SPORTS-SPECIFIC FITNESS TESTING IN SQUASH

K. STEININGER, Dr. med. and R. E. WODICK, Prof. Dr. Dr. rer. nat.
Sports Medicine Research Centre, University of Ulm, Germany

ABSTRACT

Maximum oxygen uptake and the running speed at the anaerobic threshold were determined during treadmill running. Performance in these laboratory tests and performance on a squash-specific field test were compared and examined with respect to subjective ratings of squash fitness.

The field test was performed in a squash court. Six light bulbs were connected to a programming device causing individual bulbs to light up in a given sequence. The players were instructed to react to the flashes by running towards and striking balloons mounted in the vicinity of the bulbs. By altering the interval between the lighting of the bulbs the intensity of exercise could be varied. The test consisted of a series of 3 min periods of exercise at increasing intensities (increased number of runs per unit of time). The results showed a low correlation (r = 0.52) between treadmill ergometry data and a rank-order list based on an independent, partly subjective estimate of fitness. A higher correlation (r = 0.90) was found for the results of the field test and the rank-order list. Maximum oxygen uptake values and anaerobic threshold values derived from laboratory measurements were thus not sufficient for a valid estimate of competition fitness in these players. The results show that a valid estimate of fitness can be derived from measurements involving exercise closely resembling that which is specific for the sports activity in question. Improved training advice and guidance may result from such studies.

Key words: Squash, Fitness, Testing

INTRODUCTION

The development of appropriate fitness tests is generally considered to be one of the essential tasks of sports medicine. Competition experience and the results of many investigations (Keul et al, 1981; Mader et al, 1976) show that the customary standardised cycle- and treadmill-ergometry is not sufficient for an unequivocal prediction of success in sport. Sport-specific laboratory tests, such as rowing ergometry for rowers or cycle ergometry for cyclists, also show deficiencies with respect to their capability of forecasting the results of competition. In part, these may be explained by the unfamiliar surroundings of the laboratory. In addition, in sports involving non-rhythmic movements and characterised by a complicated time-course of movement, as in handball, gymnastics, squash, alpine skiing and the like, sport-specific testing is either impossible or may be performed only with the help of elaborate and expensive technical equipment.

For all reasons, recent efforts have been directed towards performing the fitness tests in the framework of so-called field tests made at the training place under competition-stimulating or actual competition conditions. Results and experience gathered in recently developed field tests (Oelschläger, 1969; Steininger et al, 1985) show that they have a high prognostic value.

In squash, a game which was introduced to Germany only recently (1973) and has hitherto attracted little evaluative attention, the problems show up with particular clarity. Squash, an indoor game which may be compared with tennis and badminton, is considered to be the fastest of the racket-games. Lasting up to 3 hours in the case of a 5-set game, it puts high demands on a good player, calling for development of high forces, rapid changes of direction, fast reactions and a sure eye. A high level of energy reserves and their availability for anaerobic glycolysis and aerobic processes (Beaudin et al, 1978; Blanksby et al, 1973) is required because the rate of energy expenditure is 2-3 times as high as in tennis. A forceful strike, a good technique and adequate tactical abilities are also required. To test all these capacities, a specific fitness test (Davies, 1979) involved mimicking the nature of this sport. We developed a testing procedure involving well-defined load levels which is analogous to the usual forms of ergometry. In this paper, the results of a standard treadmill test were compared with those obtained in our field test. The results of both tests were examined by considering the competition record of the individual players participating in the test.

Address for correspondence:
Dr. K. Steininger
Team Doctor of the German Squash Team
University of Ulm
Sportmed. Untersuchungsstelle
Oberer Eselsberg
D-7900 Ulm/Donau

TESTING OBJECTS AND METHODS

Thirteen squash players (7 men and 6 women), all of whom belonged to German junior teams, participated in the tests. The data for men and women were pooled in accordance with the rank-list (for explanation see later) which listed the squash players regardless of sex. The field test was carried out 3 days after the laboratory test.

