Original Article

Concurrent Validity of Power Output Derived from the Non-motorised Treadmill Test in Sedentary Adults

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Abstract

Introduction: Many consider the Wingate Anaerobic Test (WAnT) as a reference standard assessment mode in the measurement of lower limb short-term power output. However the WAnT is criticised for having low ecological validity, in non-cycling tasks and is reliant on a pre-determined applied force, which might not elicit the highest power output. A viable alternative to the WAnT is the Non-Motorised Treadmill (NMT) Test, which allows for power measurement in all-out intensity effort sprint-running. With the reliability of the NMT to elicit power in sedentary adults already established, the aim was to compare peak power (PP) and mean power (MP) derived from a 10-s sprint on the NMT to that derived from a 10-s WAnT, to establish concurrent validity. Materials and Methods: Twelve male [age 26.6 ± 2.4 years, body mass (BM) 63.0 ± 7.2 kg] and 11 female (age 25.3 ± 3.6 years, BM 51.0 ± 4.0 kg) sedentary adults participated in the study. PP and MP in absolute, ratio-scaled and allometrically-scaled to BM were analysed. Ratio limits of agreement (LOA) was used to establish the agreement between PP and MP from the NMT and the WAnT. Results: PP in absolute and ratio-scaled to BM from the NMT was between 1.04 and 1.12 times that of PP from the WAnT in 95% of the attempts (PP: NMT, 647.1 ± 176.4W vs WAnT, 597.0 ± 146.0W). MP in absolute and ratio-scaled to BM from the NMT test was between 0.88 and 0.97 times of that from the WAnT (MP: NMT, 508.9 ± 130.7W vs WAnT, 548.7 ± 131.3W). Power produced on the NMT and the WAnT by sedentary adults shared moderate and acceptable levels of agreement. Conclusions: These results affirmed that the NMT could be considered as a viable alternative to the WAnT for the assessment of PP and MP in all-out intensity sprint-running lasting 10 s in sedentary adults.

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Key words: Ratio limits of agreement, Validity, Wingate Anaerobic Test

Introduction

The use of the Wingate Anaerobic Test (WAnT) for assessing all-out intensity short-duration sprint cycling lasting between 10 and 40 seconds is pervasive. Many consider the WAnT as the reference standard for the assessment of short-duration sprint performance. Numerous studies[1,2] have documented the construct validity of peak power (PP) and mean power (MP) generated from the WAnT, often comparing the power output to parameters such as the time taken for a 50-m sprint, increase in blood lactate concentration after the test and maximal oxygen uptake ($\dot{V}O_{2\ max}$). The WAnT was used for assessing the cycling-sprint power of diverse populations, namely, children,[3] elite athletes,[2] and the elderly.[4] There are however more data on athletes than on sedentary subjects, as the former is more likely to volunteer for testing in the laboratory. However, as more adults are participating in sport and involved with exercise in Singapore,[5] it is important to garner data on sedentary subjects so that a database of sprint performance of the sedentary population, which is the majority in most cases, can be built up for comparative purposes. These data are helpful in formulating appropriate and relevant exercise and sport programmes for this segment of the population who are making an effort to be more physically active.

Despite the widespread use of the WAnT, many challenge the suitability of the WAnT for assessing the sprinting capabilities of athletes not involved with cycling activities.[6]

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Others argue that in the WAnT, there is an over-reliance on a pre-determined resistance[7-9] to elicit PP and MP, which might not be optimal for both PP and MP.[10]

Moreover, using sprint-cycling, as in the WAnT to assess sprint-running performance is not appropriate, as it is predominantly a lower-limb activity with a sizeable amount of the upper body mass (BM) supported. This is a view echoed by Sutton et al[11] in their work on children. Discordant methodologies in the WAnT are also a common feature in the research literature, and these make comparisons across studies inconvenient. These include the choices of the applied resistance used, with resistive forces ranging equivalent to 6.8% of BM for children[10] to 10% of BM for athletes.[12] The need for an alternative test to the cycling-based WAnT, to assess power generated by all-out intensity effort during sprint-running have challenged researchers for some time. Earlier versions of the self-propelled non-motorised treadmill prototypes were available only to a few laboratories[11,13-15] but at least one model, Tecmachine[16] is commercially available.

