B. Blanksby

B. C. Elliott

K. Davis

M. Mercer

BLOOD PRESSURE AND RECTAL TEMPERATURE RESPONSES OF MIDDLE-AGED SEDENTARY, MIDDLE-AGED ACTIVE AND "A"-GRADE COMPETITIVE MALE SQUASH PLAYERS

B. A. BLANKSBY* PhD, B. C. ELLIOTT* PhD, K. H' DAVIS** MEd, M. D. MERCER* BSc

**Department of Human Movement and Recreation Studies, The University of Western Australia, Western Australia.*

***Department of Physical Education, Deakin University, Victoria.*

INTRODUCTION

Squash is a leisure activity currently attracting a high level of community participation. Previous investigations (Blanksby et al., 1973; Docherty and Howe, 1978; Beaudin et al., 1978) have shown squash to demand high

levels of energy expenditure especially when played by middle-aged sedentary males.

The thermoregulatory changes during this vigorous game have not previously been studied. In the thermal equilibrium of rest or exercise, heat gains and losses are

balanced by adjustments in sweat secretion and circulation to the skin (Nielsen, 1969). During work, about three-quarters of the energy expended is converted to heat which must be dissipated to avoid excessive elevation of body temperature. The circulatory mechanism of heat dissipation becomes increasingly important as the energy requirements of an activity increase, especially if taking place in warmer environmental surrounds (Brouha and Radford, 1960).

This study was undertaken to evaluate the changes in blood pressure (BP) and rectal temperature (Tre) incurred by middle-aged sedentary, middle-aged active and "A"-grade competitive men squash players during a game.

PROCEDURES

Sources of the Data

Twenty-seven male squash players were selected from the clientele of various squash centres in the Perth metropolitan area of Western Australia. Groups of nine subjects were chosen for each of the three categories. The middle-aged sedentary group consisted of nine men aged forty years and over who played squash once per week for recreation and who did not participate in any other form of physical activity. Nine men aged forty years and over, who played squash at least once a week in addition to participating regularly in other forms of physical recreation, were selected for the middle-aged active group. A minimum of three exercise sessions per week, each of at least thirty minutes duration, was necessary for the subject to be included in this category. The third group comprised nine men who played in "A" Grade in the Western Australian Squash Rackets Association Competition.

Administration of the Tests

Each subject participated in a thirty-nine-minute test period on a squash court in temperatures not exceeding 22.2°C, relative humidity not exceeding 60% (Berggren and Christenen, 1950) and with a partner of his own choosing of similar standard. At a time several days prior to the test, candidates were assembled in the laboratory to become familiar with test equipment and protocol. Responses during graded treadmill exercise were also recorded to provide insight to ranges of values to be expected, thus facilitating the calibration of the equipment used for recording the blood pressure.

On the actual test day, each subject was required to have pre-game measures taken both outside and on court. To collect the BP data, a Narco Biosystems BP cuff with microphone was placed on the arm and the output plugged into a matched Electrospgmograph. This, in turn, was coupled to an amplifier and a U-V recorder which provided a trace indicating diastolic (DBP) and systolic (SBP) blood pressures.

To collect the data relating to temperature changes, a rectal thermistor probe was inserted to a depth of 20 cm and connected to a Telethermometer to record rectal temperature (Tre) directly. Tapes were attached at a point 21 cm from the end of the probe and tied to a tape around the waist, one to the front and one to the back, in order to maintain the correct and constant position of the thermistor.

Prior to each test, the pressure of the electrospgmograph was calibrated with a pressure taken on the same arm immediately after with a Bonn S-P sphygmomanometer. A thermos flask of water with a thermometer was used to calibrate the rectal probe within the expected range (35°C – 42°C).

Following a three-minute 'hit-up' period, a game was played for thirty-nine minutes with interruptions to play occurring at the end of a rally just prior to the end of each three-minute period in order to record heart rate (HR), BP and Tre. Nine minutes had been allowed for the measurements taken over the total playing time. The subject, at the sound of a whistle, moved swiftly and joined the rubber tubes hanging down inside the back of the court from the BP recorder onto the microphone cord of the cuff, plugged in the Telethermometer extension cord to the rectal probe fitting attached to a belt, and then stood stationary. One tester pumped the cuff up immediately after the first connection was made and when the subject was stationary. The U-V recorder was switched on at paper speed of 12.5 m/s with the pressure gradually being released. During this time the Tre was determined by the other tester. After the readings had been taken, the subject detached the equipment and returned to the game. The whole procedure took approximately twenty seconds to complete. Meanwhile the opponent collected the ball and prepared for service so that the game could resume immediately after the readings were taken.

At the conclusion of the thirty-nine minutes of playing time, recovery measures were taken every minute for five minutes and after the final reading the BP was again checked on the Bonn S-P sphygmomanometer.