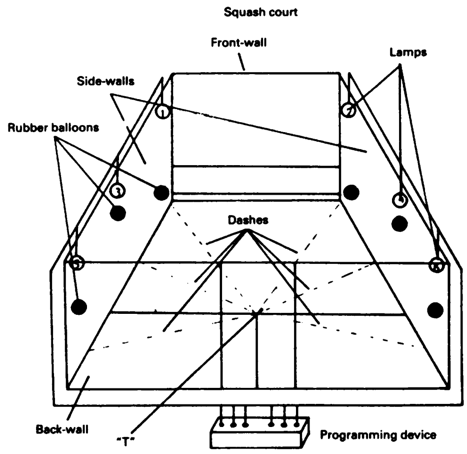

Fig. 1: Field test squash.

Field test (Fig. 1)

In a squash court, 3 lamps were positioned on each of the side walls: The first pair (denoted by numbers 1 and 2) was located near the front-wall corners, the second pair (lamps 3

TABLE I

Results of the treadmill tests for individual players

Test-person	Max. heart rate	Heart rate 5 min after load end	Max. blood-lactate (mmol/l)	Max performance last load step	time (min)	VO_2 max (ml/min kg KG)	Performance at the anaerobic threshold (km/h)
A	203	129	5.8	7	1.5	60.5	13.0
B	203	134	7.0	7	2.0	61.0	12.1
C	194	126	6.1	5	1.75	60.2	11.0
D	197	127	5.2	7	1.75	70.2	13.5
E	204	118	5.8	4	2.0	61.5	9.5
F	185	126	5.6	5	1.0	57.1	10.0
G	192	121	7.3	4	0.5	57.1	8.0
H	186	113	6.4	4	2.5	66.9	10.7
I	197	130	6.5	5	2.0	63.1	10.2
J	187	121	5.8	5	1.5	61.9	10.8
K	197	113	6.4	5	0.5	58.1	10.7
L	200	128	6.5	4	1.5	45.6	10.5
M	196	124	5.2	4	0.5	37.7	8.8
$\bar{x}$ (n = 13)	195.4	123.8	6.1			58.5	10.6
SD	6.1	6.1	0.6			8.1	1.4

and 4) in the middle of the side walls and the third pair (lamps 5 and 6) mid-way between lamps 3 and 4 and the back-wall corner. Rubber balloons (spring-mounted squash balls in a more recent version) were positioned under the lamps, knee-high for lamps 1 and 2, eye-high for 3 and 4, and hip-high for 5 and 6. The lamps were connected to a programming device located outside the court. Different fixed programmes (switch-in sequences of light flashes) were selected for each of the exercise intensities. In addition, the switching frequency could be altered in a stepwise manner.

The players were instructed to run from a central point (point T) toward each of the balloons as soon as the corresponding bulb was lit and to strike the balloon in a technically appropriate manner. As in the treadmill protocol the test consisted of successive 3 min periods of exercise. At the beginning 12 light pulses/min were delivered, resulting in a total of 36 dashes at intensity level 1. The intensity was then increased by 6 pulses (or dashes) per level until subjective exhaustion was reached, i.e. until a lamp was lit before the preceding one was touched by the player.

For determination of lactate concentration, blood was drawn from a hyperaemic ear lobe at rest, during a 45 sec rest interval interposed between periods of activity immediately after the activity and one and 3 min after cessation of activity. Simultaneously and 5 min following the termination of activity the ECG was taken with a three-lead system.

Treadmill ergometry

Treadmill ergometry was performed in a standard manner. At the beginning, a speed of 1.67 m/s (6 km/h) at a 5% slope was used followed by an increase of 0.55 m/s (2 km/h) at 3 min intervals until exhaustion was reached. The rest-interval duration, blood lactate and pulse frequency determinations were as described for the field test.