The non-motorised treadmill test (NMT) is a promising alternative to the sprint-cycling based WAnT for several reasons: the test is self-propelled by the sprinting subject, where the mechanics of sprinting on a treadmill can be studied and power output generated by muscle groups during treadmill sprint-running can be analysed; there is also no requirement for a pre-determined applied force since the subject's body weight is the applied force during sprint-running (as is the case in real-life); and many sports (e.g., soccer, hockey, basketball and rugby) require sprint-running, and therefore the NMT is more ecologically relevance to the sport. Lim and Chia[17] had established the reliability of PP and MP derived over 10 s in the NMT in a similar cohort of sedentary and healthy adults (n = 9 male and n = 9 female) using a variety of reliability indicators (repeatability coefficient, typical error, change in the mean and coefficient of variation) for both intra- (within the same day) and inter-session (in-between days) testing. They concluded that indicators of repeatability for both intra- and inter-session testing for both NMT PP and MP were comparable to that elicited from the WAnT.

In young people, a high validity for PP derived from the NMT (NMT PP) was reported by Sutton et al.[11] In the cited study, NMT PP correlated highly (r = 0.82, P <0.05) with PP elicited from the WAnT (WAnT PP) and that in absolute terms, the WAnT PP was significantly higher than the NMT PP. Williams et al[18] and Falgairette et al[19] also reported higher WAnT PP than NMT PP produced by young athletes, as did Holmyard et al,[15] on rugby backs and Fargeas et al[14] on children. Such results are unexpected since sprint-cycling involves a smaller absolute muscle mass than sprint-running. However, studies by Too[20] in athletes and Falk et al[13] in children, showed that NMT power was significantly higher than WAnT power, when the tests were repeated in the same subjects. These results require further verification as the different methods used in the computation of power in the WAnT and the NMT could have obfuscated the results. There is apparently no previous study on the cycle-sprint and sprint-running performances of sedentary adults in a single study. Data from such studies are useful as greater numbers of sedentary adults are encouraged to take up exercise and participate in team sports (which require repeated and short-term sprint-running) in order to make changes for a more active lifestyle. Researchers need to study the all-out intensity exercise of this segment of the population so that they can better understand the physiological responses to all-out intensity exercise in this group and provide appropriate information for exercise programme designers so that activities can be carried out safely. As a sports culture develops within the society and the momentum of the Sports Hub gathers pace, with the public having greater access to sports science testing, it is envisaged that more people will make use of laboratory testing services and associated sports science services so that they can get more out of their sporting pursuits.

In the validation of similar variables (e.g. power) produced in different tests, statisticians recommend the use of the ratio limits of agreement (LOA) rather than inter-class correlation coefficient (ICC) when comparing the results of data sets from 2 different tests, as was the case in the present study (i.e., comparison of PP and MP from the WAnT and the NMT). Lamb[21] explained that a high ICC only reflected the stability of rank order within the test sample, but the individual scores and absolute reliability of the test scores might not necessarily be good. Therefore, the use of LOA is preferred to the ICC in establishing the validity between results from 2 different tests. Nonetheless, as the ICC continues to be reported, both the LOA and ICC should be reported so that researchers can make an informed decision and in time compute and report the LOA preferentially.

The use of allometric scaling of power from both tests in relation to BM is also recommended to reflect arguments that the conventional use of ratio-scaling in relation to BM did not always produce a dimensionless variable that was independent of body size.[22] The merits of allometric scaling are that its use accommodates the heteroscedasticity frequently observed in size related performance measures.[23] Logarithm-linearisation of the data, as required in allometric modelling, also corrects skewness and the effects of outliers are minimised.

