



ESCPe: Evaluating Spacesuit CPR Performance



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Abstract

Astronauts may need to perform Basic Life Support on a crewmember, which consists of cardiopulmonary resuscitation (CPR) with external chest compressions (ECC). In an emergency, astronauts will not have time to remove their spacesuits or let their heart rates return to resting conditions, and would have to perform CPR while already physically exerted. This study aims to evaluate the physiological exertion on rescuer performance while performing 6 minutes of ECC while wearing a commercially available spacesuit supplied by Final Frontier Design (Fig. 1).



Figure 1. LEA (Launch, Entry, and Abort) spacesuit by Final Frontier Design¹.

References

1. <http://www.finalfrontierdesign.com>
2. The beep test - a comprehensive guide. (2014). <http://www.5-a-side.com/fitness/the-beep-test-a-comprehensive-guide/>
3. <https://humansystems.arc.nasa.gov/groups/TLX/>

Methods

Twelve (12) participants, balanced by age, gender, and BMI, completed 3 trials: 1) CPR without spacesuit; 2) CPR with spacesuit; 3) CPR with spacesuit and physical exertion. The sequence in which trials were performed was randomized among the participants.

- Multistage shuttle run (beep test) provided physical exertion (Fig. 2).
- CPR consisted of ECC performed at a depth of 50 mm and a rate of 100 compressions per minute.
- Six (6) continuous minutes of ECC per trial.

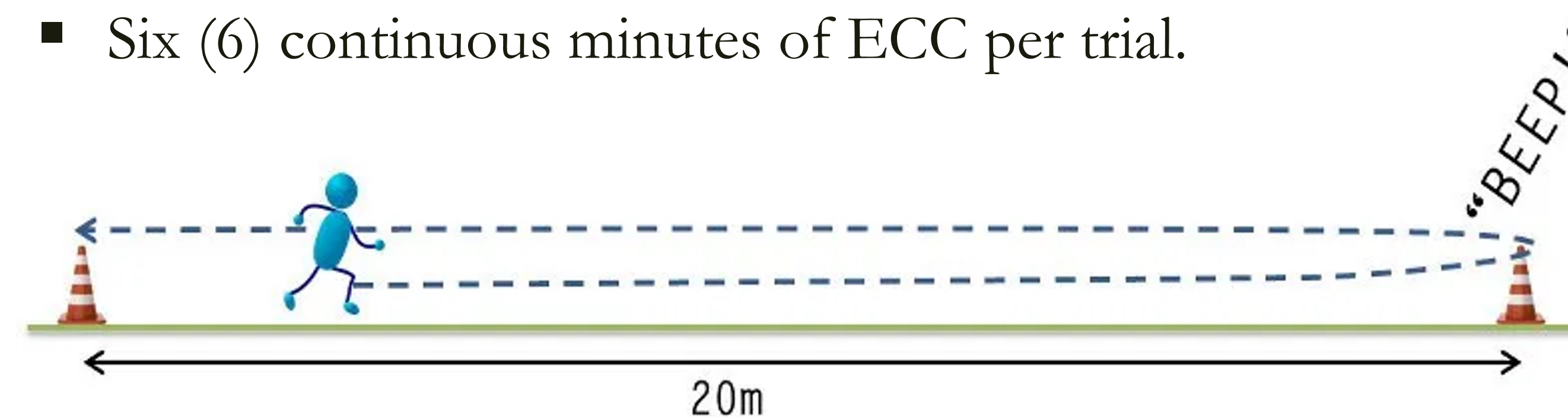


Figure 2. Illustration of the multistage shuttle run (MSR)².

- Heart rate (HR) and blood pressure (BP) measured before and after each of the 3 trials.
- NASA Task Load Index³ questionnaire given after each trial of CPR provided qualitative feedback.

