RESEARCH REPORT - MIO™ LIFESTYLE WATCH

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INTRODUCTION

The accurate measurement of heart rate at rest and during exercise is an essential tool in the field of sports medicine. Athletes from the elite level to those with recreational interests have incorporated the information gained from portable telemetric heart rate units into their training programs. Heart rate can represent a valuable indicator of exercise intensity, a marker for recovery from aerobic activity and, in general terms, a rough indicator of cardiovascular fitness.

There are several types of heart rate monitors with the gold standard being the direct electrocardiographic signal, obtained from chest wall leads (strap or ECG electrodes), which is transmitted to a receiver, commonly worn on the wrist and incorporated into a sport watch. The heart rate signal of the MIO Lifestyle watch is electrocardiographic in nature but does not involve the use of a strap or ECG electrode.

The purpose of this project was to determine the heart response to aerobic activity on a cycle ergometer and to validate the heart rate obtained from the MIO Lifestyle to that achieved by direct lead ECG and a telemetric unit

METHODS

Subjects. 15 individuals, 8 males [age = 26.6 * 10.9 yrs; height = 180.5 * 8.4 cm; weight = 83.9 * 10.8 kg] and 7 females [age = 28.1 * 10.9; height = 168.4 * 8.3 cm; weight = 62.2 * 7.4 kg] volunteered for the study. The research protocols were approved by the Clinical Screening Committee for Research and Other Studies Involving Human Subjects and informed consent was obtained from each subject.

Experimental Protocol. Before testing, all subjects were given time to become familiar with using the MIO sport watch. Their individual data - birth date, weight, sex and resting heart rate - were entered into the watch. Following a 5 minute warm-up, each subject performed two tests on a cycle ergometer. The first test was of 30 minute duration with heart rate and metabolic data collection. It began with a 1 minute rest period followed by 28 minutes cycling at varied workloads to elicit heart rates ranging from near resting, up to 140 bpm and back to near resting. This was done twice during

the 28 minutes followed by a 1 minute recovery period. The subject was instructed to activate the MIO sensors at the end of every minute throughout the 30 minutes and the MIO, ECG and Telemetric (heart rate monitor with a chest strap) heart rate values were recorded simultaneously.

After a self-selected rest period, each subject performed a maximal exercise bout using a ramp protocol beginning at 50 watts, with increments of 25 watts/minute. Heart rate was recorded as in test one and the subject continued to volitional fatigue.

Experimental Measures. Both tests were conducted on an electronically-braked cycle ergometer [LODE Excalibur]. Heart rate was monitored and recorded every minute using e separate devices: a portable heart rate monitor with a chest strap and wrist receiver, a direct lead ECG [Physio Control Lifepak 6]; and a MIO Lifestyle watch. The MIO sensors were activated by the subject each minute.

Statistical Analyses. Pearson's product moment correlation coefficients were calculated to determine the association between heart rates recorded from the 3 separate devices during the incremental ride to exhaustion.

RESULTS

The relationship between the different methods of determining heart rate are presented in Figures 1 - 3. There is a significant linear relationship which is maintained from resting to heart rate values at maximal exercise. There are no significant differences between methods of determining heart rate. The MIO Lifestyle watch compares favorably with the direct ECG signal and the values determined with the portable telemetric heart rate monitor.

OBSERVATIONS

Heart Rate Accuracy
The determination of heart rate with the MIO Lifestyle watch operates on the same electrophysiological principles as the direct ECG and the portable telemetric heart rate technology. It is not surprising, therefore, that the accuracy is similar. The correlation between methods is excellent ($R2 > 0.98$).

The MIO Lifestyle watch has the advantage of not requiring a chest strap or chest electrodes. The chest strap can be annoying to some individuals, particularly if they wear it for extended periods of time. Although the lack of a chest strap is an advantage, it does introduce human error into the measurement of heart rate. There are several factors that contribute to the determination of heart rate using the MIO watch and these must be considered for each individual. The shape of the wrist and interface with the watch, the skin conductance, the amount and direction of pressure on the watch sensors all determine the success in obtaining an ECG signal. In the 30 minute aerobic task, the MIO watch was successful in obtaining a signal 79% of the time, compared to the direct ECG and portable telemetric heart rate device, which both received the signal

100% of the time. These factors are primarily related to gaining familiarity with the watch and the success in obtaining a signal will increase with use.