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Validity of a Squash-Specific Fitness Test

Michael Wilkinson, Damon Leedale-Brown,
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Purpose: This study examined the validity of a squash-specific test designed to assess endurance capability and aerobic power. **Methods:** Eight squash players and eight runners performed, in a counterbalanced order, incremental treadmill (TT) and squash-specific (ST) tests to volitional exhaustion. Breath-by-breath oxygen uptake was determined by a portable analyzer and heart rate was assessed telemetrically. Time to exhaustion was recorded. **Results:** Independent *t* tests revealed longer time to exhaustion for squash players on the ST than runners (775 ± 103 vs. 607 ± 81 s; $P = .003$) but no difference between squash players and runners in maximal oxygen uptake (VO_{2max}) or maximum heart rate (HR_{max}). Runners exercised longer on the TT (521 ± 135 vs. 343 ± 115 s; $P = .01$) and achieved higher VO_{2max} than squash players (58.6 ± 7.5 vs. 49.6 ± 7.3 mL·kg⁻¹·min⁻¹; $P = .03$), with no group difference in HR_{max} . Paired *t* tests showed squash players achieved higher VO_{2max} on the ST than the TT (52.2 ± 7.1 vs. 49.6 ± 7.3 mL·kg⁻¹·min⁻¹; $P = .02$). The VO_{2max} and HR_{max} of runners did not differ between tests, nor did the HR_{max} of squash players. ST and TT VO_{2max} correlated highly in squash players and runners ($r = .94$, $P < .001$; $r = .88$, $P = .003$). **Conclusions:** The ST discriminated endurance performance between squash players and runners and elicited higher VO_{2max} in squash players than a nonspecific test. The results suggest that the ST is a valid assessment of VO_{2max} and endurance capability in squash players.

Keywords: squash, fitness, VO_{2max} , endurance

Common with multiple-sprint activities, such as soccer, basketball, and other racket sports, the specific movement patterns and demands of squash provide a unique challenge to physiologists in their attempts to produce valid and reliable assessments of physiological factors relevant to squash performance, such as aerobic power. The challenge is to combine the control of laboratory procedures with the ecological validity of tests carried out in the specific movement patterns of the sport. Müller¹ stated that improvements in elite sport performance arise mainly from an increase in the quality of training and that this quality is best improved through the development of sport-specific tests. Valid and reliable squash-specific,

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yet controlled, tests are likely to provide more useful data for the selection of players, the design of training programs, and the tracking of sport-specific training adaptations that might otherwise go undetected by conventional nonspecific procedures.

The validity of field-based tests can be determined by (a) comparison of the new test with a “gold standard” procedure (criterion validity); (b) the ability of the test to discriminate between groups of performers from sports with different characteristics or between abilities within a group of performers (construct validity); (c) the test’s ability to assess components of fitness known to be important for performance (logical validity).² Endurance capability is such a component for squash players and a contributory factor to this is maximal oxygen uptake. Recent analysis of physiological responses to elite squash match play revealed a mean oxygen uptake of $54.4 \text{ mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ ($\approx 86\%$ of $\text{Vo}_{2\text{max}}$) and a mean heart rate of $177 \text{ beats}\cdot\text{min}^{-1}$ ($\approx 92\%$ of HR_{max}).³ The $\text{Vo}_{2\text{max}}$ values of 62 to 66 $\text{mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ previously reported in elite male players confirm the importance of high aerobic power for squash players.^{4,5} Furthermore, $\text{Vo}_{2\text{max}}$ has been shown to be a strong predictor of successful transition from the junior to senior elite ranks.⁴

The importance of sport-specific testing of $\text{Vo}_{2\text{max}}$ has been previously demonstrated. St Clair Gibson et al⁶ reported that maximal oxygen uptake estimated from a field-based 20-m shuttle test correlated more highly with laboratory-determined $\text{Vo}_{2\text{max}}$ in runners ($r = .71$) than in squash players ($r = .61$). This indicates sport-specific differences in the prediction of $\text{Vo}_{2\text{max}}$. The test specificity of $\text{Vo}_{2\text{max}}$ in squash players has also been demonstrated elsewhere. Two studies compared responses of elite squash players in squash-specific incremental tests and laboratory-based treadmill incremental tests and showed that higher $\text{Vo}_{2\text{max}}$ was achieved by squash players on the squash-specific tests.^{7,8} Furthermore, both studies also reported strong correlations between player rank and maximum performance on the squash-specific tests, thus demonstrating both the construct and logical validity of the sport-specific protocols.

