Physical Fitness Research on Handballers - April 1986
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Recently, the Canadian Handball Association (CHA) funded a research project carried out by Dr. Marion Alexander and Susan Boreskie of the University of Manitoba Physical Education Department. The purpose of this study was to conduct a time/ motion analysis for the game of handball, as well as assess the physical fitness level of two handball players, namely Merv Deckert and Rick Jackiw. Merv, 36 years old, is the current Canadian and World handball champion. Rick, 35 years old, is the current Canadian Seniors, 35-plus, singles champion.

As a consequence of this study we hoped to be in a better position to determine the anaerobic and aerobic energy requirements of the sport as well as to design training programs appropriate to the sport and to the fitness level of the participants.

Before reporting on the results of our study, it is necessary to define some terms that are essential to an understanding of the study. To over simplify, different sports demand different types and amounts of muscle activity resulting in different energy systems being called into action.
The three energy systems are the anaerobic alactic, anaerobic lactic, and aerobic system.

The anaerobic alactic system is the one referred to as the stored-energy system. This system provides the energy when athletes do bursts of high-speed movements that last one to 10 seconds. It is present in the form of limited high-energy phosphagens (A TP and CP) that are stored in the muscles. Depletion of the energy from this source is said to take six to 30 seconds. A five or six to one ratio of rest to work allows ti me for the ATP and CP to build up again.

The anaerobic lactic energy system supplies the majority of energy for the bursts of activity lasting longer than 10 seconds, but less than two minutes. This energy system, which runs on carbohydrate fuel and produces lactic acid, has its peak output in all-out efforts at about 30 seconds. In order to train this system, rest periods should be five or six times as long as work periods.

The aerobic energy system is a complex system involving oxygen transport and utilization. It is the predominant energy pathway in any long duration, continuous-effort event. As such, the length of time for training this system must be a minimum of 20 minutes.

While it is relatively easy to determine the energy requirements involved in sports of continuous activity, such as swimming, track, cycling and speed skating, it is more difficult to assess the energy requirements in sports with an intermittent exercise schedule, such as court sports, soccer, basketball, hockey, etc. It

appears, for example, that in these intermittent exercise sports that the fast bursts are primarily anaerobic lactic or alactic. In the case of court sports, however, when the exercise-to-pause (E:P) ratios are determined, it seems that the pause between rallies is not long enough for a re-synthesis of ATP/CP to occur. This suggests, therefore, that the anaerobic alactic system is not the primary one being utilized.

Furthermore, blood samples taken after courtsports games show low to moderate lactic acid levels, which would appear to indicate that the anaerobic lactic system is not being stressed. Generally, time/motion analysis of court sports have indicated that the primary energy system being utilized is the aerobic system.

The purpose of the time/motion study that we conducted was to determine the average work intensity during a handball game. The following sub-problems were investigated:

1.) The average length of rallies during the game and the average length of time between rallies.

2.) The average heart rate maintained during the course of the game and how this heart rate compared between players.

3.) The percentage of maximum heart rate at which each player worked during the course of the game.

In conjunction with the time/motion study, we did a fairly extensive fitness assessment of Merv Deckert, and due to financial constraints, a less extensive assessment of Rick Jackiw.

Our fitness tests determined that Merv and Rick are well-conditioned athletes, especially considering that they were assessed in their off season. Although their V02 maximum (a measure of aerobic power) was similar, i.e., 55 for Merv and 53 for Rick, there was a significant difference in their time on the anaerobic treadmill, i.e., 105 seconds for Merv and 72 seconds for Rick. A V02 maximum in the mid50s compares favorably to tests done on the top 15 nationally-rated racquetball players in the U.S. as reported in Physician and Sports Medicine, October 1979. The average V02 maximum for these players was 58. Unfortunately, our testers were unable to supply us with norms for the anaerobic treadmill test. The difference in their scores on this test was significant because we know fatigue resulting from lactic acid buildup results in poorer coordination and slower responses.

Space and time do not permit me to reveal the other results and the norms for the other tests we did on Merv other than to say he scored very well in all areas with the exception of three tests related to flexibility. Handball players may have a tendency to neglect training programs related to flexibility in favor of programs

involving strength training, cardiovascular fitness and skill development. Flexibility training programs should not be neglected, however, as increased range of movement can be advantageous in handball and beneficial in regard to injury prevention.

