MONITORING EXERCISE HEART RATE USING MANUAL PALPATION

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LEARNING OBJECTIVE

- To understand the shortcomings of using postexercise heart rate palpation to monitor exercise intensity.

Key words:
Postexercise HR, HR Underestimation, Exercise Intensity, Exercise Prescription, Pulse Rate

Exercise professionals rely on heart rate (HR) to monitor exercise intensity because HR and intensity are directly related (1). Because of this relationship, exercise professionals use exercise HR to establish effective and safe exercise intensities for their clients. Although electronic HR monitors exist, postexercise pulse palpation is most popular because it is relatively easy and requires no equipment. Pulse is usually taken immediately after exercise because movement artifact makes it difficult to palpate pulse during activity (2). Postexercise palpation usually involves counting the pulse for 6 seconds at the radial (wrist) or carotid (neck) artery sites followed by computation of HR in beats per minute (BPM) (2). Despite its popularity, pulse palpation tends to underestimate exercise HR (3–6).

Underestimation of exercise HR via palpated postexercise pulse rate is a product of movement artifact and measurement delay. Movement artifact during early recovery, related to hyperventilation, makes it difficult to locate the carotid pulse quickly (6). Measurement delay affects the accuracy of the estimated exercise HR because the autonomic nervous system rapidly lowers HR by as much as 42 beats within the first minute after exercise (7). Because of rapid HR recovery after exercise, the longer it takes to palpate pulse, the less likely the obtained HR will accurately reflect exercise intensity (3). Therefore, to minimize error in estimating exercise HR from postexercise measures, pulse must be rapidly located and accurately counted.

Unfortunately, a palpated HR obtained with minimum delay and good technique after exercise still may not reflect actual exercise HR (3). This is because an inherent and unavoidable delay (i.e., the time taken to count pulse) accompanies the palpation method. Even an accurately palpated postexercise HR underestimates true exercise HR by approximately 25 beats (3). This is a serious problem because underestimating exercise intensity may leave clients feeling that they are not working hard enough. Consequently, they might overexert themselves in subsequent exercise bouts, which could lead to injury. Therefore, it would be helpful if postexercise palpated HR could be corrected to better estimate exercise HR. A correction factor...

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for postexercise HR could be determined if HR recovery followed a linear pattern in the first minute postexercise.

The objectives of this study were fourfold: to measure the typical postexercise delay for obtaining palpated HR, to examine the effects of that delay on exercise HR prediction accuracy, to determine the linearity of HR recovery in the first minute postexercise, and to derive correction factors that would allow accurate estimation of exercise HR from HR palpated during the postexercise period. Each of these objectives will be reported on following a brief description of the methods we used to collect data.

METHODS

To achieve our objectives, we recruited 54 female subjects (mean age, 19.9 ± 1.6 years) from group exercise classes held at the Ithaca College Fitness Center. All participants exercised regularly for 56.0 ± 28.1 minutes/day and 4.3 ± 1.4 days/week over the previous 9.2 ± 7.3 months. Data collection occurred during the normal confines of the class setting. We chose to study group exercise classes because they involved running and walking, which are the most popular forms of cardiovascular exercise. These classes lasted approximately 60 minutes and included warm-up and cooldown as well as high-intensity exercise segments. Class instructors taught pulse palpation to the students, so that they could assess exercise HR and, therefore, achieve desired exercise intensities, which were based on wall charts found in most exercise facilities. Instructors taught carotid and radial pulse palpation techniques, along with 6- and 10-second pulse counts. Because they are easier to do, most students choose the carotid pulse and a 6-second pulse count, as was the case with the classes we studied. Instructors stressed the importance of rapid and accurate postexercise HR measurement. They also cautioned students to palpate the carotid pulse lightly to avoid triggering a baroreceptor reflex, which may cause a drop in HR. Similar practices are commonly used at most exercise facilities.