While there have been attempts to produce controlled tests to replicate squash-specific physiological demands,^{9,10,11} these tests were designed to simulate match play rather than assess squash-specific fitness components. The study of Kingsley et al¹¹ describes a squash-specific incremental test that *could* be used to assess squash-specific fitness. However, the study focuses on the use of the procedure in the development of a squash simulation protocol and does not address the validity of the incremental test for assessment of squash-specific fitness. Although several groups are working in this area, only two previous papers designed to assess the validity of on-court squash protocols for assessment purposes have been published, the findings of which are summarized above.^{7,8}

The procedure of Steininger and Wodick⁷ was devised to mimic physiological demands and techniques specific to squash movement, but in clearly defined increments to allow the assessment of squash-specific endurance fitness. Even though movement patterns created by the test clearly replicate those of squash play, an account for the randomness of true squash movement was not made. The predictable sequence of movements used means the player must only travel *through* the T area en route to the next court position. In contrast, match play is characterized by uncertainty about movement direction.¹² The muscular demands

of random movement are likely to be much greater and different from movement that is predictable. The ability of muscle to accommodate to unanticipated changes in direction and speed is a crucial performance characteristic in squash but is likely to go undetected by a test in which movement sequences are predictable.¹³

The squash-specific test described by Girard et al⁸ overcomes the limitations of Steinger and Wodick's⁷ test by including uncertainty of movement direction. It does so by means of specialized software on a computer placed at the front center of the court. A visual stimulus directs players to a particular location on court. However, it should be acknowledged that squash players also make use of auditory stimuli during match play such as the sound of the ball from the wall and an opponent's racket to judge movement direction and speed.

In summary, maximal aerobic power is a key aspect of fitness in squash and is known to be specific to sporting background (continuous activity performers vs. intermittent activity performers) and to test procedures.⁶⁻⁸ A valid assessment of squash-specific aerobic power should therefore discriminate between performers of sports with continuous and mostly linear movements and squash players whose activity profile is intermittent and whose movement is stochastic in nature.⁶ Furthermore, maximum values of squash players from a squash-specific test are likely to differ from those measured using nonspecific tests of aerobic power.⁸ Accordingly, the purpose of this study was twofold: first, to examine the validity of a squash-specific incremental test that comprised randomized movements and auditory stimuli, by determining the endurance capability and $\text{VO}_{2\text{max}}$ of trained squash players (intermittent activity profile) and distance runners (continuous activity profile) using a squash-specific incremental test, and second, to compare the $\text{VO}_{2\text{max}}$ values with those determined on an incremental treadmill protocol.

Methods

Participants

With institutional ethics approval, eight trained squash players age (mean \pm SD) 30.0 ± 11.2 years, stature 1.80 ± 0.04 m, body mass 81.3 ± 10.2 kg and eight trained distance runners age (mean \pm SD) 29.6 ± 9.4 years, stature 1.77 ± 0.05 m, body mass 69.4 ± 6.7 kg who had previously undergone two visits to habituate to the procedures participated. Habituation involved all participants undertaking two performances of the full test procedures on a squash-specific test and a treadmill test wearing data collection apparatus, but with no data being collected. All visits were conducted on separate days. Squash players were all regular and current competitors in the premier or first division of the regional leagues, with at least 5 years' playing experience at this standard. Distance runners were good club- or county-standard athletes training and competing with a frequency similar to that of the squash players (three to five times per week). All participants were instructed to report for testing well rested, well hydrated, and well nourished and to have refrained from eating at least 2 hours before testing. Participants were also instructed to abstain from drinking alcohol and avoid stimulants such as caffeine for at least 8 hours before testing.

