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Energy Expenditure Performing Hands-Only Cardiopulmonary Resuscitation During Average Emergency Response Times

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Energy Expenditure Performing Hands-Only Cardiopulmonary Resuscitation During Average Emergency Response Times

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Abstract

Early cardiopulmonary resuscitation (CPR) by civilian responders is a critical aspect in the survival of cardiac arrest patients. According to the American Red Cross (ARC), the average response time to a 911 call is 8-12 min. High-quality CPR performed as soon as possible following cardiac arrest considerably increases a person's chances of survival and recovery. It is possible that fatigue may decrease CPR quality, and to date no data exists on the metabolic cost of performing hands-only CPR. **PURPOSE:** To determine the energy expenditure of performing hands-only CPR during the average emergency response time. **METHODS:** Eight college-aged participants (23.6 ± 4.6 years) with a current CPR certification from the ARC or American Heart Association (AHA) volunteered for the study. Anthropometric measurements were collected, participants were then fitted with a heart rate (HR) monitor. Indirect calorimetry was used to measure oxygen consumption and caloric expenditure during hands-only CPR for the minimum 8-minute response time. Participants were instructed to provide hands-only CPR to a manikin at a rate of 100-120 compressions per minute with a metronome (110 bpm) providing pacing. Descriptive statistics (mean ± SD) were evaluated for peak HR, peak metabolic equivalents (MET), estimated maximal HR, percent of maximal HR and caloric expenditure (kcal). **RESULTS:** Participants expended 33.3 ± 13.7 kcal when performing hands-only CPR for 8 minutes. Further, participants provided compressions at an intensity of 5.7 ± 1.5 METs. **CONCLUSION:** Our data suggest that the metabolic cost of performing hands-only CPR for the minimum 8-minute response time is comparable to the energy expenditure of a very brisk walk. One of the common reasons to discontinue CPR is that the responder is too exhausted to continue. The results of our study suggest it is unlikely that cardiorespiratory fatigue is the primary cause of exhaustion. Therefore, future research should aim to measure the energy expenditure of hands-only CPR to volitional exhaustion and identify perceived sources of fatigue.

Introduction

The average emergency response time in the United States is about 8 minutes (American Red Cross [ARC], 2017). The ability for an individual to perform continuous hands only CPR can decide the outcome of a patient. There currently has been no research conducted analyzing the metabolic expenditure associated with CPR compressions.

This observational, descriptive research study will allow us to look at the metabolic costs during hands only CPR, which will help us better understand what kind of fitness levels would be beneficial for an individual to successfully perform hands only CPR while waiting for emergency responders. Our hypothesis for this study is that there will an association between metabolic cost and CPR compressions.

Purpose

To measure the metabolic cost of performing Hands-only CPR during the minimum average EMS response time in the U.S.

Methods

PARTICIPANTS

- Participants were college individuals between the ages of 18–31 years.
- All participants were CPR certified through either the American Heart Association or The American Red Cross.

METHODS

- Anthropometrics were measured and participants were then supplied with a heart rate monitor, mouth piece, nose clip and head gear to connect them to the metabolic cart for data collection purposes.
- Participants then proceeded to performed CPR for 8 minutes on a Little Anne CPR manikin. A metronome set at pace of 110 beeps per minute was used to assist participants in maintaining proper compression rate; halfway between the recommended 100-120 compressions per minute required for adequate CPR (Koster, R., 2015).
- Compressions were recorded every 30 seconds to ensure participants stayed within proper range. Heart rate, kcal, and METs were also measured using the metabolic cart.
- Data were analyzed using descriptive statistics (mean ± SD) for 7 of the 8 participants in the study. Data from one participant in the study was omitted due to an equipment malfunction with the heart rate monitor.

Results

The average metabolic cost of performing hands only CPR was 5.7 ± 1.5 METs. This indicates that performing CPR is equivalent to walking at a very brisk pace.

Participants performed an average of 898.1 ± 35.7 compressions. This puts the average well within the 100-120 compression rate required for proper CPR. The CPR performed also resulted in an average caloric expenditure of 33.3 ± 13.7 kcal.

Some participants almost reached their estimated HRmax, one participant even reached 90.5% of their HRmax. While the rest of the participants achieved an average of 74.3 ± 12.4 percent.

