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ASSESSING DAY-TO-DAY RELIABILITY OF THE NEWTEST 2000 SPRINT TIMING SYSTEM

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Abstract The purpose of the present study was to assess the day-to-day test-retest reliability of the Newtest 2000 - sprint timing system. The reliability of the system was assessed by testing 52 Physical Education students. All participants were tested on 30 m sprint, with 10 m, 20 m and 30 m split times obtained as well. All measurements were performed on two subsequent days at the same place and time of the day with identical settings and configurations. The results from this investigation indicate that the performance variations between test day one and test day two was small and the Intra-Class Correlation (ICC) indicates a high repeatability of the students' performance during the day-to-day test-retest. In the examination of the system reliability, the results did not show any marked systematic bias ($P < 0.05$) in the mean difference (errors) between the measurements on the first day (test) and second day (retest) occasions. We conclude that the Newtest 2000 sprint timing system examined in this study is a reliable testing instrument for testing Physical Education students and a useful instrument for measuring running speed. However, in future studies it would be interesting to examine if the system would be able to monitor the small changes in running speed that could result from increasing the training of an already elite athlete.

Key words: Assessment, reliability, measurement, running, sprint speed

INTRODUCTION

Sprint performance and repeated sprint ability have been extensively described within both male and female elite and non-elite athletes [2, 3, 4, 7, 8, 13, 17, 18, 19]. A number of measurement methods (shuttle runs, straight forward acceleration, sprinting and treadmill testing) using equipment such as photocells or light beams have been introduced [3, 13, 15, 19]. One of the applicable systems used in assessing sprint time is the Newtest 2000 - sprint timing system (Newtest Oy, Oulu, Finland). However, the reliability of the system has yet to be verified.

Reliability is of paramount importance in sport sciences, and has been defined as the "consistency of measurements" or "absence of measurement error" [1, 9, 14]. A basic requirement of any test is that repeated measurements yield consistent results. Therefore, reliability refers to the reproducibility of a measurement; measures should be reproducible so that there is neither marked systematic (learning, motivation, fatigue) nor random (sampling) variation [9, 10, 14]. Furthermore, poor reliability degrades the ability to track changes in measurements in clinical or in experimental studies and the degree to which the eventual measurement errors can be accepted for practical use is of high importance [1]. Consequently, the aim of the present study was to assess the day-to-day reliability (repeatability) of the Newtest 2000 - sprint timing system.

MATERIALS AND METHODS

SUBJECTS

52 healthy male and female physical education students, whose age, body mass and stature (± SD) were 21.4 (± 8.9) years, 73.1 (± 10.4) kg, and 175 (± 0.08) cm, respectively, accepted to take part in this study. Written consent was obtained from all participants, and the institutional ethics committee approved the study.

INSTRUMENTS

Body mass (kg) was attained using an electronic scale (A & D Company Limited, Tokyo, Japan), and the stature was measured using a wall mounted stadiometer (KaWe Medizintechnik, Asperg, Germany).

The Newtest 2000 - sprint timing system consisted of photocells installed in metal wall-mounted cases and with fixed sensors for increased stability. The IR-beam of the photocell measurement distance was adjusted to its maximal detecting range, namely 2 m. These photocells were positioned at the distance of 0 m, 10 m, 20 m and 30 m and interconnected via cables and connected to a computer (PC Pentium 4) which, according to the manufacturer, measures time to 0.001 s. The photocells were mounted at a 45 m sprint running track.

TESTING PROCEDURE

Following a regular track and field warm up ending with three near maximal 30 m sprints, the participants were asked to perform three maximum attempts on 30 m sprint with at least three minutes' recovery between the attempts. The sprints were performed from a standing position 30 cm behind the starting line. Measurement of the 30 m sprint started when the participant broke the beam from the first photocell (Time Zero), and times for 10 m, 20 m and 30 m were measured at the same run. The best result was retained for analysis. Furthermore, all measurements were performed on two subsequent days at the same place and time of the day with identical settings and configurations.