Before data collection, all subjects attended three mandatory practice classes to ensure that they were comfortable with the pulse palpation technique; subjects also were habituated to the presence of video cameras and the use of HR monitors (Polar S610; Polar Electro Inc, Lake Success, NY). Data were collected during a fourth exercise class that was videotaped. Exercise HR was recorded at 10-second intervals throughout the exercise period and for 1 minute postexercise. Pulse palpation was completed at the midpoint and end point of the exercise period while subjects slowly walked about. In other words, participants actively recovered and were not passively sitting or lying down. To avoid influencing the subjects’ HR measuring habits, a mild deception was used. Participants were told that we were studying the effects of biomechanical technique on exercise HR. In addition, HR monitors were covered to prevent participants from seeing their HR monitor readout. After data collection, videotapes were reviewed to measure the typical postexercise delay in obtaining HR via palpation. Data from HR monitors and palpation were downloaded to a computer for analyses. The results follow.

DELAYED PULSE PALPATION

It took approximately 17 to 20 seconds for subjects to obtain their palpated HR postexercise, including the 6-second pulse count duration (Figure). From observations and informal interviews, we concluded that pulse palpation was delayed because participants waited a few seconds to catch their breath or find their pulse. The magnitude of this delay (17 to 20 seconds) is quite large, despite the three practice classes that emphasized technique and importance of taking HR immediately postexercise.

![Mean HR Recovery at 10-second Intervals](image_url)

Line graph of mean HR at 10-second intervals in the first minute postexercise from HR monitor data. Actual exercise HR is at second ‘0’, and dark-shaded area indicates the period (17 to 20 seconds postexercise) when subjects obtained pulse.
EFFECT OF DELAY ON PALPATED HR ACCURACY

Data revealed that palpated HR underestimated exercise HR by 20 to 27 beats. In other words, HR palpated postexercise (142 BPM) underestimated actual exercise HR (167 BPM) by nearly 20%. Translating this error to a real-world setting, clients estimating a percentage of age-predicted maximum HR from palpated HR, as based on wall charts found at most exercise facilities, would have believed that they exercised at 71% of their age-predicted maximum HR, when, in actuality, they were at 84% of their age-predicted maximum. Accordingly, these clients might conclude that they exercised moderately rather than vigorously, which might frustrate them or lead them to exercise at a higher and potentially unsafe intensity.

POSTEXERCISE HR

Heart rate monitors recorded recovery of approximately 30 beats in the first minute postexercise. Heart rate recovered at the rate of 11 beats per 20 seconds during the first 40 seconds of recovery but was slower in the last 20 seconds, decreasing by only 8 beats. In the first minute postexercise, HR was somewhat lower than previously reported (7), but our subjects were moderately active (e.g., walking, moving about) in contrast to earlier studies when subjects recovered passively (e.g., seated or supine). Active recovery probably slows the return of resting level autonomic nervous system activity, leading to a more gradual HR recovery (8).

With HR recovering approximately 5 beats every 10 seconds, any delay in postexercise HR measurement exacerbates the inaccuracy of palpated HR, reducing ability to reflect exercise HR. Subjects in this study took 17 to 20 seconds to obtain HR measures using a 6-second pulse count. The difference between palpated and actual exercise HR (approximately 25 BPM) may have been halved (10 to 12 BPM) if subjects had palpated pulse without delay and obtained HR within approximately 10 seconds after exercise. Although a fast pulse palpation would reduce inaccuracy, palpated HR would still underestimate exercise HR by at least 10 beats mainly because of normal HR recovery.

POOR SKILL AND INACCURACY OF PALPATED HR

To determine the effect of poor skill on accuracy of palpated HR measures, we compared palpated HR to a delay-adjusted HR measure. To obtain delay-adjusted HR, palpated HR was matched with HR simultaneously measured by the HR monitor at the closest time point postexercise. For example, if the delay in palpated HR measurement for a subject was between 18 and 22 seconds, the corresponding value was the 20-second postexercise HR obtained from the monitor. Using this system of comparison, we found that palpated HR underestimated delay-adjusted HR measures by approximately 10%. This made it clear that in addition to time delay (i.e., normal HR recovery), poor skill was a second factor causing a discrepancy between palpation estimated and actual exercise HR. This roughly 10% difference between delay-adjusted and palpated HR suggests that our subjects were not sufficiently skilled at pulse palpation, despite the three practice classes they attended before data collection. It is possible that a portion of this lack of skill was caused by using the carotid pulse to palpate HR. Excess pressure at the carotid pulse site may have evoked a baroreceptor reflex that decreases HR. To minimize this possibility, class instructors urged subjects to press lightly while palpating their pulse.