Therefore, the main objective of the study was to assess the concurrent validity of PP and MP generated in the

NMT, in comparison with PP and MP generated in the WAnT in a cohort of sedentary male and female adults.

Materials and Methods

Subjects

Institutional ethical approval for the study was obtained from the University's Ethics Involving Human Subjects Committee. Male and female subjects, aged between 20 and 30 years, were recruited and all test procedures, perceived benefits and risks were carefully explained to them. All subjects gave informed consent to participate in the study. None of the subjects were involved in any regular exercise or formalised sports training programme for at least 6 months prior to the commencement of the study. Subjects were instructed not to engage in strenuous physical activity for at least 24 hours prior to testing. Fasting was not required and fluid intake was not restricted.

Anthropometric Measurements

Standing height and BM, as was the age of each subject, were recorded. A dual energy X-ray absorptiometric (DXA) scan (QDR 4500 Hologic model, Waltham, MA, USA, V8.23A.5) was used to assess BM, lower limb BM and fat-free mass. The scanning procedure required subjects, clad in exercise attire, to lie supine and motionless on the scanning table, arms by the side and with the palms pronated. The hips were internally rotated till both toes touched. The scan for each subject took about 7 min. The DXA was calibrated in accordance to the manufacturer's instructions.

Sprint Duration of the Tests

Each sprint on the WAnT and the NMT was for 10 s. The 10-s duration was chosen, based on results of pilot trials and because the subjects were sedentary and it was important that subjects were able to give an all-out effort sprint that was unaffected by their fitness levels or pacing. Moreover, many sprint efforts during team sports seldom last beyond 10 s at a stretch. For instance, Bangsbo[24] reported that in a 90-min soccer game players performed many repeated sprints of maximal or near-maximal efforts lasting 1 to 6 s, with brief recovery intervals.

Familiarisation and Standardised Warm-up

All subjects had one familarisation session on the cycle ergometer and another on the non-motorised treadmill. Pilot data revealed that the sedentary subjects were able to replicate PP (PP trial 1 vs PP trial 2, $P > 0.05$) in 2 sprint attempts on the cycle ergometer and NMT. This was taken as evidence that subjects were able to provide a maximum sprint effort in the WAnT and NMT. All subjects were appropriately practised, habituated and accustomed to what was required in the 10-s NMT and to the 10-s WAnT, over 2 separate sessions prior to the actual test sessions.

A standardised warm-up was conducted for each subject before they commenced the tests. This consisted of pedalling on the cycle ergometer at approximately 60 rpm interspersed with 4 all-out intensity cycle-sprints, each lasting 4 to 6 s. This was followed by general static stretching for the lower limbs (calf, thigh and back of thigh) and the groin muscles for about 5 minutes. The NMT and the WAnT were conducted on 2 separate days, within a 14-day period.

Conduct of the NMT

The NMT (SPRINT CLUB™ 2000, Médical Développement, Andrézieux-Boutheon, France) was set up according to instructions provided by the manufacturers.[16] The subject wore a hip belt, which was connected to a stress gauge force sensor on the treadmill via a rigid supporting tether bar. The tether bar was adjusted horizontally so that it coincided with the height of the subject's centre of mass. The joint between the bar and the stress gauge was articulated to allow for vertical and side-to-side movements. The stress gauge was calibrated using 2 known forces at zero N and at 196 N. A full-length mirror was placed in front of the treadmill to provide visual feedback to the subject whilst sprinting.

Figure 1 is an illustration of the set up for the NMT. The test commenced from a walking start. Each subject was given the instructions "3, 2, 1, Go!" On the command "Go!" each subject sprinted as fast as he/she could on the treadmill. Verbal encouragement was given throughout the 10 s of sprint-running.