STATISTICAL ANALYSIS

Raw data was transferred to SPSS 13.0 for Windows and Analyse-it for Microsoft Excel (Version 2.11). First, a two-way mixed Intra-class Correlation (ICC) reliability and the coefficient of variation (cV%) between day-to-day test-retest were calculated for all measures in this study according to the guidelines provided by Hopkins [10]. Then, the data were examined by the scatter plot, and Pearson's *r* correlation was computed to observe the relationships between all variables from test day one and test day two; if the correlation was found to be strong, a leaner regression was applied to the scatter plot to calculate R^2 and the equation of the predicted variable. To assess the reliability of the testing system, the data were plotted using Bland and Altman's 95% limits of agreement described by Atkinson and Nevill [1]. Paired t-test was used to assess the hypothesis of zero bias in the reliability analysis. If heteroscedasticity (the differences depend on the magnitude of the mean) was suspected or the data did not follow normality, a logarithmic (natural) transformation of the data was assessed before calculating bias and limits of agreement. Then the data was presented after the antilog was performed. Paired t-test was then applied on the log transformed data. Pearson's *r* was calculated to examine heteroscedasticity between absolute differences and individual means. The 0.05 level of significance was adopted for all statistical tests. To determine if the Newtest 2000 sprint timing system can be of practical use, the analytical goals regarding reliability were set based on our use of the systems at the University and the results of improvement found in the literature [5, 6, 11, 16]. Therefore, our analytical goals were set to a total error (systematic bias and random error) that did not exceed ± 0.15 s.

RESULTS

The between day-to-day reliability for 0–10 m sprint time was intra-class correlated (ICC) =0.85 with a cV% of 3.2%, for 0–20 m sprint time was ICC = 0.95 with a cV% of 1.9%, and for 0–30 m sprint time was ICC = 0.97 with a cV% of 1.5%.

Linear regression analysis was conducted on the data to determine the relationship; the shared variance and the linear regression equation between test day one and test day two are presented for 0–10 m sprint time (Figure 1), 0–20 m sprint time (Figure 2) and 0–30 m sprint time (Figure 3).

The day-to-day reliability did not show any marked systematic bias. In the examination of heteroscedasticity of the Newtest 2000 sprint timing system, an outlier was observed and removed from the 0–10 m sprint time (Figure 4), 0–20 m sprint time (Figure 5) and 0–30 m sprint time (Figure 6) measures.

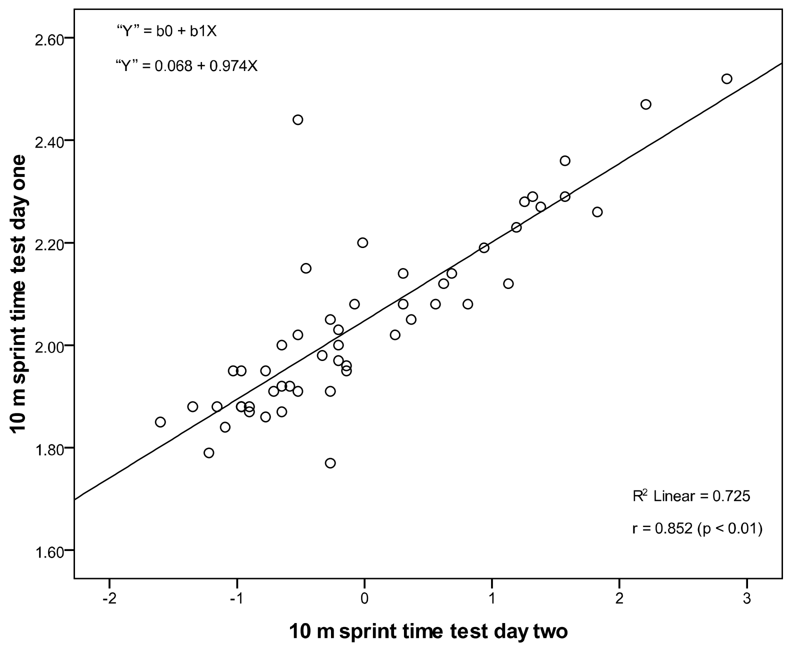

Figure 1. R^2, Pearson's r correlation, p-value and linear regression equation between the results of the 10 m sprint time test day one and 10 m sprint time test day two