Experimental Design

In a counterbalanced order, participants performed incremental treadmill (TT) and squash-specific (ST) tests to volitional exhaustion separated by at least 48 hours. All squash players also performed a second trial of the ST 7 days after the first to assess the reproducibility of $\text{VO}_{2\text{max}}$, HR_{max} , and time-to-exhaustion scores. Test-retest coefficients of variation showed good reproducibility of scores for all variables ($\text{VO}_{2\text{max}}$ 2.4 mL·kg⁻¹·min⁻¹, 4.7%; HR_{max} 2 beats·min⁻¹, 1.3%; time to exhaustion 27 seconds, 4%). Tests were conducted under similar environmental conditions (temperature 18.9 ± 3.4°C, relative humidity 49 ± 8%, barometric pressure 1016 ± 11 mb) at the same time of day and in the same footwear and clothing.

Experimental Procedures

Incremental Treadmill Test. Participants underwent a standardized 5-minute warm-up on a motorized treadmill (Pulsar, h/p/ Cosmos Sports And Medical GmbH, Nussdorf-Traunstein, Germany) at 10 km·h⁻¹ and 0% grade before the incremental test. The TT comprised an initial speed of 13 km·h⁻¹ at 0% grade followed by an increase in speed of 1 km·h⁻¹ every minute up to 16 km·h⁻¹. Thereafter, speed remained constant but treadmill grade was increased by 1% every minute until volitional exhaustion. The test was designed to cater for the range of habitual running speeds of the distance runners, while allowing both runners and squash players to reach volitional fatigue quickly without inability to run at higher speeds becoming a factor leading to premature ending of the test.

Incremental Squash-Specific Test. The squash-specific incremental test involved squash-specific movement patterns, to and from four marked positions (two front corners, and two back corners) on a squash court floor (Figure 1). Movements began from a central T position performed in 1-minute stages and were performed randomly with the order and frequency controlled by an audio signal of a number corresponding to one of the four marked and numbered targets. Whereas individual movements were administered randomly, the proportions of movements to particular court areas minute-by-minute reflected those seen in match play as identified from match analysis (74% back corner movements, 26% front corner movements).¹⁴ The movement distances and mean movement speeds involved were encompassed in the ranges reported in previously published match analysis studies.^{12,14}

Upon hearing a signal, the participant was required to move to that court position from the T position; place one foot on the marked target; “ghost,” that is, mimic a forceful shot down the nearest side wall of the court; and return to the T position in time for the next audio signal. Participants were instructed to keep pace with the audio signals so that they were arriving back at the T just as the next audio signal was given and not before, or after the signal. This was to ensure that the mean movement speed for the stage corresponded to that dictated by the audio signal. No specific or technical instructions about stroke technique or movement were provided to the runners or squash players, but care was taken to ensure that all participants adhered to the requirement to place one foot on the target and mimic a forceful shot on each displacement. Stage 1 of the test comprised 14