The power generated by the sprint was determined electronically, based on the registered strain on the stress gauge force sensor. Both vertical and horizontal forces during sprinting were measured. Data acquisition were at 100 Hz. The following equations were used to calculate power.

Vertical power: P(v) =
speed (v) {mass [9.81+acc(v)] + F(v)}

Where, speed (v): vertical speed of the participant ($m.s^{-1}$),
mass: mass of the participant (kg),
9.81: earth's acceleration ($m.s^{-2}$),
acc (v): vertical acceleration of the participant ($m.s^{-2}$),
F(v): vertical resultant force (N),
F(v) = F (measured force)·sin *a* and where *a* was the angle between the bar and horizontal.

Horizontal power: P(H) = F(h)·belt speed

Where, belt speed: speed of the belt generated by the participant ($m.s^{-1}$),
F (h): horizontal resultant force (N),
F (h) = F (measured)·cos *a* and where *a* was the angle between the bar and horizontal.

The total power output was the sum of the horizontal and vertical power. NMT PP was integrated over one second and was the highest 1 s power over 10 s and NMT MP was the averaged power over the 10-s NMT.

Conduct of the WAnT

A cycle ergometer (Monak® model 834E, Varberg, Sweden) was used for the WAnT. The test commenced with each subject seated on the cycle ergometer, with the height of the seated individually adjusted such that there was a slight flex of the knee when the foot pedal was the lowest point of the pedal cycle. The cycle ergometer was calibrated for applied force at zero velocity using a 1 kg mass and a 4.5 kg mass, in accordance to the manufacturer's instructions. The applied resistance was set equivalent to 0.74 $N.kg^{-1}$ BM for each subject. This applied resistance is suitable for adults who are non-athletes.[4] The all-out intensity sprint commenced at a pedalling speed of 60 rpm, following a count down of "3, 2, 1, Go!" Verbal encouragement was given throughout the 10 s of sprint-cycling.

Power output on the WAnT was calculated using power = $\omega (T_i + T_r)$ in accordance to that, outlined by Chia et al.[25] In essence, the computation proposed by the researchers took into account the inertia of the flywheel and the internal resistance of the cycle ergometer in the computation of PP and MP.

Where, ω: angular velocity ($m.s^{-1}$),

$T_{i:}$ inertial torque, calculated by multiplying the momentum of inertia (flywheel, crank and sprocket) by the angular acceleration of the flywheel,

$T_{r:}$: resistive torque, calculated by multiplying the applied restive Force, plus the frictional loss in overcoming the internal resistance of the ergometer, by the radius of the flywheel.

WAnT PP was integrated over 1 s and was the highest 1 s power over the 10-s test. WAnT MP was the average power over the 10-s WAnT.

Data Treatment

The Statistical Package for Social Science (SPSS) v15.0 for Windows was used for all statistical analyses. Data were presented as mean ± standard deviation (SD). All power data were analysed using the absolute, ratio-scaled and allometrically-scaled values. Power data in absolute terms were expressed in W and ratio-scaled power data were expressed in relation to BM ($W.kg\ BM^{-1}$).

To derive the allometrically scaled data, a regression technique applied on natural log-transformed (Ln) data (i.e., Ln PP or Ln MP in W and Ln BM in kg, and Ln stature in m) provided the allometric parameters *b*, respectively for male and female subjects. Results showed that Ln BM rather than Ln stature was the dominant predictor for Ln PP and Ln MP. Therefore, Ln BM was used in subsequent analyses. The natural log-transformation of the presumed allometric relationship between Ln PP or Ln MP and Ln BM is given by:

Ln PP or Ln MP (W) = Ln A + *b* Ln BM, where Ln A is the natural Ln scaling constant, corresponding to the Y-intercept and *b* is the scaling factor.[22] Subsequently, the derived equations for male and female athletes were written as (Y i.e. PP or MP) = $A.BM^b$.