Fitness coefficients

A rank-order was established for the players by the coach/trainer, based on competitive results during the previous season and on subjective estimates of current squash fitness obtained from match play. This rank-order list was made by the trainer without knowledge of the results of other tests. The rank-order list was independent of age and sex. From this list, fitness coefficients were derived which served as a basis for comparison with the results of laboratory and field tests.

The relationship between these coefficients (match vs. field test and match vs. laboratory test) was established by linear correlation. Blood lactate (enzymatic determination by using the ROCHE Lactate-Analyser) and heart rate measurements will be commented on in the text. The value of 4 mmol/l was taken as the anaerobic threshold.

TABLE II

Results of the field test for individual players

Test-person	Max. heart rate	Heart rate 5 min after load end	Max. blood-lactate (mmol/l)	Max performance last load step	time (min)	Performance at the anaerobic threshold (light pulses/min)
A	176	107	8.6	6	0.5	54.0
B	190	110	9.7	5	2.25	56.1
C	185	115	5.5	5	1.25	50.1
D	182	110	6.1	5	1.0	55.5
E	195	119	10.1	4	3.0	33.6
F	184	117	8.5	5	1.0	44.4
G	175	116	11.4	5	0.5	45.3
H	180	120	8.4	5	1.5	45.3
I	190	122	9.0	5	1.5	45.3
J	190	121	8.3	5	0.75	49.2
K	178	120	4.8	4	2.75	48.9
L	195	122	6.1	4	2.0	34.5
M	190	124	7.8	3	3.0	32.1
$\bar{x}$ (n = 13)	185.3	117.1	8.0			45.7
SD	6.5	5.1	1.8			7.7

TABLE III

Fitness estimation factors calculated on the basis of data presented in Table I (treadmill)

Test person	Rank Order: Circulation recovery vl.	Max. performance	VO_2 max	Threshold performance	Estimation Factors $\bar{x}$ (n = 4)
A	11	3	7	2	5.75
B	13	1	6	3	5.75
C	7	5	8	4	6.0
D	9	2	1	1	3.25
E	3	10	5	11	7.25
F	7	7	10	10	8.5
G	4	12	10	13	9.75
H	1	9	2	6	4.5
I	12	4	3	9	7.0
J	4	6	4	5	4.75
K	1	8	9	6	6.0
L	10	11	12	8	10.25
M	6	12	13	12	10.75

TABLE IV

Fitness estimation factors calculated on the basis of data presented in Table II (field-test)

Test person	Rank Order: Circulation recovery vl.	Max. performance	Threshold performance	Estimation Factors $\bar{x}$ (n = 3)
A	1	1	3	1.6
B	2	2	1	1.6
C	4	5	4	4.3
D	2	6	2	3.3
E	7	10	12	9.6
F	6	6	10	7.3
G	5	9	7	7.0
H	8	3	7	6.0
I	10	3	7	6.6
J	9	8	5	7.3
K	10	11	6	9.0
L	12	12	11	11.6
M	13	13	13	13.0

RESULTS

The results obtained separately in treadmill and field test are presented in Tables I and II. Fitness coefficients calculated on the basis of these data are presented in Tables III and IV. Fitness coefficients were compared with the corresponding coefficients derived from the rank-order list. There was a close correlation between rank-order and field test, ($r = 0.90$, $p < 0.001$; Fig. 2). A lower correlation was found for rank-order vs. laboratory test ($r = 0.52$, $p > 0.05$; Fig. 3).

Maximal blood lactate concentrations for the field test were significantly higher than those obtained on the treadmill (Fig. 4). Measurements of the heart rate showed clearly that recovery following exercise was faster on the squash court test than in the laboratory test (Fig. 5). Other values were not significantly different in the two tests.

DISCUSSION

The value of a laboratory test is uncontestable for sports involving simple, rhythmic movements like cycling, rowing or running. These tests fail in sports characterised by complicated, non-rhythmic movements in which quickness, rapid force development and fast reactions are required. The failure is due to the excessive simplicity of these tests.