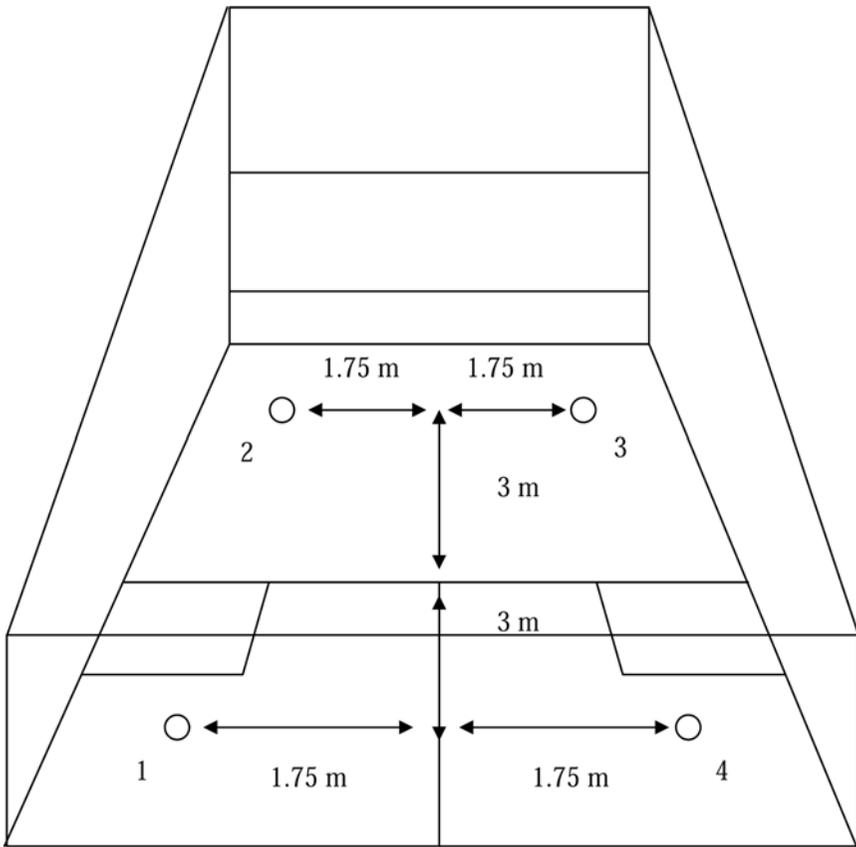


Figure 1 — Setup and dimensions of the squash-specific incremental test. Numbered court positions are indicated (1–4). Arrows indicate distances for the location of the numbered court positions relative to court markings, not the route to the court positions.

movements in that 1-minute stage. The number of movements per stage increased continuously by one move per minute until volitional exhaustion.

Physiological and Performance Measures

During both tests, breath-by-breath oxygen uptake (Vo_2) and heart rate (HR) were continuously recorded using a portable telemetric system (Metamax 3B, Cortex Biophysik, Leipzig, Germany) that was calibrated according to manufacturer guidelines before each test. In both tests, 30-second means were calculated for cardiopulmonary variables, and the highest values for Vo_2 and HR over 30 seconds, during the final stages, were regarded as $\text{Vo}_{2\text{max}}$ and HR_{max} . Time to exhaustion on each test was recorded using an electronic stopwatch (FastTime 1, Click Sports, Cambridge, UK). With due acknowledgment to recent criticisms,¹⁵ attainment of a plateau in Vo_2 ($\leq 2.1 \text{ mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ rise with an increase in exercise intensity), respiratory exchange ratio (RER) > 1.1 , posttest blood lactate concentration > 8

mmol·L⁻¹, HR within 10 beats·min⁻¹ of age-predicted maximum and participant subjective reporting of maximal effort were used as criteria to judge whether test performances were truly maximal. If a participant failed to satisfy three or more of these criteria, the test result was deemed to be a peak rather than a maximum value.

Ranking of Squash Players

Two England Squash qualified coaches (part three—advanced level), located in the area where the study was performed, independently assigned a rank to each squash player using personal knowledge of the players and recent performances in local regional league matches. Where independent ratings differed, a resolution was obtained through discussion between the two coaches.

Statistical Analysis

Data were analyzed using SPSS version 12 (SPSS Inc., Chicago, IL) statistical software. Mean and standard deviation were calculated for each measure. Following verification of underlying assumptions such as normality of distributions (using the Shapiro–Wilks procedure) and homogeneity of variance (using the Levene procedure), independent *t* tests compared the squash players and runners in $\text{Vo}_{2\text{max}}$, HR_{max} and time to exhaustion, both on the ST and TT. Paired sample *t* tests were used to compare $\text{Vo}_{2\text{max}}$ and HR_{max} scores between the TT and ST. Paired sample *t* tests were also used to compare end-test RER, change in Vo_2 in response to the final intensity increase, and posttest blood lactate concentration between the TT and ST. Cohen's *d* effect size was calculated for significant differences and interpreted against effect size categories of ≤ 0.2 = small effect, ≈ 0.5 = moderate effect, and ≥ 0.8 large effect.¹⁶ Spearman's rho examined the relationship between maximum scores on the ST and subjective ranking of the squash players' ability. Pearson's correlation examined relationships between $\text{Vo}_{2\text{max}}$ scores on the ST and TT in squash players and runners. Statistical significance for all tests was accepted at $P \leq .05$.