An alpha level of 0.05 was set for the attainment of statistical significance. The independent-sample *t*-test and Pearson Product Moment Correlation coefficient were used to determine differences and the strength of association, between PP and MP, in the WAnT and in the NMT.

The LOA was used to determine the agreement between the tests for PP in absolute terms and ratio-scaled to BM.[26] However, the LOA could not be applied to allometrically-scaled PP since the units of measurement are different. Therefore, a regression analysis was used instead.[27] A regression line was plotted for PP and MP derived from the WAnT against corresponding PP and MP derived from the NMT. The regression equation used the observed power elicited from the NMT test to estimate the predicted WAnT power measurement (the reference standard). A range of values of the WAnT on a sample was computed, and this was known as the 95% prediction interval. This was the interval within which the WAnT power would be with probability 95% for any power derived on the NMT test.[27]

Results

Twelve male adults (age, 26.6 ± 2.4 years; BM, 63.0 ± 7.2 kg) and 11 female adults (age, 25.3 ± 3.6 years; BM, 51.0 ± 4.0 kg) completed the study. Regression analysis on natural Ln PP and MP, entered as dependent variables, natural Ln body size descriptors, standing height (Ht), BM and lower limb body mass (LLBM), entered as covariate variables, and sex as the independent variable, revealed that Ln BM was the best predictor variable for both Ln PP and Ln MP in the WAnT and NMT. Hence, a common *mass* exponent (b = 1.34) was used for both sexes as there were no significant differences (*P* >0.05) in the interaction between Ln BM and Ln Sex.

Sex Difference in Power Output

Table 1 shows the PP and MP derived from the WAnT and NMT. There was a significant difference between male and female adults in absolute PP and MP, with male adults generating about 1.3 times PP and MP that of female adults in both the NMT and WAnT. However, when NMT PP and WAnT PP were ratio-scaled to BM or allometrically-scaled to $BM^{1.34}$ and $BM^{0.98}$, respectively, statistical analysis using paired-sample *t*-tests revealed no significant difference (*P* >0.05) for BM-adjusted PP between the sexes. Similar observations were made for MP-derived from the NMT and WAnT.

Table 1. Peak Power (PP) and Mean Power (MP) Derived from the NMT and WAnT

	Expressed as absolute values (W)		
	Pooled (n = 23)	**Male (n = 12)**	**Female (n = 11)**
WAnT MP	548.7 ± 131.3	614.8 ±113.30	476.5 ± 113.1
WAnT PP	597.0 ± 146.0	667.8 ± 130.0	520.0 ±126.1
NMT MP	509.0 ± 130.7	569.1 ± 138.1	443.3 ± 86.7
NMT PP	647.1 ± 176.4	731.8 ± 191.0	554.8 ± 101.9
	Expressed as ratio scaled values ($W.BM^{-1}$)		
	Pooled (n = 23)	**Male (n = 12)**	**Female (n = 11)**
WAnT MP	9.6 ± 1.8	9.8 ± 1.6	9.3 ± 2.0
WAnT PP	10.4 ± 2.0	10.6 ± 1.8	10.2 ± 2.2
NMT MP	8.9 ±1.8	9.0 ± 1.9	8.7 ± 1.7
NMT PP	11.2 ± 2.3	11.6 ± 2.6	10.9 ± 1.9
	Expressed as allometrically scaled values ($W.BM^{-b}$)		
	Pooled (n = 23)	**Male (n = 12)**	**Female (n = 11)**
WAnT MP	11.2 ± 2.1	11.5 ±1.9	10.9 ± 2.3
WAnT PP	11.3 ± 2.2	11.5 ± 2.0	11.0 ± 2.4
NMT MP	3.8 ± 0.8	3.8 ± 0.8	3.8 ± 0.7
NMT PP	2.8 ± 0.6	2.8 ± 0.6	2.9 ± 0.5

BM: body mass; MP: mean power; NMT: Non-motorised Treadmill Test; PP: peak power; WanT: Wingate Anaerobic Test

The NMT and WAnT were performed for 10 s. PP was integrated over 1 s and MP was averaged over 10 s in the WAnT and NMT. Twelve male adults and 11 female adults participated in the study.