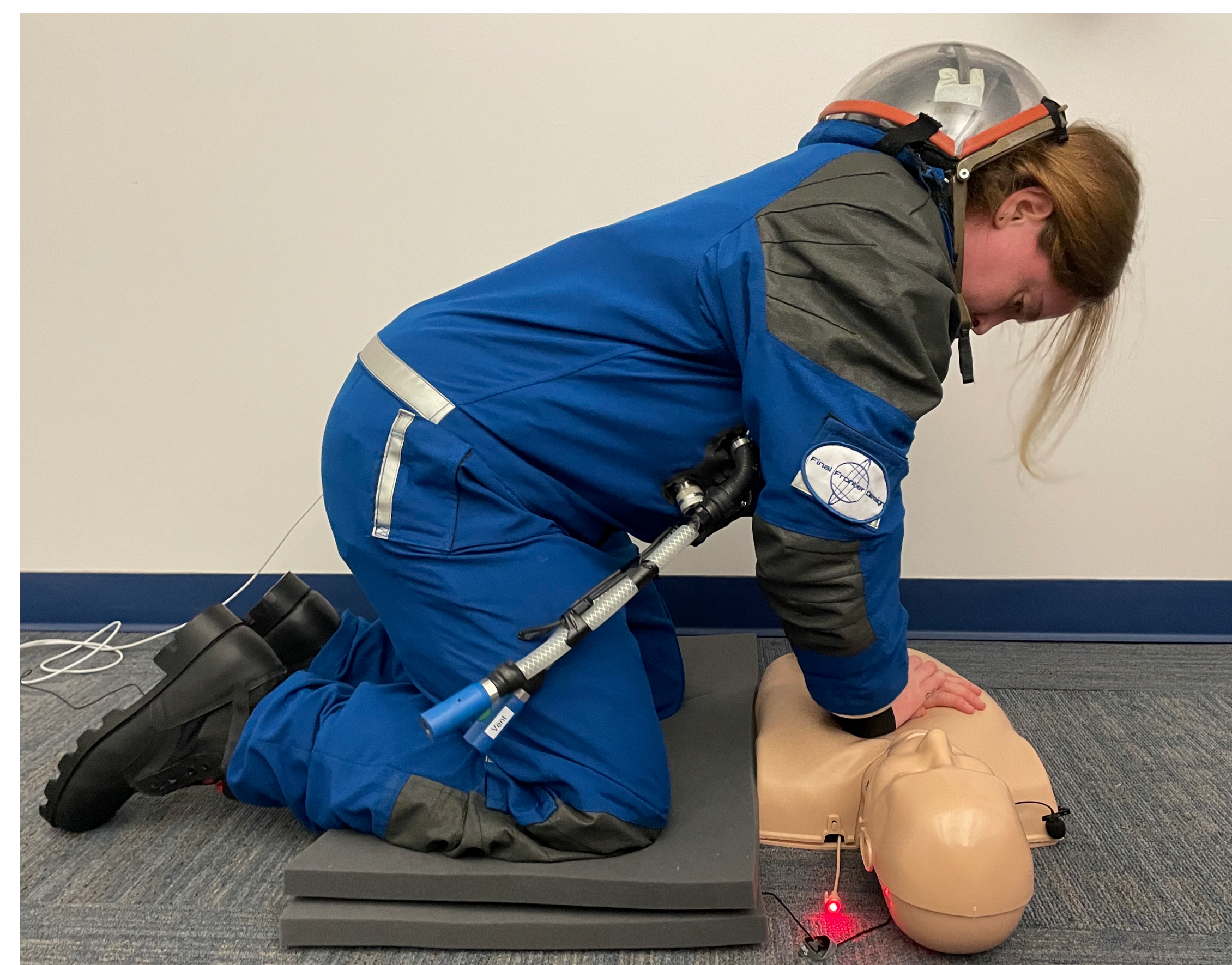


Figure 3. Suited subject in CPR position

Results

Heart Rate by Trial Design

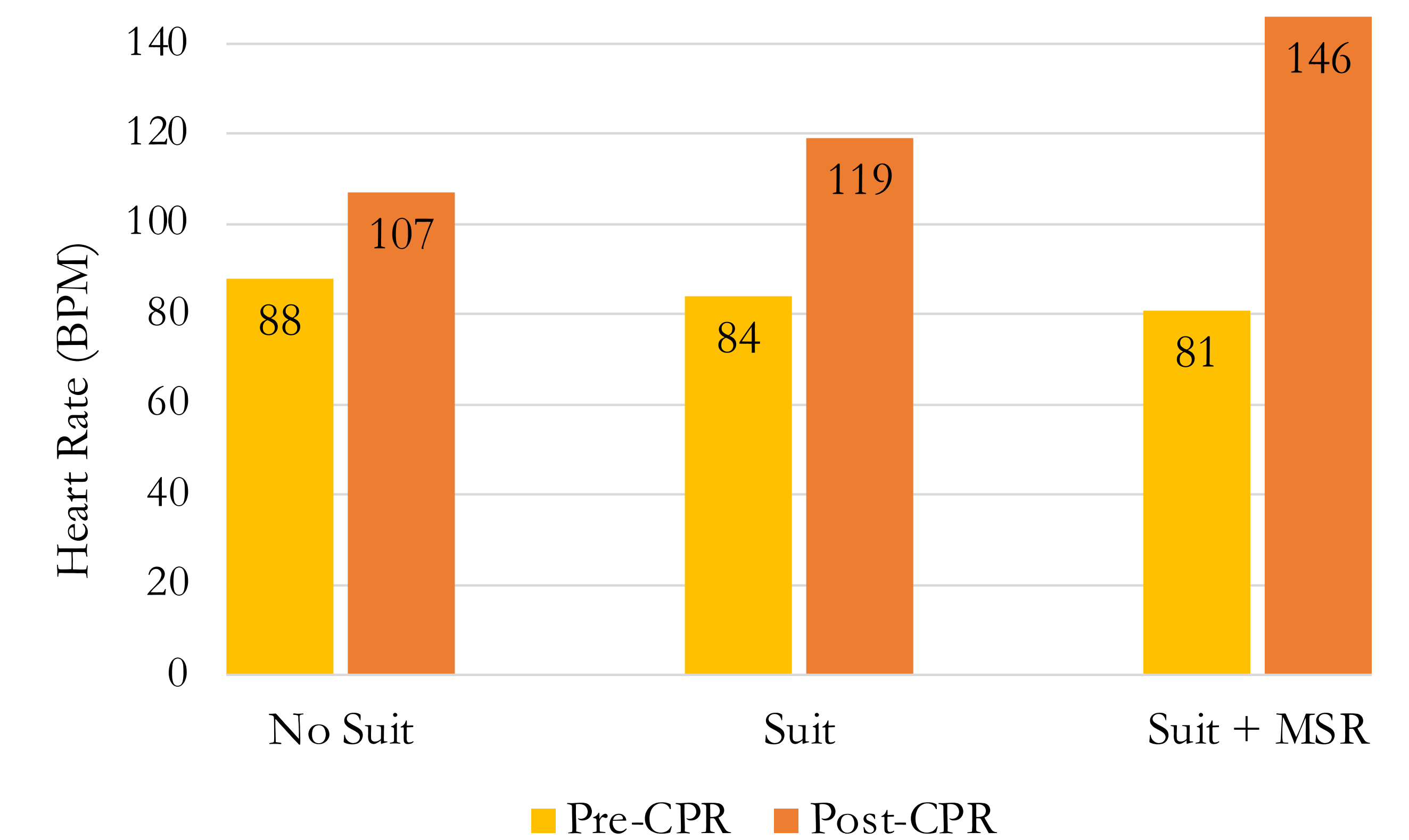


Figure 4. Mean HR for each trial

Trial Comparisons	Mean Change	p-value
No Suit vs. Suit	+ 16 BPM (Suit)	p = 0.004
No Suit vs. Suit + MSR	+ 46 BPM (+MSR)	p < 0.0001
Suit vs. Suit + MSR	+ 30 BPM (+MSR)	p = 0.0007

Table 1. Mean change in HR between trials

Conclusions

- Statistically significant differences between the mean HRs (paired samples t-test).
- The addition of the suit alone increased HR and, therefore, physiological stress while performing CPR, and with the MSR adding even more stress.
- No significant differences in BP pre- and post- CPR, with or without the suit, were demonstrated.

Future Work

- Include additional participants and a “no suit” MSR trial.
- Measure compression depth and elbow joint angles throughout the duration of each ECC trial.
- Additional forms of exertion, such as emergency egress.