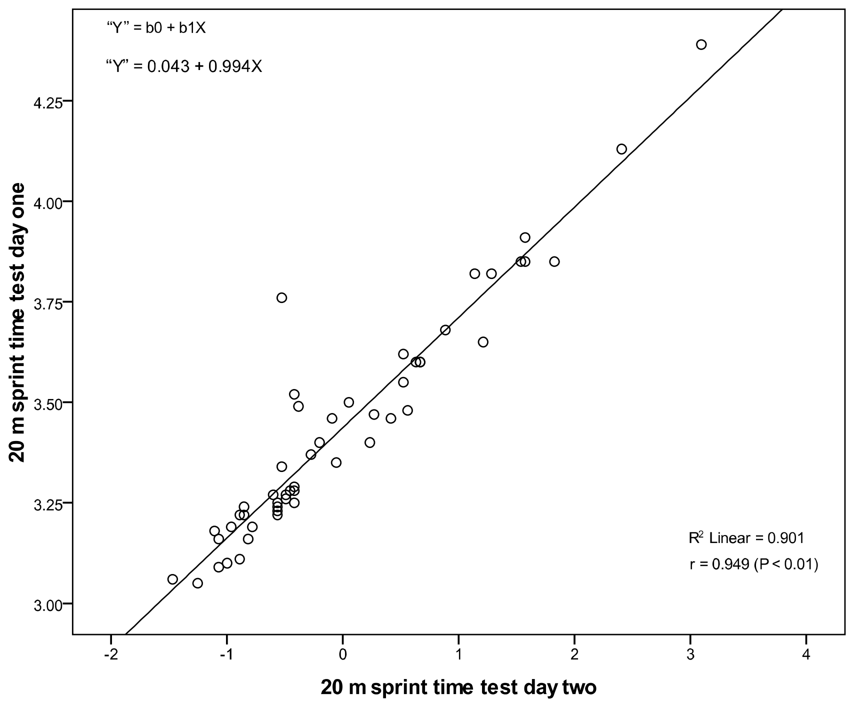

Figure 2. R^2, Pearson's r correlation, p-value and linear regression equation between the results of the 20 m sprint time test day one and 20 m sprint time test day two

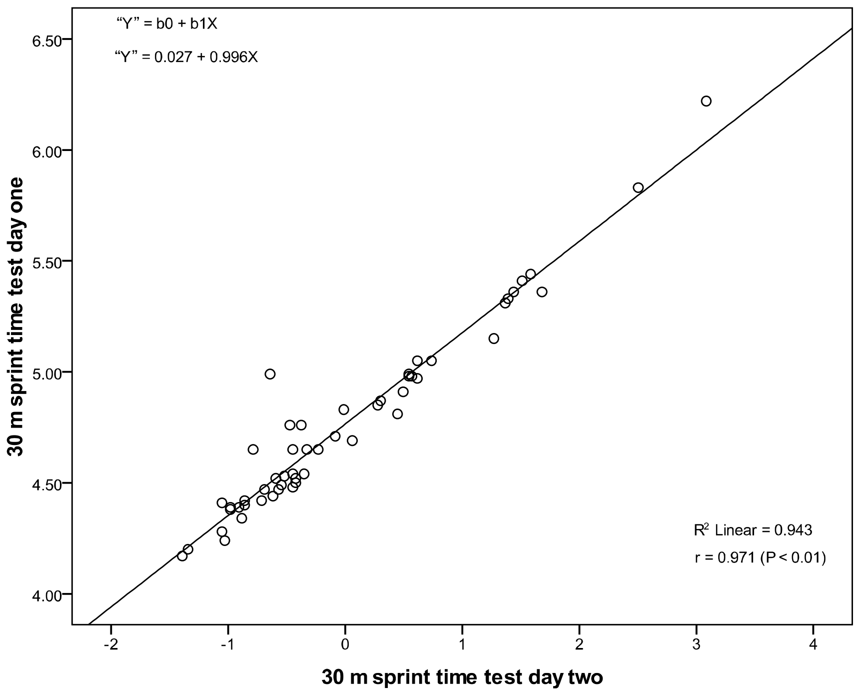

Figure 3. R^2, Pearson's r correlation, p-value and linear regression equation between the results of the 20 m sprint time test day one and 20 m sprint time test day two