Table 2. Comparison of Absolute and Ratio-scaled PP and MP: NMT versus WAnT

	Ratio LOA	**Pearson correlation co-efficient**	**Paired-sample *t*-test**
Male and female adults (n = 23)			
NMT PP vs WAnT PP	1.08 x/¸ 1.037	0.89	*P* <0.05*
NMT MP vs WAnT MP	0.93 x/¸ 1.05	0.83	*P* <0.05*
Male adults (n = 12)			
NMT PP vs WAnT PP	1.08 x/¸ 1.05	0.91	*P* <0.05*
NMT MP vs WAnT MP	0.92 x/¸ 1.06	0.85	*P* <0.05*
Female adults (n = 11)			
NMT PP vs WAnT PP	1.08 x/¸ 1.06	0.94	*P* <0.05*
NMT MP vs WAnT MP	0.94 x/¸ 1.08	0.85	*P* >0.05

BM: body mass; MP: mean power; NMT: Non-motorised Treadmill Test; PP: peak power; WanT: Wingate Anaerobic Test

The NMT and WAnT were performed for 10 seconds. PP was integrated over 1-s, and MP was averaged over 10 seconds for the WAnT and NMT. Twelve male adults and 11 female adults participated in the study.
*Significantly different at *P* <0.05. Correlations were significant at *P* <0.05.

Power Derived from the NMT and WAnT

Table 2 shows the absolute and ratio-scaled PP and MP from the NMT compared to that from the WAnT. PP derived from the NMT test was between 1.04 and 1.12 times (1.08 x/÷ 1.037) that elicited from the WAnT in 95% of the attempts. Similarly MP derived from the NMT test was between 0.88 and 0.97 times of that from the WAnT.

Outcomes of paired-sample *t*-test analysis showed that there was a significant difference (P <0.05) between MP elicited from the NMT test and MP from the WAnT. This difference was observed in the pooled (male and female) data and in male adults. Similar outcomes were obtained when the data, ratio-scaled to BM or taken in absolute terms, were analysed. Strong correlation coefficients were established between PP and MP in the WAnT and NMT when the male and female data were pooled.

In terms of the allometrically-scaled power data, a 95% prediction interval was derived, which was the range of possible values for the reference standard (i.e., WAnT power) for the new method (i.e., NMT power). The 95% limits for 10-s NMT power values on the 10-s WAnT power values were expressed as regression equations. These are shown in Figure 2. Figure 3 illustrates the upper and lower limits for the WAnT.

Discussion

The aim of the present study was to establish the concurrent validity of the NMT in assessing short-term power output in a cohort of sedentary male and female adults. The ratio LOA was used to compare agreement in PP and MP between the NMT and the WAnT, using power data that were in absolute terms and that which was ratio-scaled to BM. These results showed that there was moderate agreement and results varied up to 12% for PP (LOA of 1.08 x/÷ 1.037) and up to 22% for MP (0.93 x/÷ 1.05). In terms of the power data that were allometrically-scaled to BM, regression equations generated for WAnT and NMT were unique and apparently were not reported before for sedentary adults. These data are useful for future studies in predicting NMT power data from WAnT, in laboratories that do not have the NMT, for similar sedentary adult samples. Access to the WAnT is still more pervasive than access to the NMT.