It would be rare for an exercise professional to spend three sessions with a client emphasizing the importance of HR measures, but apparently, this is still not enough. The problem of skill acquisition may be solved through more practice (5). Only good teaching and adequate practice can correct errors in palpation technique.

RECOVERY HR TREND AND ESTIMATING EXERCISE HR

Collectively, poor technique and recovery of HR lead to postexercise measures that underestimate the actual exercise HR. A correction factor to better estimate exercise HR from postexercise HR can be found if HR recovers linearly in the first
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minute postexercise. Heart rate monitor data clearly showed (Figure) a linear trend for recovery of HR. This linear recovery allowed us to develop equations at 10-second intervals postexercise that satisfactorily increased the accuracy of estimating exercise HR from well-measured postexercise palpatory HR. These equations are impractical for use in a regular exercise setting, so we devised simpler “correction factors” to estimate exercise HR from postexercise palpatory HR. The table shows the number of beats (or the correction factor) that must be added to postexercise HR measures at 10, 20, 30, and 60 seconds postexercise to generate a more accurate estimate of exercise HR. We considered corrected HR to be acceptably accurate when it was within 5 BPM of actual exercise HR. Maximum accuracy was obtained when 10-second postexercise HR was corrected, although 20-second postexercise corrections also led to an estimate that was within 5 beats of true exercise HR more than 70% of the time (Table). This 10- to 20-second window covers the approximate delay (17 to 20 seconds) in obtaining postexercise palpatory HR for the subjects in the present study (Sidebar).

LIMITATIONS IN PREDICTING HR
The use of these correction factors increases the accuracy of estimating exercise HR via postexercise palpation. Correction factors are only applicable if HR is palpated during active recovery and not while seated or supine. Furthermore, correction factors may only apply to a 6-second pulse count and if the pulse is measured accurately and within 60 seconds. Lastly, these corrections apply to palpated HR obtained after and not during exercise. Factors we did not study that might affect the accuracy of correction factors include fitness level, sex, age, and location of pulse palpation. These correction factors should be studied on a larger scale across different groups to verify if they are applicable to a wider population than fit college-aged female subjects.

CONCLUSIONS
Pulse palpation is a technique that demands careful teaching and extensive practice, which a client typically does not receive. Clients must be strongly encouraged to palpate correctly and immediately after exercise and then to predict exercise HR by applying a correction factor to compensate for the normally rapid recovery of HR. For practical purposes, clients skilled at palpation can obtain reasonably accurate estimates of true exercise HR if they add 5 or 10 beats to HR recorded at 10 and 20 seconds postexercise, respectively. This practice will minimize the underestimation of true exercise HR. Ultimately, an HR monitor is needed if an accurate assessment of exercise HR is required.

Example for correcting palpatory HR using correction factors

Mary Jane is a 22-year-old college student who participates regularly in dance aerobics classes. To measure exercise intensity at the end of her dance class today, Mary Jane counted her pulse at the carotid site for 6 seconds. She counted a total of 16 beats in 6 seconds and then computed her HR to be at 160 BPM after exercise (16 pulse counts x 10).

She was unhappy that she was not achieving her target HR according to the HR chart on the wall. Her exercise HR was supposed to be at 168 BPM, which was 8% of her age adjusted maximum HR. She then remembered that she had not measured HR immediately after exercise and had waited approximately 20 seconds before completing the pulse count. Mary Jane realized that she had to correct the postexercise HR measurement for the 20-seconds delay in measurement. According to her class instructor, she could do this by adding 10 more beats to the HR she had computed after exercise (i.e., 160 BPM + 10 beats = 170 BPM). This new HR represented her exercise HR more accurately, and Mary Jane was happy to know that she had indeed achieved her target HR of 168 BPM.

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