For the time/motion study, Merv and Rick played a typical three-game match, though Merv won all three games. The scores were 21-9, 21-6, 11-9.

The results of the heart-rate monitoring were similar to those reported in time/motion studies of racquetball and squash. Rick had a mean working (not including time between games) heart rate of 163.6 beats per minute, which was 88 percent of his maximum. Merv was working at 80.6 percent of his maximum. Given that both were working at a level above 80 percent of their maximum, the athletes were attaining a significant conditioning effect from their handball play.

The heart-rate monitoring also revealed that Merv was able to recover more completely after rallies and between games, i.e., Merv's heart rate would fall to a lower level than Rick's du ring these times. This difference was attributed to Merv's greater skill level and greater fitness level. It was felt that Merv's higher score on the anaerobic treadmill test indicated that he was able to work at a higher portion of his V02 maximum before having to utilize anaerobic energy sources and deal with the accompanying lactic acid buildup that hinders performance.

The analysis with regard to the length of rallies and the time in between rallies was also similar to reports of time/motion studies of racquetball. The mean length of rallies in the first two games was 8.9 and 8.75 seconds with a mean time interval between rallies of 9.9 and
9.6 seconds. In the third game the ratio was E:9.22 to P:12.82 seconds reflecting a closer and more tiring game.

In analyzing the number of shots taken, the only significant finding was that Merv took 158 shots with his right hand and 118 with his left hand, whereas Rick took 207 with his right and 81 with his left. Both players are right-handed. Dr. Alexander, who conducted the study, observed that running around the ball to hit it with the dominant hand is wasteful of energy and inefficient (of course, he wasn't playing Deckert).

As noted earlier, the average length of rallies was about nine seconds.
The longest rallies were in the range of 34 to 39 seconds. Nine percent of the rallies were over 20 seconds, 24 percent between 10 and 20 seconds, 34.5 percent between five and 10 seconds, and 32.14 percent were less than five seconds. The high percentage in the short time periods, perhaps, reflects the difference in skill levels and Merv's strong serve.

The ball was in play for an average of 47.3 percent of the match. The match was played fairly quickly with few timeouts or delays. Actual playing time totaled 21 minutes and 35 seconds.

The findings of this study cannot be regarded as conclusive due to only having two subjects. These findings, though, appear to be useful in providing reasonable estimates in regard to recommending training programs for handball.

Before outlining a few of the suggestions that have arisen as a result of this study, it should be noted that handball, based on this study and anyone's observation, is a strenuous game. Heart rates in this study averaged over 80 percent and on many occasions reached their maximum level. Given the cardiovascular stress inherent in this game, it would be advisable for anyone considering taking up the game, about to embark on a training program for handball, or who has doubts about his or her fitness level, to consult with their doctor in order to ensure that they can withstand the vigorous demands of the perfect game. Players should also be cognizant of the importance of a gradual cooling down period after they play.

The following suggestions were made based on the findings of this study and our fitness assessments of Merv and Rick.

1.) **Training should occur at a heart rate above 80 percent of maximum.**

2.) **Interval training is desirable in the game of handball as this most closely mimics the game situation. The E:P ratio should be varied to account for the varied length of rallies that occurs during the game.**

3.) **Anaerobic base is desirable as the game is largely aerobic. A running program should emphasize short distances at a fast pace**.

4.) **Running backwards is an important component of the game and should be included in the training program**.

5.) **Strength training should be utilized, especially arm and shoulder girth strength**.

6.) **Training should include extra practice taking shots with the non-dominant hand**.

7.) **Skipping rope can be a good form of training for handball players. As a player becomes more proficient at skipping he can reach a point of diminishing returns in regard to the training effect. If you skip, make sure you work as hard as you would in handball game.**

8.) **Anaerobic lactic training could be beneficial to handball players, especially if there is a weakness in this area. E:P ratio should be one to six with intervals done at 85-90 percent of maximum effort**.

9.) **Because of the large energy demands inherent in playing handball, carbohydrate loading for two or three days prior to a tournament would seem to be in order.**