There are no equivalent published data for comparison on agreement in WAnT- and NMT-generated power, as apparently this was the first study that had examined the validity of the NMT in sedentary subjects. There is therefore a need for more research laboratories to focus on the exercise performances of sedentary subjects as more sedentary adults are encouraged to initiate a more physically

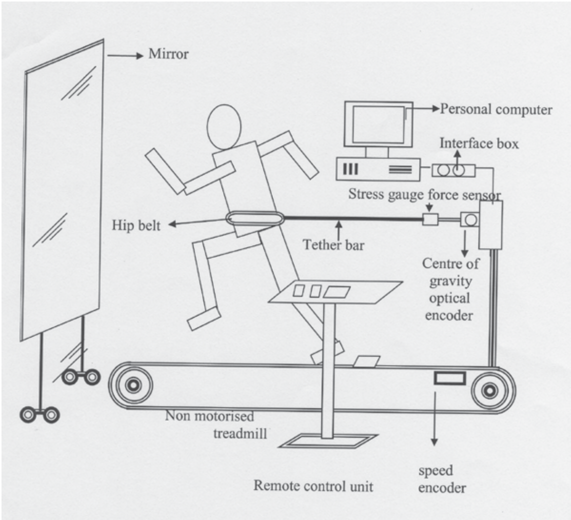

Fig. 1. Schematic representation of the NMT Test (Mukherjee & Chia, unpublished data, with permission).
BM: body mass; NMT: Non-motorised Treadmill Test; WanT: Wingate Anaerobic Test
The 95% limits for allometrically-scaled NMT PP on the allometrically-scaled WAnT PP expressed as regression equations.
The upper limit for PP is WAnT ($W.BM^{0.98}$) = 3.34 x NMT ($W.BM^{1.34}$) + 3.80 and the lower limit for PP is WAnT ($W.BM^{0.98}$) = 3.34 x NMT ($W.BM^{1.34}$)-0.28.
The NMT test and WAnT were performed for 10 s. Peak power was measured, integrated over 1 s for the WAnT and NMT test. Twelve male adults and 11 female adults participated in the study.

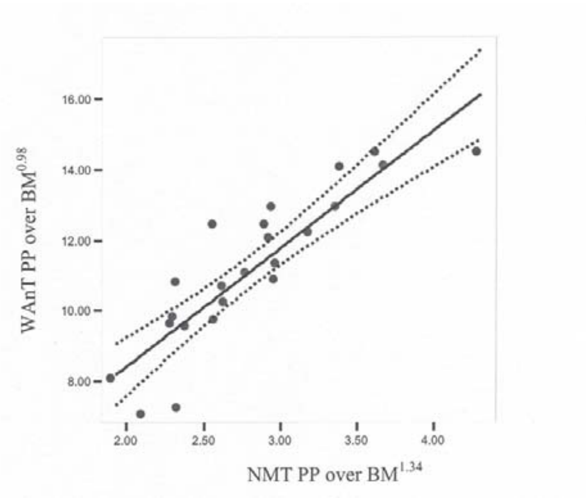

Fig. 2. Regression of allometrically-scaled WAnT PP To NMT PP.
BM: body mass; NMT: Non-motorised Treadmill Test; WanT: Wingate Anaerobic Test
The 95% limits for NMT MP on allometrically-scaled WAnT MP were expressed as regression equations.
The upper limit for MP is WAnT ($W.BM^{0.96}$) = 2.20 x NMT ($W.BM^{1.21}$) + 5.30 and the lower limit is WAnT ($W.BM^{0.96}$) = 2.20 x NMT ($W.BM^{1.21}$) + 0.4.
The NMT test and WAnT were performed for 10 s. Mean power was averaged over 10 s in the WAnT and NMT. Twelve male adults and 11 female adults participated in the study.