Treatment of Data

The mean measures of all subjects for SBP, DBP, Tre and HR were calculated for outside and on court prior to commencement of play, at three-minute intervals throughout the thirty-nine-minute game and at one-minute intervals during the first five minutes of the recovery period. A two-factor design with repeated measures on one factor was computed to investigate possible interaction between the groups and differences between the groups at the same stage during the game. A significance level of 0.01 was established to determine differences between the physiological measures.

RESULTS

The mean ages of the groups was 44.8 years for the middle-aged sedentary; 44.2 years for the middle-aged active, and 25.8 years for the "A"-grade-level players.

Fig. 1 shows that a consistent increase in rectal temperature occurred during the game.

Fig. 2 reveals that systolic blood pressure for all three groups rose over the pre-game period between the time the reading was taken outside the court and then when standing on court.

A sudden elevation of SBP was common to all groups with the transition from pre-game to activity conditions.

The "A"-grade group which had the lowest pre-game SBP level of 133.8 mmHg registered its highest mean level of 170.1 mmHg by the end of the third minute of play. Its SBP plateaued from the end of the sixth minute to the end of the twenty-first minute of play at a level of approximately 160 mmHg, before reducing to 142.2 mmHg by the end of the playing period.

A significant interaction was found between the three groups over the playing period which can be seen from the SBP gradients in Fig. 2. The only significant difference in SBP between the three groups during play occurred at the twelfth minute when the middle-aged active group recorded a level significantly higher than the middle-aged sedentary players.

The effect of activity on diastolic blood pressure was different from that indicated by rectal temperature systolic blood pressure recordings. A gradual reduction in pre-game levels over the entire period of play was experienced by each group (Fig. 3).

Fig. 4 demonstrates that the heart rate levels of the middle-aged sedentary group were generally less than those of the middle-aged active and "A"-grade groups. A maximum recorded HR of 167 bpm for the "A"-grade group was greater than the 160 bpm maximum recorded by the middle-aged active group and the 157 bpm recorded by the middle-aged sedentary group.

DISCUSSION

The rapid increase in SBP at the onset of exercise has been well-supported previously (Holmgren, 1956; Eskildsen et al., 1950; Fraser and Chapman, 1954; Julius et al., 1967; Åstrand, 1970, and Holmberg, 1971) but the DBP pattern is, on first inspection, in direct contrast to the weight of research (Eskildsen et al., 1950; Åstrand, 1965; Julius et al., 1967; Åstrand, 1970, and Saltin et al., 1972). The study carried out by Aikas et al. (1963) showed SBP to continue to rise as HR and body temperature increased, which does not agree with the findings of this study.

During prolonged heavy work, Holmgren (1956) showed that SBP and DBP decreased but, in maximal work, a pressure increase was observed. More specifically, after six minutes of work at the same load, SBP began to fall and continual work at a constant load was accompanied by a decrease to DBP (Holmgren, 1956). It has been shown that after the sixth to ninth minute of play there was only minimal variation in HR (Blanksby et al., 1973; Docherty and Howe, 1978) for the remaining time of play (twenty-five to thirty minutes). This would suggest that the intensity of the game, which Docherty and Howe (1978) found to be approximately 80 to 85 percent of the individual's predicted maximum and independent of skill level, had plateaued and therefore remained relatively constant for the remaining playing time. The fall in SBP occurred by the end of the sixth minute of play for the two middle-aged groups and at the end of the third minute of play for the "A"-grade group, coinciding with this "steady state" effect. In this instance the vasodilation in the vascular bed of the working muscles would exceed the elevation of cardiac output, causing reduced peripheral resistance to blood flow with the resultant decreases in BP. Eskildsen et al. (1950) have postulated that an observed pressure fall in untrained subjects after the workload increases above a certain level is due to peripheral insufficiency. This study, however, found that BP reductions in squash were independent of the fitness level of the group tested as based on its activity habits.

Cooper and Kenyon (1957) reported that BP was reduced when body temperature was elevated in excess of 1.5°C per hour, and this occurred during the present study. The increase in Tre supports the findings of Hardy et al. (1938) and helps to explain the fall in BP as evidenced during the majority of the squash game.

The immediate fall of SBP on the cessation of play for the middle-aged sedentary group was not paralleled by the middle-aged active and "A"-grade groups which demonstrated a rise in SBP at the end of the first minute of recovery before then decreasing toward its pre-game levels. Diastolic pressure, however, increased immediately for all groups at the cessation of play. It is not

really clear as to why only the SBP of the middle-aged sedentary group fell immediately upon cessation of play. Possibly the others demonstrated better vasomotor tone due to improved venous return while standing during the recovery period.