Results

Achievement of $\text{Vo}_{2\text{max}}$ Criteria

All squash players satisfied three or more of the criteria for attainment of $\text{Vo}_{2\text{max}}$ in both the TT and ST. Values for TT and ST (mean \pm SD) RER (1.31 ± 0.1 and 1.23 ± 0.8 , $P = .158$), posttest blood lactate concentration (9.8 ± 2.4 and 9.0 ± 1.3 mmol·L⁻¹, $P = .245$), and final Vo_2 increase (0.71 ± 0.7 and 1.02 ± 0.8 mL·kg⁻¹·min⁻¹, $P = .426$) did not differ between the tests. Similarly, all runners also satisfied three or more of the criteria for attainment of $\text{Vo}_{2\text{max}}$ both in the TT and ST. The TT and ST (mean \pm SD) RER (1.29 ± 0.2 and 1.24 ± 0.1 , $P = .448$), posttest blood lactate concentration (9.4 ± 2.2 and 9.3 ± 1.2 mmol·L⁻¹, $P = .945$), and final Vo_2 increase (1.0 ± 0.8 and 1.28 ± 1.2 mL·kg⁻¹·min⁻¹, $P = .384$) did not differ between the tests.

Comparisons Between Groups on the ST

Squash players had greater time to exhaustion on the ST than the runners (mean \pm SD 775 \pm 103 vs. 607 \pm 81 seconds, $t_{14} = 3.638$, $P = .003$, effect size = 1.83). There was no difference in $\dot{V}O_{2\max}$ or HR_{\max} between the squash players and runners on the ST ($\dot{V}O_{2\max}$ 52.2 \pm 7.1 vs. 56.6 \pm 4.8 mL \cdot kg $^{-1}\cdot$ min $^{-1}$ $P = .17$; HR_{\max} 190 \pm 7 vs. 182 \pm 11 beats \cdot min $^{-1}$, $P = .12$ respectively).

Comparisons Between Groups on the TT

Runners had greater time to exhaustion (mean \pm SD 521 \pm 135 vs. 343 \pm 115 seconds, $t_{14} = -2.84$, $P = .013$, effect size = 1.42) and also achieved higher $\dot{V}O_{2\max}$ than the squash players on the TT (58.6 \pm 7.5 vs. 49.6 \pm 7.3 mL \cdot kg $^{-1}\cdot$ min $^{-1}$, $t_{14} = -2.43$, $P = .029$, effect size = 1.22). There were no differences in HR_{\max} between the runners and squash players on the TT (183 \pm 10 vs. 191 \pm 13 beats \cdot min $^{-1}$, $P = .17$ respectively).

Within-Group Comparisons Between the ST and the TT

Squash players achieved higher $\dot{V}O_{2\max}$ on the ST than on the TT (mean \pm SD 52.2 \pm 7.1 vs. 49.6 \pm 7.3 mL \cdot kg $^{-1}\cdot$ min $^{-1}$, $t_7 = 3.105$, $P = .017$, effect size = 0.4). There were no between-test differences in HR_{\max} in the squash players (190 \pm 7 vs. 191 \pm 13 beats \cdot min $^{-1}$, $P = .711$). There were no differences in HR_{\max} and $\dot{V}O_{2\max}$ in the runners between the ST and TT (182 \pm 11 vs. 183 \pm 10 beats \cdot min $^{-1}$, $P = .90$ and 56.6 \pm 4.8 vs. 58.6 \pm 7.5 mL \cdot kg $^{-1}\cdot$ min $^{-1}$, $P = .453$ respectively).

