjects completed a graded treadmill test to exhaustion for the determination of $\dot{V}O_{2peak}$ and $v\dot{V}O_{2peak}$. Prior to the test, each subject completed a 3 min warm-up on the treadmill at a velocity of 4.8 km·h$^{-1}$ and 0% grade, followed by a 3 min passive recovery. Following the warm-up, each subject was fitted with a nose clip and had to breathe through a 2-way valve (Hans Rudolph 2700 breathing valve, Kansas City, MO, USA). Expired gas samples were collected and analyzed using a calibrated TrueMax 2400 metabolic cart (Parvo Medics, Sandy, UT, USA). The gas analyzers were calibrated with room air and gases of known concentration prior to all testing sessions. The $O_2$, $CO_2$, and ventilator parameters were recorded breath-by-breath and expressed as 20 s averages [14]. In addition, HR was recorded with a Polar Heart Rate Monitor (Polar Electro Inc., Lake Success, NY) that was synchronized with the metabolic cart. Heart rate was recorded continuously throughout the test and expressed as 20 s averages. Each subject gave a rating of perceived exertion (RPE) during the last 10 s of each minute using the Borg 6-20 RPE scale [15]. The incremental test began at a treadmill velocity of 6.4 km·h$^{-1}$ and 0% grade. Following the 14.4 km·h$^{-1}$ stage, the velocity no longer was increased, however, the treadmill grade was increased by 2% every 2 min until the subject no longer could maintain the running velocity and grasped the handrails to signal exhaustion. The $\dot{V}O_{2peak}$ was defined as the highest 20 s average $\dot{V}O_2$ value recorded during the test. The velocities performed at 0% grade (6.4 to 14.4 km·h$^{-1}$), were plotted against $\dot{V}O_2$ and the regression equation derived was used to determine the $\dot{V}O_{2peak}$.

2.5 Estimated Performance Times and CV Parameter Determination

Following the graded treadmill test, each subject completed a written survey asking them to provide the ET$_{com}$ for maximal-effort runs at 400m, 800m, 1600m, and 3200m. The TD was plotted against ET$_{com}$ for each of the four distances. The CV and ARC were defined as the slope and y-intercept of the regression line, respectively, of the TD versus ET$_{com}$ relationship.
2.6 Determination of \( \text{PT}_{\text{com}} \)
The \( \text{PT}_{\text{com}} \) for three distances (200, 600, and 1000m) was derived using the CV and ARC estimates from the TD versus ET\(_{\text{com}}\) relationship, along with the average running velocities (V) calculated for each distance from the AT\(_{\text{com}}\) (V = TD / AT\(_{\text{com}}\)). The PT\(_{\text{com}}\) values were derived for each of the standard distances using the equation: \( \text{PT}_{\text{com}} = \text{ARC} / (V - \text{CV}) \).

2.7 Examination of the Estimated CV and ARC Parameters
During visits 2 – 7, the PT\(_{\text{com}}\) values for the 200m, 600m, and 1000m distances, obtained from the TD versus ET\(_{\text{com}}\) relationship, were validated against the AT\(_{\text{com}}\) runs at 200m, 600m, and 1000m. All of the runs were conducted outside on a measured running loop on a city block. The subjects performed a standardized running warm-up. Following the warm-up, a rest period of 10 min was given prior to beginning the max-effort run. The maximal-effort runs at each of the three distances were performed on separate days, and each distance was performed twice, in a randomized order with a minimum of 24 h of recovery between runs for the determination of the test-retest reliability (ICC) at each distance. The AT\(_{\text{com}}\) was recorded by the tester using a stopwatch.

The subjects were given strong verbal encouragement during each run and were not aware of how much time had elapsed. The faster of the two trials at each distance was used to compare to the PT\(_{\text{com}}\) derived from the CV model.

2.8 Statistical Analysis
The mean differences between the PT\(_{\text{com}}\) determined from the TD versus ET\(_{\text{com}}\) relationship and the fastest recorded AT\(_{\text{com}}\) for each distance were analyzed using paired samples t-tests. The relationship between the PT\(_{\text{com}}\) and AT\(_{\text{com}}\) were assessed using Pearson correlations, coefficients of determination, and the standard error of the estimates (SEE). In addition, the relationships among CP, ARC, and AT\(_{\text{com}}\) for each distance (200, 600, and 1000 m) were examined using a Pearson product correlation matrix. The relative reliability of AT\(_{\text{com}}\) for each distance was examined using the intraclass correlation coefficients (ICC), with the inclusion of systematic error 2,1 and 2,k equations \[166\]. Absolute reliability of AT\(_{\text{com}}\) for each distance was examined using the standard error of the measurement (SEM). Bland-Altman plots were used to assess the agreement between: 1) PT\(_{\text{com}}\) and AT\(_{\text{com}}\) at each distance (200, 600, and 1000m); and 2) the first and second set of performance trials for each distance (200, 600, and 1000m).