The increase in Tre was 1.56°C for the middle-aged sedentary group, 1.79°C for the middle-aged active group and was similar to the 1.80°C reported by Hardy et al. (1938). These temperatures were considerably less than the 41°C to 42°C reported as being danger levels for body temperatures (Robinson, 1961; Ruch and Patton, 1966) although core temperatures of 41.7°C have been recorded in distance runners without obvious distress (Maron et al., 1978).

Åstrand (1960), and Saltin and Hermansen (1966) reported that body temperature increases were proportional to the percentage of the individual's maximum aerobic capacity. It would appear therefore that the subjects in this study were working at the same percent of maximum aerobic power as there was no significant difference between the groups in the Tre reading by the end of the thirty-nine minutes of play. The minimal difference in Tre between the middle-aged sedentary and middle-aged active groups was probably because of the slightly higher percent of maximum that the active group played, as indicated by the higher HR's in Fig. 4. The behaviour of the Tre after the cessation of play indicated that the subjects were not working at their maximum, since Saltin and Hermansen (1966) have shown that at 100 percent workload Tre continues to rise after cessation of exercise.

Blanksby et al. (1973) concluded that playing squash once per week constituted severe activity for middle-aged sedentary males. They worked at 97.2 percent of their maximal heart rate, as determined by the method outlined by Åstrand (1968). Middle-aged active players never exceeded 85.5 percent of their maximal, and "A"-grade players only worked at 73.9 percent of their maximum level when using the same criterion. Beaudin et al. (1978) found that a group of men with a mean age of 29.4 years worked at 77.2 percent of their maximum aerobic power, while Docherty and Howe (1978) reported levels of between 80 and 85 percent for a group of 30 men with a mean age of 29 years. It is evident in comparing these studies with the results in Fig. 4 that the "A"-grade players recorded heart rates similar to those found in Blanksby et al. (1973), and Docherty and Howe (1978) while the middle-aged active group was stressed more and the middle-aged sedentary group less than the findings of Blanksby et al. (1973). Due to the fact that the middle-aged sedentary group was playing for only 50% of the time on the court (Blanksby et al., 1973), it could have been that the extra 20 s rest taken every three minutes in the present study was sufficient to allow greater recovery between rallies.

On the basis of the findings in this study, the BP response to squash indicated a prolonged, heavy workload but not maximal work (Holmgren, 1956). This was supported by the Tre response during recovery (Saltin and Hermansen, 1966) which did not reach dangerous levels when played under comfortable environmental conditions. A direct comparison with the earlier studies by the authors is not possible until telemetered responses to the BP and Tre measures can be recorded, thus eliminating the need for artificially-introduced rest periods, albeit brief.

Thus, in moderate climatic conditions, each group

worked within its maximum capabilities and, although demonstrating that squash is a vigorous game, did not record temperatures at a dangerous level. In the hotter summer months, however, it might be advisable to introduce extra rest periods to maintain satisfactory body temperature levels.

The elevated BP measures also were no cause for concern but anyone with an already elevated BP should seek medical advice before stepping onto a squash court, particularly in summer and if in possession of a type A aggressive personality.

REFERENCES

- Aikas, E., Karvonen, M. J., Piironen, O. and Rwesteenoja, R., 1963 "Intermuscular, Rectal and Oesophageal Temperature During Exercise", *J.Appl.Physiol.* 18: 51-64
- Åstrand, I., 1965 "Blood Pressure During Physical Work in a Group of 221 Women and Men, 48-63 Years Old", *Acta Med. Scand.*, 178: 41-46
- Åstrand, I., 1960 "Aerobic Work Capacity in Men and Women with Special Reference to Age", *Acta Physiol. Scand.*, 49: Suppl. 169, 64-73
- Åstrand, P. O., 1968 "Physical Performance as a Function of Age", *J.A.M.A.* 205: 729-33
- Åstrand, P. O. and Rodahl, K., 1970 *Textbook of Work Physiology*, Sydney, McGraw-Hill
- Beaudin, P., Zapiec, C. and Montgomery, D., 1978 "Heart Rate Response and Lactic Acid Concentration in Squash Players", *Res. Quart.*, 49: 406-412
- Berggren, G. and Christensen, E. H. 1950 "Heart Rate and Body Temperature as Indices of Metabolic Rate During Work", *Arbeitsphysiologie*, 14: 255,
- Blanksby, B. A., Elliott, B. C. and Bloomfield, J., 1973 "Telemetered Heart Rate Responses of Middle-aged Sedentary Males, Middle-aged Active Males and "A" Grade Male Squash Players", *Med.J.Aust.*, 2: 477-481
- Bjerkedal, T. and Natvig, H., 1966 "Changes in Blood Pressure With Age", *Acta Med.Scand.*, 180: 257-271
- Brouha, L. and Radford, O., 1960 "The Cardiovascular System in Muscular Activity", *Science and Medicine of Exercise and Sports*, edited by W. Johnson, Harper and Row, New York
- Buskirk, E. and Bass, E., 1960 "Climate and Exercise", *Science and Medicine of Exercise and Sports*, edited by W. Johnson, Harper and Row, New York
- Cooper, K. E. and Kenyon, J. R., 1957 "A Comparison of Temperatures During Hypothermia", *Brit.J.Surg.* 44: 616-619
- Docherty, D. and Howe, B., 1978 "Heart Rate Response of Squash Players Relative to their Skill Level", *Aust.J. Sports Med.*, 10, 4: 90-92
- Donald, K. W., Bishop, J. M., Cummings, G. and Wade, O. L., 1955 "The Effect of Exercise on the Cardiac Output and Circulatory Dynamics of Normal Subjects", *Clin.Sc.*, 14: 37
- Eskildsen, P., Gotzsche, H. and Hansen, A. T., 1950 "Measuring Intra-arterial Blood Pressure During Exercise", *Acta Med. Scand., Suppl.* 239: 245