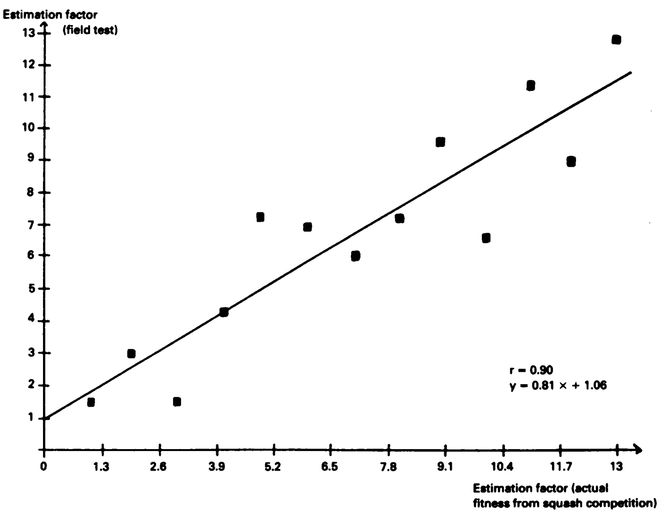

Fig. 2: Correlation between rank-orders field test and actual fitness.

Squash belongs to the latter group of sports. The test described was developed to measure the player's ability to master many of the requirements of the game. To ensure a high information content, the test was devised in a way such that the player's activity was very similar to that during an actual squash game. The high correlation between the field-test data and the rank-order list ($r = 0.90$) argues for the adequacy of the pattern of exercise intensity which was chosen.

Consistently higher blood lactate values were measured in the field than in the laboratory test throughout the period of exercise. This may be explained by a more intense muscle use and a higher motivation in the field test. Most of the players were already working above the anaerobic threshold during the second intensity step of the field test. This may be explained by an enhanced muscle effort (onset, dash, run-back) at this intensity level. It was assumed that the performance limit in the field test was set by muscle acidity. Peak acidity, comparable to that measured in the field test, is presumably reached also during an actual squash game.

The heart-rate data showed that the players were under maximal load during the field, as well as during the laboratory, tests (Fig. 5). Differences were found merely between recovery values, significantly faster recovery being

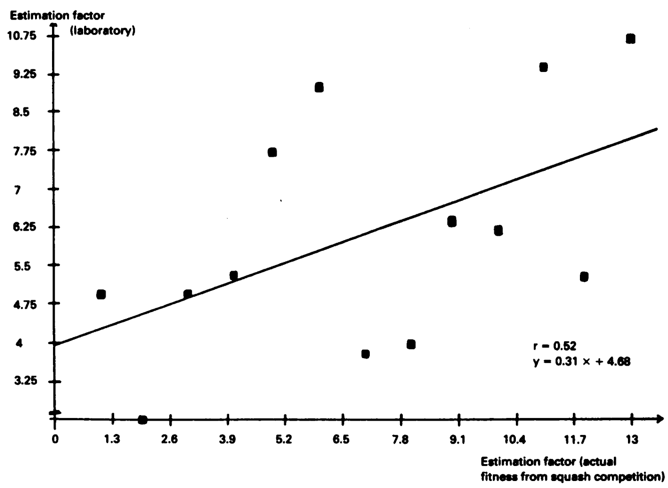

Fig. 3: Correlation between rank-orders laboratory test and actual fitness.