Age (years)	Weight (kg)	Estimated Heart Rate Max (bpm)	Heart Rate Max Achieved (%)	Relative VO ₂ (ml/kg/min)	Compressions performed
23.6 ± 4.6	68.9 ± 24.5	196.0 ± 5.0	74.3 ± 12.4	20.1 ± 5.1	898.1 ± 35.7

Table 1. Results found in testing for each participant the averages and the standard deviation

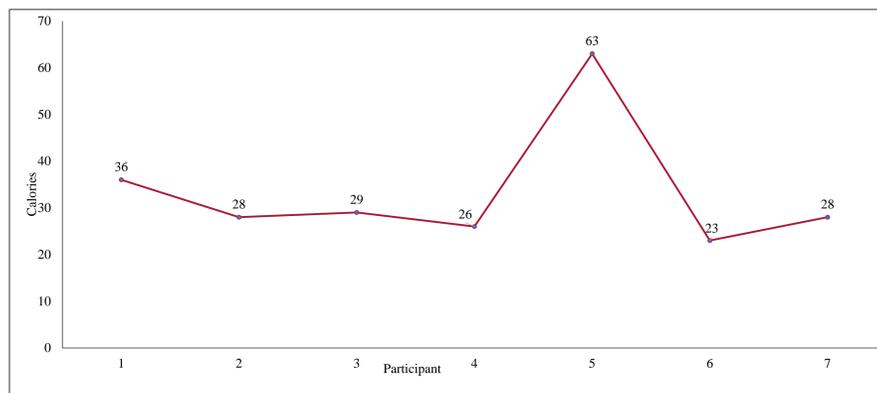


Figure 1. Display the caloric cost of performing hands only CPR for 8 minutes

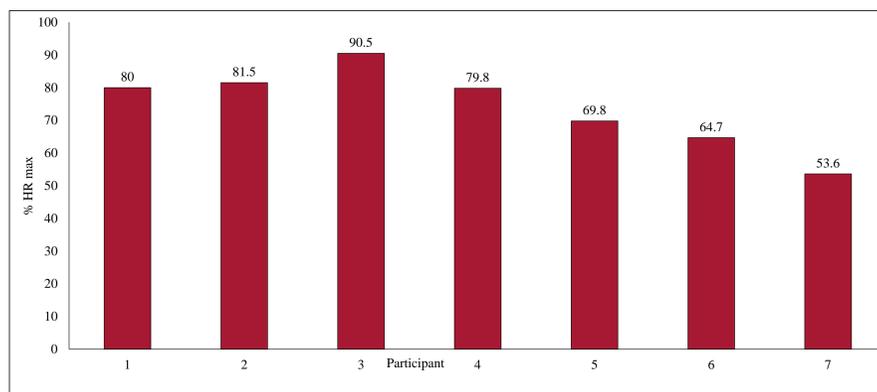


Figure 2. Displays the percent of HR max achieved by participants

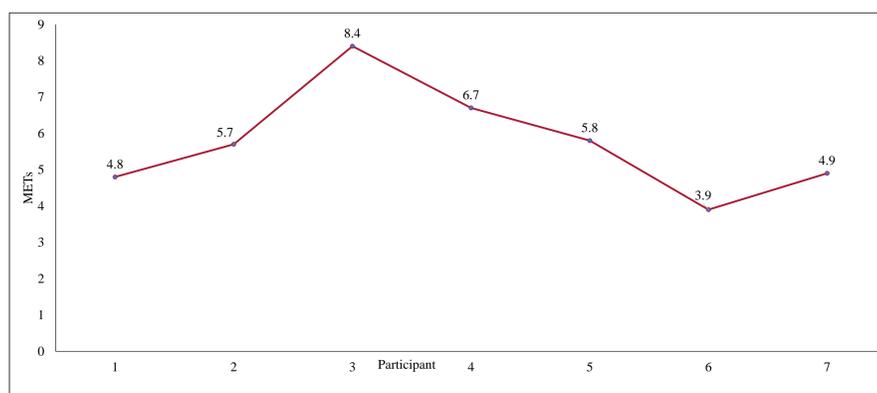


Figure 3. Display the metabolic equivalent of performing hands only CPR for 8 minutes



Figure 4. Participant performing hands-only CPR while connected to the metabolic cart.

Conclusion

The current study found that the average caloric expenditure for performing hands only CPR for the average 8-minute response time was 33.3 kcal. This means that the average caloric expenditure per minute is about 4.2 kcal. 4.2 kcal is equivalent to the average energy cost of walking at a speed of 3.5 mph, which is about 5 kcal/min for men and 3.9 kcal/min for women (Kenney, Willmore & Costill, 2015).

This indicates that central aerobic fatigue is most likely not the cause of why someone would stop performing CPR. For that reason, future studies should focus on having participants perform CPR until volitional exhaustion and then fill out a survey/questionnaire depicting why they stopped to determine the real reason why most individuals stop performing CPR.

The limitations of this study are the small sample size and the specific population of college aged individuals tested. Because the population is so specific we cannot generalize our findings to other populations. The strengths of this study are the use of the metabolic cart, which is the gold standard in measuring VO₂.

Future research on the subject should aim for a larger sample size, broader demographic and look to see the gender differences when performing CPR. Future research should also aim to have participants perform CPR until volitional exhaustion. Having this information can help determine if there should be a minimum fitness level that participants that must have in order to receive a CPR certification.

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