3. Results
The mean ± SD and range of values derived from the incremental treadmill test and body composition analyses are presented in Table 1. The ET\(_{\text{com}}\) for the four distances (400m, 800m, 1600m, and 3200m) used to determine the CV and ARC ranged from 60 s to 1080 s. The \( r^2 \) values for the TD versus ET\(_{\text{com}}\) relationship ranged from 0.996 to 1.000. The mean (± SD) CV and ARC were 14.3 ± 2.9 km·h\(^{-1}\) (81.3\% of \( \dot{V}_{\text{O}_2\text{peak}} \)) and 125.07 ± 32.43 m, respectively. The mean ± SD and range of values for the PT\(_{\text{com}}\) and AT\(_{\text{com}}\) for the 200, 600, and 1000m runs are presented in Table 2. There was a significant difference (t\(_{\text{df}}\) = 6.90, \( p < 0.001 \)) and no significant relationship (\( r^2 = 0.02, \text{SEE} = 4.79 \text{ s}, p = 0.72 \)) between the PT\(_{\text{com}}\) (53.77 ± 9.28 s) and AT\(_{\text{com}}\) (32.40 ± 4.55 s) at 200m (Figure 1). The results of the Bland-Altman analyses are presented in Figure 2. The PT\(_{\text{com}}\) was not significantly different from the AT\(_{\text{com}}\) at 600 m (PT\(_{\text{com}}\) = 111.16 ± 19.14 s and AT\(_{\text{com}}\) = 119.90 ± 20.35 s; t\(_{\text{df}}\) = -1.10, \( p = 0.30 \)) or 1000 m (PT\(_{\text{com}}\) = 198.52 ± 127.44 s and AT\(_{\text{com}}\) = 213.30 ± 32.40 s; t\(_{\text{df}}\) = -0.34, \( p = 0.74 \)), and there was no significant relationship between PT\(_{\text{com}}\) and AT\(_{\text{com}}\) at either distance (600 m: \( r^2 = 0.04, \text{SEE} = 21.18 \text{ s}, p = 0.59 \) and 1000 m: \( r^2 = 0.05, \text{SEE} = 33.47 \text{ s}, p = 0.53 \)) (Figures 3 and 4). The results of the Bland-Altman analyses for 600 m and 1000 m are presented in Figures 5 and 6. The relationships among CV, ARC, and AT\(_{\text{com}}\) for each distance are presented in Table 3. The test-retest reliability at each distance (200, 600, and 1000m) resulted in ICC Values of R = 0.98 – 0.99. The SEM values for 200, 600, and 1000 m runs were 0.12 s, 0.87 s, and 0.69 s, respectively. Furthermore, there were no mean differences (p = 0.081 – 0.965) between test-retest for any of the distances.

### Table 1: Subject demographics, body composition (% body fat), and maximal aerobic capacity (\( \dot{V}_{\text{O}_2\text{max}} \)) for 5 male and 5 female subjects.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>22.6 ± 3.24</td>
<td>19-29</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>173.7 ± 8.9</td>
<td>162.6-188.0</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>64.3 ± 7.4</td>
<td>48.6-75.5</td>
</tr>
<tr>
<td>Body Comp (% Fat)</td>
<td>14.2 ± 9.2</td>
<td>1-28.1</td>
</tr>
<tr>
<td>( \dot{V}_{\text{O}_2\text{max}} ) (ml·kg(^{-1})·min(^{-1}))</td>
<td>63.96 ± 12.39</td>
<td>48.69-82.71</td>
</tr>
</tbody>
</table>

### Table 2: Mean ± SD for predicted (PT\(_{\text{com}}\)) and actual (AT\(_{\text{com}}\)) times to completion for the 200, 600, and 1000m runs for 5 male and 5 female subjects.

<table>
<thead>
<tr>
<th>Distance</th>
<th>PT(_{\text{com}}) (s)</th>
<th>AT(_{\text{com}}) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 m</td>
<td>53.77 ± 9.28*</td>
<td>32.40 ± 4.55</td>
</tr>
<tr>
<td>600 m</td>
<td>111.16 ± 19.14</td>
<td>119.90 ± 20.35</td>
</tr>
<tr>
<td>1000 m</td>
<td>198.52 ± 127.44</td>
<td>213.30 ± 32.40</td>
</tr>
</tbody>
</table>

*Significantly (P < 0.05) greater than the actual time to completion

### Table 3: Correlation matrix for the critical velocity (CV), anaerobic running capacity (ARC), and the actual times to complete (AT\(_{\text{com}}\)) running trials at 200, 600, and 1000m (n = 10).