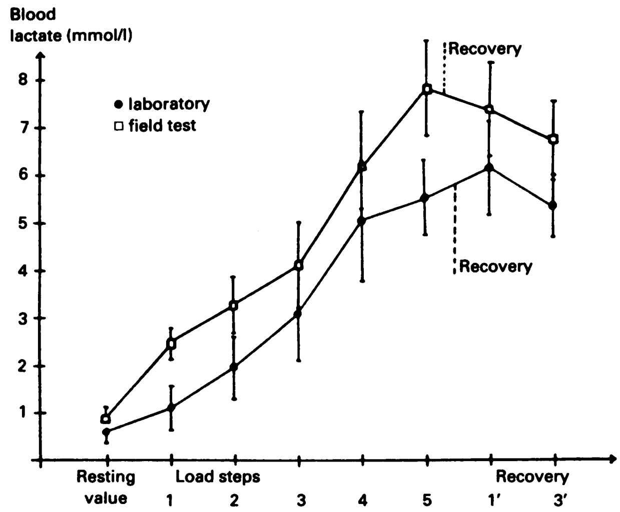

Fig. 4: Blood lactate: treadmill and field test (average value n = 13).

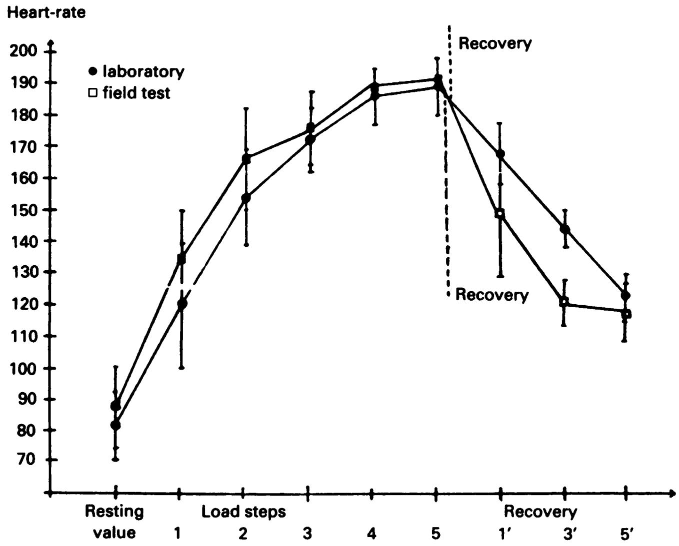

Fig. 5: Heart-rates: treadmill and field test (average value n = 13).

observed in the field test than in the laboratory test. The familiar surroundings, a more appropriate training preparation and exercise intensity may account for the observed difference.

In conclusion, we believe that our test allows reliable estimates to be drawn on the fitness of squash players and it may be used effectively in place of or in addition to laboratory tests.

References

Beaudin, P., Zapiec, C. and Montgomery, D., 1978 "Heart rate response and lactic acid concentration in squash players". Am.Assoc.Health Phys.Educ. 49: 406-412.

Blanksby, B. A., Elliot, C. and Bloomfield, U., 1973 "Telemetered heart rate response of middle aged sedentary male, middle aged active males and a great male squash players". Med.J.Austr. 2 (10): 477-481.

Davies, J. E., 1979 "Squash-Performance Testing & Problem Injuries". Medisport 3 (6): 36-39.

Keul, J., Dickhut, H., Berg, A., Lehmann, M. and Huber, G., 1981 "Allgemeine und sportartspezifische Leistungsdiagnostik im Hochleistungsbereich" Leistungssport 11: 382-390.

Mader, A. H., Liesen, H., Heck, H., Philippi, H., Rost, R. and Hollmann, W., 1976 "Zur Beurteilung der sportartspezifischen Leistungsfähigkeit im Labor" Sportarzt und Sportmedizin 27: 80-88.

Oelschläger, H., 1969 "Vergleich zwischen spiroergometrischen Befunden und tatsächlichem Leistungsvermögen in Training und Wettkampf" Inaugural-Dissertation, Leipzig.

Steininger, K., Gerl, H. and Wodick, R. E., 1985 "Sportartspezifische Belastungstests bei handballspielern, Vergleich der Laborroutinediagnostik mit Feldtests". Dtsch.Z.Sportmedizin 9: 266-276.