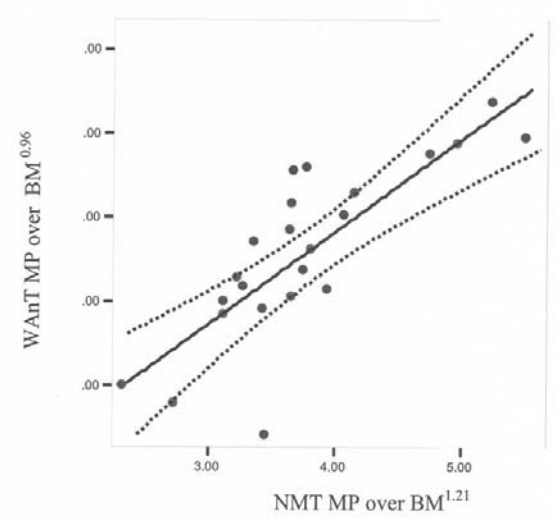

Fig. 3. Regression of allometrically-scaled WAnT MP To NMT MP.

active lifestyle for health and for recreation.

There was a variance of the observed magnitude in power generated in the tests as the WAnT and NMT are not identical tests, with the WAnT assessing power produced during sprint-cycling and the NMT assessing power produced during sprint running on the treadmill. Therefore, the impulse-momentum characteristics of the two tasks are likely to differ.[9] Moreover, during sprint-running on the NMT and sprint-cycling in WAnT, different muscle masses and groups, which have different degrees of mechanical efficiency are involved.[13] Inter-class correlation coefficients between NMT PP and MP and WAnT PP and MP were significant at P = 0.85 to P = 0.91, despite significant differences between NMT PP and MP and WAnT PP and MP. These comparative agreement and strength of association between test variables (LOA and inter-class correlation coefficients) are instructive in that, the results demonstrate clearly that the choice of statistical test can influence the decision made about the validity of a new test (NMT), compared to the reference test (WAnT) by a researcher.

Results of the study showed that in absolute terms NMT PP was significantly higher than WAnT PP; for male subjects, this was 9.6% higher and for female subjects, this was 6.7% higher in the NMT. These results mirrored the results reported by Too[20] in athletes and Falk et al[13] in children which showed that NMT power was significantly higher than WAnT power. They attributed the higher muscle masses involved during sprint-running compared to sprint-cycling as a likely explanation. A second plausible explanation could be that the applied force used in the WAnT may not be optimised for PP generation. The recommendation of 0.74 $N.kg^{-1}$ applied resistance was to optimise MP over 30 s of the WAnT and not meant to elicit PP that was optimised.[12]

Notwithstanding the above explanations, there are conflicting results in the related literature. Holmyard et al,[15] Fargeas et al,[14] Sutton et al,[11] Williams et al[18] and Falgairette et al[19] reported significantly higher WAnT PP than NMT PP. In the cited studies, the applied resistance used for the WAnTs were optimised for PP, using multiple force-velocity tests to derived the optimised applied resistance for each subject. Another explanation could be that the subject's BM provided insufficient applied force to elicit NMT PP.[15] Moreover, it was also plausible that in the cited studies, where earlier prototypes of the NMT were used, the power computed neglected to account for the vertical component of force generated whilst sprint-running on the treadmill and this would have resulted in a lower power output computed.

Sex differences in WAnT power and NMT power reflect some of those reported elsewhere[10,28] in that even in sedentary adults, once BM is appropriately accounted for, the sex differences in PP and MP generated in the WAnT and NMT, are nullified.

Conclusions

This study was apparently the first to compare the power derived from the NMT with that in the WAnT, using various statistical tests to assess agreement and also strength of association and hence the validity of the NMT, in a cohort of sedentary male and female adults. Power values derived from the NMT test and WAnT were of up to 12% LOA for PP and 22% LOA for MP, and researchers must be aware of this when comparing data sets from the 2 tests. The data sets showed a high inter-class correlation coefficient despite a moderate agreement between the tests. This study concluded that the NMT could be considered as a viable alternative to the WAnT for the assessment of PP and MP during all-out intensity short-term sprint-running in a sample of healthy but sedentary adults. However, researchers must be aware that the difference in power output could be up to 12% for PP and 22% for MP.

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