<table>
<thead>
<tr>
<th></th>
<th>CV</th>
<th>ARC</th>
<th>AT(_{\text{com}}) 200</th>
<th>AT(_{\text{com}}) 600</th>
<th>AT(_{\text{com}}) 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARC</td>
<td></td>
<td>-1.88</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AT(_{\text{com}}) 200</td>
<td></td>
<td>-0.90*</td>
<td>-0.93</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>AT(_{\text{com}}) 600</td>
<td></td>
<td>-0.88*</td>
<td>-1.17</td>
<td>0.960*</td>
<td>1.00</td>
</tr>
<tr>
<td>AT(_{\text{com}}) 1000</td>
<td></td>
<td>-0.869*</td>
<td>-1.51</td>
<td>0.917*</td>
<td>0.982*</td>
</tr>
</tbody>
</table>

*Significant at \( p \leq 0.05 \)

Fig 1: The relationship between the actual time to completion (AT\(_{\text{com}}\)) versus the predicted times to completion (PT\(_{\text{com}}\)) for the 200m run.
Fig 2: Bland Altman analysis of agreement between the actual (AT\textsubscript{com}) minus predicted (PT\textsubscript{com}) and actual time for the 200m. The middle solid line represents the mean of the difference of the actual time and predicted time. The upper and lower dotted lines represent the bias ±1.96 SD (95% Limits of Agreement). The $r^2 = 0.1171; P > 0.05$

Fig 3: The relationship between the actual time to completion (AT\textsubscript{com}) versus the predicted time to completion (PT\textsubscript{com}) for the 600m run

$r^2 = 0.04$

SEE = 21.18 s

p = 0.59

Fig 4: The relationship between the actual time to completion (AT\textsubscript{com}) versus the predicted times to completion (PT\textsubscript{com}) for the 1000m run

$r^2 = 0.05$

SEE = 33.47 s

p = 0.53

Fig 5: Bland Altman analysis of agreement between the actual (AT\textsubscript{com}) minus predicted (PT\textsubscript{com}) and actual time for the 600m. The middle solid line represents the mean of the difference of the actual time and predicted time. The upper and lower dotted lines represent the bias ±1.96 SD (95% Limits of Agreement). The $r^2 = 0.44; P > 0.05$

Fig 6. Bland Altman analysis of agreement between the actual (AT\textsubscript{com}) minus predicted (PT\textsubscript{com}) and actual time for the 1000m. The middle solid line represents the mean of the difference of the actual time and predicted time. The upper and lower dotted lines represent the bias ±1.96 SD (95% Limits of Agreement).

$r^2 = 0.1965$

4. Discussion

The primary purpose of the present study was to determine if estimated performance times at four different distances can be used to accurately define the parameters of the CV test. The TD was plotted as a function of the ET\textsubscript{com} for four running distances (400, 800, 1600, and 3200m). The $r^2$ values for the TD versus T\textsubscript{lim} (0.996 – 1.000) relationship were consistent with the $r^2$ values (0.987 – 0.999) reported in previous studies of recreationally trained subjects [6, 7], and indicated a close relationship between running distance and time. These findings suggested that the mathematical model used to derive the CV parameters (CV and ARC) from times to exhaustion during constant velocity running, was also applicable to estimated performance times at specified distances. The mean ± SD and range of CV (14.3 ± 2.9 km·h\textsuperscript{-1}; 10.2 – 17.9 km·h\textsuperscript{-1}) and ARC (0.13 ± 0.032 km; 0.09 – 0.11 km) values in the present study were higher and lower, respectively, than the mean and range of CV (13.43 ± 2.04 to 13.7 ± 1.1 km·h\textsuperscript{-1}; 10.43 – 17.85 km·h\textsuperscript{-1}) and ARC (0.20 ± 0.063 km; 0.11 – 0.23 km) values previously reported for recreationally trained subjects [6, 17]. These differences in CV and ARC values may be related to the training status of the subjects. Specifically, the subjects in the present study, although not elite, were experienced runners and had a greater aerobic capacity (63.96 ± 12.39 ml·kg\textsuperscript{-1}·min\textsuperscript{-1}), than previous
samples of subjects who exercised regularly, but were not highly trained runners (48.6 ± 7.1 to 54.4 ± 6.6 ml kg⁻¹ min⁻¹). Thus, the ARC and CV values in this present study were slightly lower and higher, respectively, compared with previous studies examining recreationally trained subjects [6, 7]. These differences may be related to the slightly greater aerobic capacity and the mode specific training adaptations of the current sample of experienced runners, compared with generally active individuals previously reported [6, 7].