- Fraser, R. S. and Chapman, C. B., 1954 "Studies on the Effects of Exercise on the Cardiovascular Function", *Circulation*, 19, 193-198
- Greenleaf, J. E. and Castle, B. L., 1971 "Exercise, Temperature Regulation in Man During Hypohydration and Hyperhydration", *J. Appl. Physiol.* 30: 847-853
- Hardy, J. D., Milhorat, A. T. and Dubois, E. F., 1938 "The Effect of Exercise and Chills on Heat Loss from the Nude Body", *J.Nutr.*, 16: 477-491
- Holmberg, J., Serzysko, W. and Varnauskas, E., 1971 "Coronary Circulation During Heavy Exercise in Control Subjects and Patients with C.H.D.", *Acta Med.Scand.*, 190: 456-480
- Holmgren, A., 1956 "Circulatory Changes During Muscular Work in Man", *Scand.J.Clin. Lab.Invest.*, 8 (Supp.): 24
- Julius, S., Amery, A., Whitlock, L. S. and Conway, J., 1969 "Influence of Age on the Hemodynamic Response to Exercise", *Circulation*, 36: 222-230
- Maron, M. B., Wagner, J. A. and Horvath, S. M., 1977 "Thermoregulatory responses during Competitive Marathon Running", *J.Appl.Physiol.* 42: 6
- Nielsen, B. and Nielsen, M., 1962 "Body Temperature During Work at Different Environmental Temperatures", *Acta Physiol.Scand.*, 56: 120-129
- Nielsen, M., 1978 "Die Regulation der Korpertemperatur bei Muskelarbeit", *Acta Physiol. Scand.*, 79: 193
- Robinson, S., 1963 "Temperature Regulation in Exercise", *Pediatrics* (Supp. Part 2): 691-702
- Ruch, J. C. and Patton, H. D., 1966 "Temperature Regulation", *Physiology and Biophysics*, W. B. Saunders Co., London
- Saltin, B., Gagge, A. P., Beigh, U. and Stolwijk, A. T., 1972 "Body Temperatures and Sweating During Exhausting Exercise", *J.Appl.Physiol.* 32: 635-643
- Saltin, B. and Hermansen, L., 1966 "Desophageal, Rectal and Muscle Temperature During Exercise", *J. Appl. Physiol.* 18: 51-56

BOOK REVIEW

Title: A GUIDE TO SPORTS MEDICINE
Editors: Peter G. Stokes, N, NZ, S, P,
Publisher: Churchill Livingstone, 1979
 Price: £6.00 197 pages Paperback

This guide is rather like a map of an island which includes only about half the coastline and none of the land. It is with great disappointment that I have read this sketchy little volume consisting largely of other people's reprints and so eclectic as to defy use as a reference text. Of 197 pages, no less than 30 are devoted to the whole question of doping, the centrepiece of which is a 14-page reprint of a French paper of 1973 couched in anecdotal and philosophical terms. Other old masters include Pugh's description of the Four Inns disaster, from *The Lancet* of 1964, a paper on air travel by Turner from 1974, reproduced from the *Traveller's Health Guide*, a 1970 article on doping by Millar, from the *Australian Journal of Sports Medicine* and my own favourite on sports hygiene reproduced from the *International Manual of Cycling*, 1972. This contains the classic sentence "Hygiene of the cyclist's person is essential in order to avoid contagion from illnesses, especially of the parasitic type".

My experience of and great respect for so many fine leaders of sports medicine from Australasia makes me sad that such an inadequate book should be offered from down-under, particularly with such a pretentious title.

J. G. P. Williams