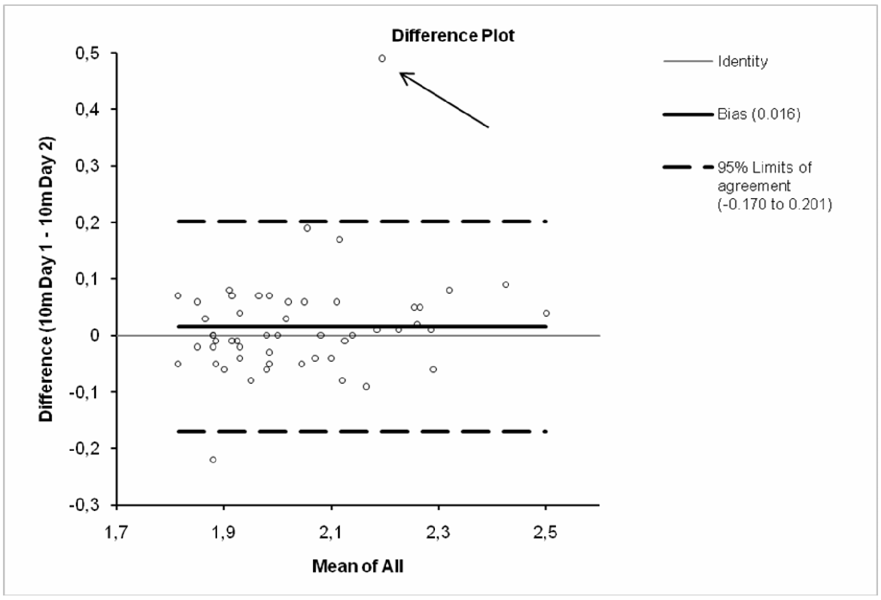

Figure 4. Bland-Altman plot with bias and 95% limits of agreement for test-retest of 10 m running speed time

The results are presented in seconds. The systematic variations are presented as bias and the random variations are presented as 95% limits of agreement (Table 1).

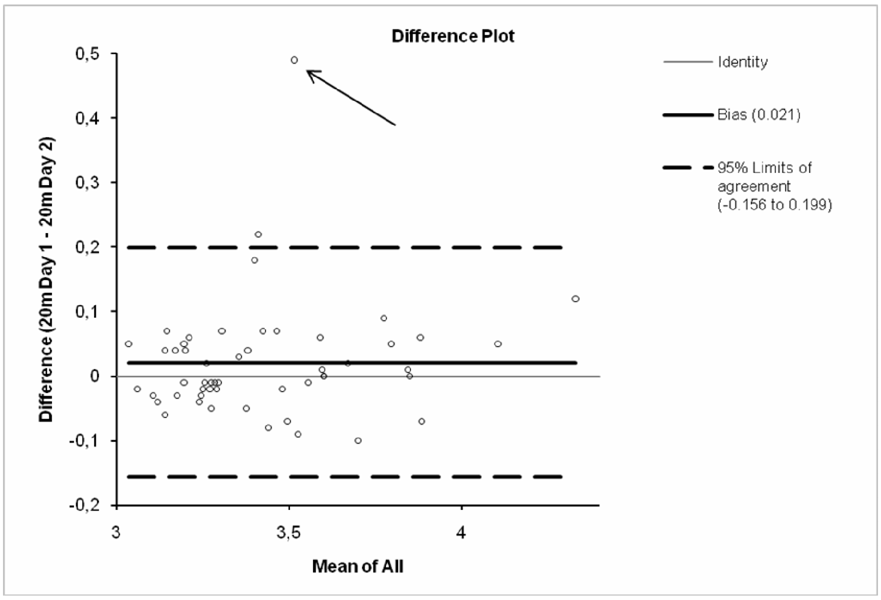

Figure 5. Bland-Altman plot with bias and 95% limits of agreement for test-retest of 20 m running speed time

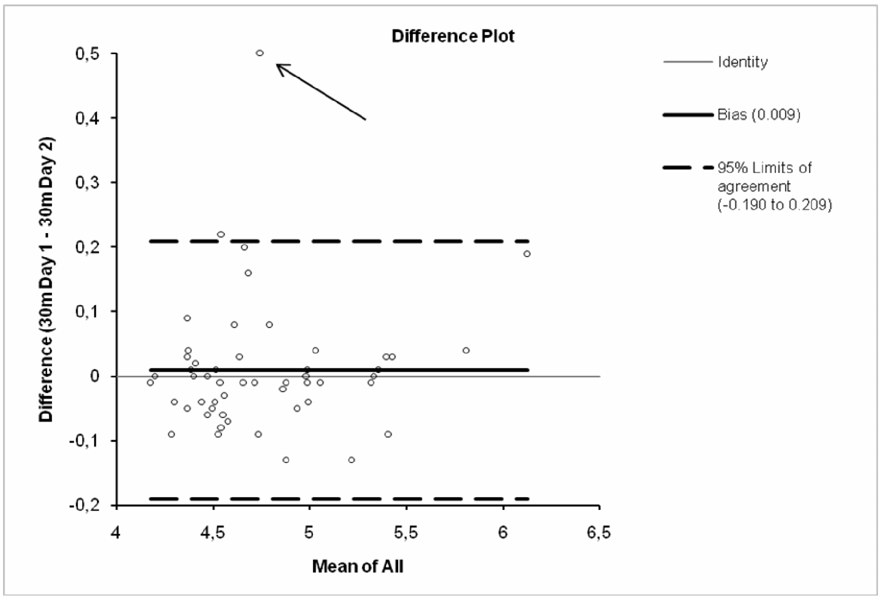

Figure 6. Bland-Altman plot with bias and 95% limits of agreement for test-retest of 30 m running speed time