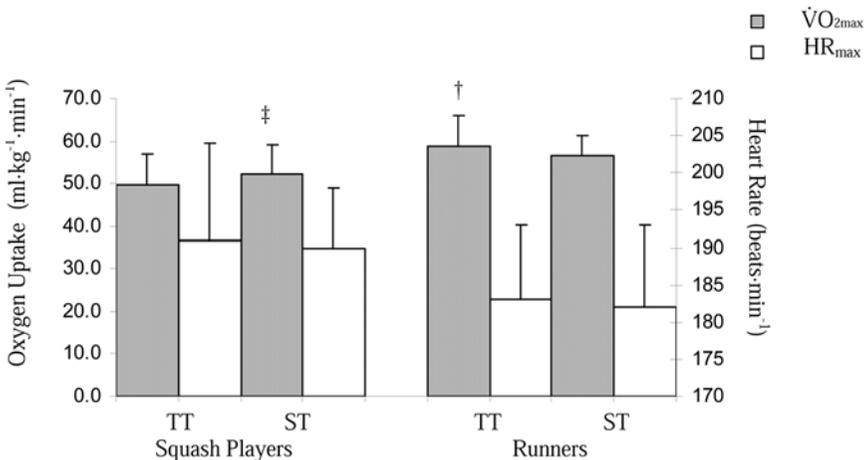


Figure 2 — Physiological variables in squash players ($n = 8$) and distance runners ($n = 8$) corresponding to the maximal exercise intensity for incremental treadmill (TT) and squash-specific tests (ST). Values are mean \pm SD. †Difference ($P = 0.03$) between runners and squash players. ‡Difference ($P = 0.02$) between scores on the TT and ST.

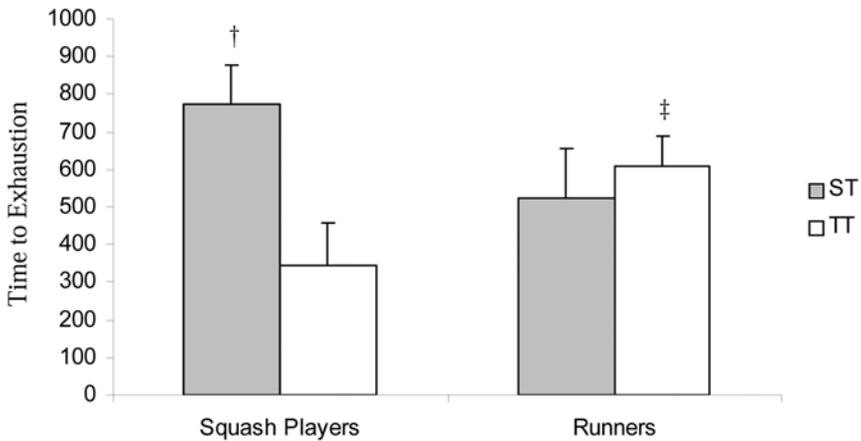


Figure 3 — Time to exhaustion (in seconds) recorded for the incremental treadmill (TT) and the squash-specific (ST) incremental tests in squash players ($n = 8$) and distance runners ($n = 8$). Values are mean + SD. †Difference ($P = 0.003$) in time to exhaustion on the ST. ‡Difference ($P = 0.01$) in time to exhaustion on the TT.

Between- and within-group differences in physiological responses and performance capability are shown in Figures 2 and 3, respectively. Figure 4 shows the mean oxygen uptake and heart-rate responses of the squash players to the ST including the linear regression equations for oxygen uptake and heart rate against exercise time (and thus exercise intensity) on the test.

Correlation of ST Performance with Player Rank in Squash Players

Spearman's rho indicated moderate but nonsignificant negative correlations between time to exhaustion ($r = -0.6$, $P = .12$) and Vo_{2max} ($r = -0.7$, $P = .07$) on the ST and player rank for the squash players.

Correlation of ST and TT Vo_{2max} in Squash Players and Runners

Pearson's correlation showed strong and significant relationships between Vo_{2max} scores from the ST and TT in both squash players ($r = .94$, $P < .001$) and runners ($r = .88$, $P = .003$).