One unique application of the CV model is the ability to predict the time to exhaustion (PT<sub>com</sub>) at any velocity greater than CV using the equation: PT<sub>com</sub> = ARC / (V – CV) [3]. In the present study, the accuracy of the PT<sub>com</sub> estimated from the CV and ARC parameters derived from the TD versus ET<sub>com</sub> relationship was examined for three distances (200, 600, and 1000m). At 200m (~150% of CV) the PT<sub>com</sub> overestimated the AT<sub>com</sub> while the PT<sub>com</sub> for the 600m (125% of CV) and 1000m (118% of CV) were not significantly different from the AT<sub>com</sub>. There were, however, no significant relationships between the AT<sub>com</sub> and PT<sub>com</sub> for any of the distances. Currently, there are conflicting data regarding the accuracy of performance prediction for intensities above CV or CP [6, 7]. For example, Pepper et al. [6] reported no significant differences and significant relationships between the predicted and actual times to exhaustion at 85% and 115% of CV, however, the time to exhaustion was over predicted at 100% and under predicted at 130% of CV. In addition, during cycle ergometry, there were no differences and significant relationships (r = 0.84 – 0.89, p < 0.05) between the predicted and actual times at power loadings above CP [7]. At CP, however, the actual time to exhaustion was significantly less than the predicted time [7]. The discrepancy between actual and predicted times for intensities greater than 130% of CV in the present study, as well as previous studies [6], may be related to the limitations of the mathematical model. Typically, the CV model is determined from work bouts ranging from 1 to 20 min [2, 18] and in the present study the range of times used to determine CV and ARC was 1 to 18 min. The prediction of the 200m time required extrapolation outside the range of values used to determine the parameters of the CV test. Thus, the significant difference between the PT<sub>com</sub> and AT<sub>com</sub> at higher intensities (>130% of CV) may be related to the limitations of the mathematical model to predict performance outside the range of values used for the CV and ARC parameter estimations.

The non-significant differences between PT<sub>com</sub> and AT<sub>com</sub> at 600m and 1000m, reflecting 125% and 118% of CV, respectively, in the present study was consistent with previous data indicating no significant differences between actual and estimated times at 115% of CV [6]. The lack of relationship between PT<sub>com</sub> and AT<sub>com</sub> (Figures 1, 3, and 4), however, was not consistent with previous research [6, 7] and indicated significant individual variability in the performance predictions. In addition, the SEE values for the three runs indicated a possible error in prediction of 4.8 s for a 32.4 s run (14.8% of mean), 21.2 s for a 2 min run (17.7% of mean), and 33.5 s for a 3.55 min (15.7% of mean) run. These SEE values indicated an error that was too large to be of practical value when predicting performance at these distances. Thus, the current findings, in conjunction with those of others [6, 7], indicated that the prediction of performances utilizing the CP and CV models tend to under or overestimate the actual times to exhaustion for high intensity, shorter duration trials (>130% of CV), and resulted in SEE values for all three distances that were too great to provide accurate estimates of performance. The lack of correlation between actual and predicted times may be related to the non-significant relationship between the independent variables (CP and ARC) used to estimate running performance and the non-significant relationships between ARC and any of the running distances. Because ARC was not related to running performance in the present study, but is used in the equation to derive the PT<sub>com</sub>, it may reduce the accuracy of the model. Therefore, the current findings did not support the validity of the equation PT<sub>com</sub> = ARC / (V – CV).

5. Conclusions

In conclusion, the purpose of this study was to determine if estimated performance times at four different distances can be used to accurately define the parameters of the CV test. The TD versus ET<sub>com</sub> relationship was highly linear (r² = 0.996 – 1.000) and indicated a close relationship between running distance and time. These findings suggested that the mathematical model used to derive the CV parameters (CV and ARC) from times to exhaustion during constant velocity running, was also applicable to estimated performance times at specified distances. The comparisons of the PT<sub>com</sub> versus the AT<sub>com</sub> indicated the PT<sub>com</sub> overestimated the AT<sub>com</sub> for the 200m. There were no significant differences between the PT<sub>com</sub> and AT<sub>com</sub> for the 600 and 1000m, however, there were no significant relationships between PT<sub>com</sub> and AT<sub>com</sub> at any of the distances. These findings were consistent with other studies that also found a discrepancy between actual and predicted times utilizing the CP and CV model [6, 7]. In addition, the SEE values for all three distances indicated error in prediction that was too great to be of practical values for the 200m, 600m, and 1000m distances. Therefore, the principal findings of this study were that the CV model could be applied to estimated performance times during outdoor running to derive the CV and ARC parameters, but the parameters of the test could not be used to accurately estimate performance times above CV using the equation PT<sub>com</sub> = ARC / (V – CV).

6. References