Table 1. Reliability measures of Newtest 2000 timing system. Data are presented in ratio scale after antilog

	Test	**Retest**	**Bias**	**95% Limits of agreement**	**Paired t-test (P-value)**
0-10m sprint (s)	2.04±0.17	2.03±0.16	1.003 (0.3%)	X/÷ 1.065 (±6.5%)	0.508
0-20m sprint (s)	3.43±0.29	3.42±0.28	1.004 (0.4%)	X/÷ 1.035 (±3.5%)	0.173
0-30m sprint (s)	4.76±0.43	4.76±0.42	1.000 (0.0%)	X/÷ 1.031 (±3.1%)	0.969

Pearson *r* between the absolute difference and the average mean was: 0-10 m (r = 0.22, n = 51, P = 0.12), 0-20 m (r = 0.16, n = 51, P = 0.26) and 0-30 m (r = 0.15, n = 51, P = 0.28).

DISCUSSION

The ICC reliability found in this study indicates a high repeatability of performance between test day one and test day two. The variations for all measures were small and less than 5% [10]. However, this was expected as it had been found that test-retest performance reliability in sprint could be achieved without the need for familiarization sessions [12]. Furthermore, when assessing the correlation coefficient (*r*), the results indicate that all the relationships between the measures from test day one and test day two were strong ($p<0.01$) and indicate a close to linear relationship [10]. Based on the strength of this relationship between test pairs, we assume that accurate predicting of the *Y* value from the *X* value could be achieved by applying the regression equation provided (Figure 1-3).

When exploring the test (day one) and retest (day two) data with Bland-Altman plot, one outlier in 0-10 m, one outlier in 0-20 m and one outlier in 0-30 m sprinting time measures were observed (Figure 4-6). Those outliers were eliminated from the study because they would affect the assessment of the timing system day-to-day reliability [1, 9]. In the examination of heteroscedasticity it was observed that the difference depends on the magnitude of the mean. Further examination of heteroscedasticity was conducted on the data from all measures by calculating the correlation coefficient between the absolute differences and the individual means. The results showed a positive but not significant correlation for all measures (Table 1). In this case, we have decided accordingly to log transform the data before calculating the systematic bias and the random error associated with the testing system and present them in a ratio scale [1, 14].

In the examination of reliability, the results indicate that the mean differences (errors) between measurements on the first (test) and second (retest) occasions (1.003 ×/÷ 1.065 for 0-10 m sprint time, 1.004 ×/÷ 1.035 for 0-20 m sprint time and 1.000 ×/÷ 1.031 for 0-30 m sprint time) were not significantly biased when assessed by paired sample t-test (Table 1). Assuming they are normally distributed, 95% of the differences should lie between the limits of 0.3% (± 6.5%) for 0-10 m sprint time, 0.4% (± 3.5%) for 0-20 m sprint time and 0.0% (± 3.1%) for 0-30 m sprint time regardless of the subjects' mean performance. Thus, for any individual who took part in this study, it would be expected that the difference between any two tests should lie within the limits of agreement (i.e. if a subject performed 4.09 s on 0-30 m on day one, it is possible that the same subject obtained a result as low as 3.96 s and as high as 4.22 s, on test day two). Comparing the results with our analytical goals, the system was found to be a useful testing system for us in testing physical education students. The findings in this study could be supported by the performance improvement reported by other studies; Ross et al [16] found a 0.10 s improvement in 30 m sprinting ($p<0.05$) after 7 weeks sprint training on current and former athletes. Also, several other studies have reported an improvement between -0.13 s to -0.22 s over 30 m sprinting after speed training interventions in young and healthy males [5, 6, 11].

CONCLUSION AND PRACTICAL APPLICATION

The Newtest 2000 sprint time system studied here has shown to be a useful tool for estimating running speed. Additionally, the results from this investigation revealed that the Newtest 2000 sprint timing system was a reliable testing instrument for testing physical education students. However, the measurement errors associated with the system suggest and advise to repeat the study on already trained athletes to examine if the system would be able to monitor the small changes in running speed that could result from increasing the training of an already elite athlete. However, if comparison of overall values of running speed is intended, it is important to use the same testing system. It is also advisable to use this equipment only if no other gold standard equipment is available.

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