Discussion

The results indicate that the squash players outperformed the trained distance runners on the squash-specific incremental test despite there being no difference in aerobic power between the groups on the squash-specific test. The extent to which participants met the criteria for a true maximal effort did not differ between the ST and TT for squash players and runners, with all participants meeting three or more

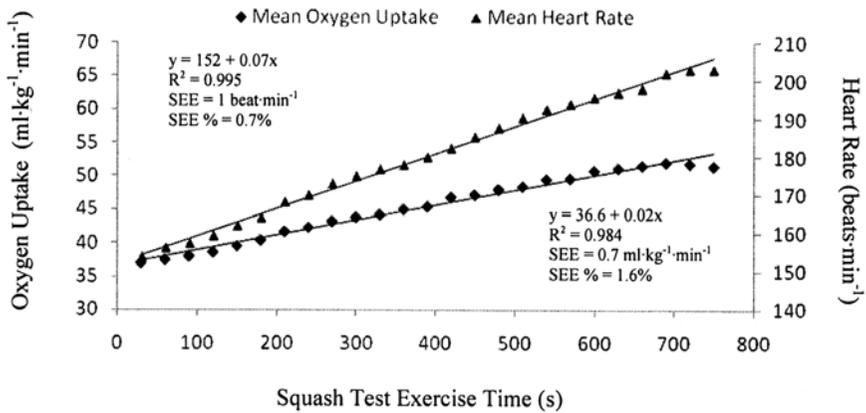


Figure 4 — Mean oxygen uptake and heart rate responses of eight trained squash players on the squash-specific incremental test (ST). Linear regression equations for mean heart rate and oxygen uptake are shown at the upper left and lower right of the figure respectively.

of the criteria in both tests. As such, differences in time to exhaustion between squash players and runners could not be explained by runners not exercising maximally. Moreover, the attainment of the criteria for a maximum effort in the ST suggests that it possesses logical validity, given the importance of $\text{VO}_{2\text{max}}$ for high-level squash players.³⁻⁵ The similarity in achievement of $\text{VO}_{2\text{max}}$ criteria in the ST and TT is in contrast to the findings of St Clair Gibson et al.¹⁷ They showed that the extent to which $\text{VO}_{2\text{max}}$ criteria were satisfied differed between a progressive incline treadmill test and a progressive speed treadmill test, indicating that achievement of $\text{VO}_{2\text{max}}$ criteria can be test specific.

The endurance performance advantage of the squash players on the ST is probably the result of specific adaptations to the movement patterns involved and, together with the similarity of aerobic power, suggests superior movement economy of the squash players in their habitual exercise mode. The poorer time to exhaustion of the runners on the ST could also be a reflection of their lack of skill in the techniques of squash movement and racket swing and the blending of these two skills characteristic of high-standard squash players. However, differences in racket and movement technique and the combination of the two are likely to contribute to test performance in squash players too, so the inclusion of technical aspects in the ST procedures is integral to the specificity of the test. The strong correlations between player rank and maximum performance on the squash-specific incremental tests of Steininger and Wodick,⁷ and of Girard et al.⁸ and the moderate though nonsignificant correlations found in this study suggest that this is the case. However, the low number of participants and homogeneity in the sample of squash players could explain the reduced and nonsignificant relationships in this study.¹⁸ Moreover, endurance capability (with $\text{VO}_{2\text{max}}$ as a contributory factor to this) is only one component of the game¹⁹ and perhaps a less important component for subelite participants such as those used in the current study. The adaptations to specific movement patterns and the advantages they confer

were also evident in the performance of the runners versus the squash players on the treadmill incremental test. The superior performance capability of the runners in their habitual exercise mode mirrored that of the squash players on the squash-specific test.

Another key finding of this study was that the squash players attained higher $\text{VO}_{2\text{max}}$ on the squash-specific test than on the treadmill test. These findings agree with those of Girard et al.⁸ In the current study, the higher $\text{VO}_{2\text{max}}$ of the squash players on the ST than on the TT despite no differences in HR_{max} could be due to a larger active muscle mass in the ST, commensurate with the upper-body actions of swinging a racket and the high loads on the lower leg musculature.

The greater time to exhaustion of squash players than runners with similar test-specific $\text{VO}_{2\text{max}}$ demonstrates the construct validity of the squash test for the assessment of squash-specific endurance capabilities.² The higher $\text{VO}_{2\text{max}}$ scores of the squash players on the sport-specific test, with all participants meeting the criteria for attainment of $\text{VO}_{2\text{max}}$, suggests that the ST also possesses logical validity,² given the importance of this fitness component at higher standards of play.^{3-5,7} Moreover, the strong correlations between $\text{VO}_{2\text{max}}$ scores on the ST and the TT is evidence that the ST demonstrates criterion validity (ie, it relates well to another recognized method of $\text{VO}_{2\text{max}}$ assessment).²

Test Specificity and Assessment

Laboratory-based exercise tests are challenged by the need to reflect the specific muscular, metabolic, and technical demands of a particular sport. In common with other racket sports, success in squash depends on technical, tactical, and motor skills.¹⁹ However, because of the nature of the game at the highest standard, aerobic fitness is an essential attribute.^{4,5,7} Nonspecific exercise tests such as treadmill running, do not account for the movement patterns and muscle actions involved in squash, for example, the frequent changes in direction and speed and the high eccentric, isometric, and concentric loads required to accomplish these. This study and others⁸ have demonstrated the test specificity of maximum aerobic fitness in squash players who performed poorly in treadmill running compared with squash-specific testing. Treadmill testing, therefore, is less discriminating for the assessment of $\text{VO}_{2\text{max}}$ in squash players.

Endurance-performance capability is another important variable that could indicate positive training adaptations in the absence of changes in maximal aerobic fitness. The superior times to exhaustion of trained squash players over runners of similar test-specific (ST) $\text{VO}_{2\text{max}}$ shown in this study is further evidence for the ability of the squash test to detect sport-specific capabilities.

Applications to Squash-Specific Testing

Sport-specific training is recognized as essential for improvement and success in any sport.¹ A large part of a squash player's training takes place on court, and the efficacy of on-court training as preparation for match play has been demonstrated.⁹ However, appropriate training intensities based on prior physiological assessment are integral to the success of training.¹ It is a recent recommendation common in other endurance-based sports, such as running, to train at heart rates and at

speeds that correspond to directly determined $\text{VO}_{2\text{max}}$ to bring about improvements in this physiological variable.²⁰ Both the test described in this study and the incremental test described by Girard et al⁸ are capable of providing training speeds for on-court movement training equivalent to an individual player's $\text{VO}_{2\text{max}}$. Accordingly, they can be used to improve this important physiological factor in ways relevant to the demands of match play.

The ST could also be used to track training-induced adaptations in $\text{VO}_{2\text{max}}$ and endurance capability. Furthermore, given the important role of $\text{VO}_{2\text{max}}$ in the prediction of successful transition from junior to senior elite ranks, the ST could be used to identify performers whose $\text{VO}_{2\text{max}}$ is sufficiently high in their age group and meeting the physiological demands of senior match play.⁴

Although not performed in this study, by the nature of its linear increase in the intensity of exercise (as shown in Figure 4), the ST described might also be useful for identification of submaximal metabolic thresholds using blood lactate analysis or ventilatory markers of metabolic acidosis. This practice was reported by Girard et al⁸ and allowed the prescription of submaximal on-court training that corresponded to match-play intensities that have been recently reported. For example, on-court training speeds that correspond to blood lactate concentrations of 8 mmol·L⁻¹.³ Further research is required to explore this possibility with the test described here.

Conclusion

The squash-specific incremental test described resulted in higher $\text{VO}_{2\text{max}}$ values in squash players than a nonspecific treadmill incremental test. In addition, squash players demonstrated superior time to exhaustion over runners of similar $\text{VO}_{2\text{max}}$ on the squash-specific test. Furthermore, ST $\text{VO}_{2\text{max}}$ scores correlated strongly with those achieved on a standard laboratory-based treadmill incremental test. The results suggest that the squash test is a valid means to assess maximum aerobic responses and endurance capability of squash players.

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