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ECG Assessment of Cardiac Function Before, During, and After a 1km Swim Performed in Normal and Cold-Water

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Abstract

Cold-water swimming is a recreational activity that may become a future Winter Olympic event. However, unintentional cold-water exposure can lead to arrhythmias, changes in electrocardiogram (ECG) appearance, and death. This study sought to characterize cardiac responses to recreational one-kilometer swims performed in normal and cold-water. Competitive swimmers (2 male 2 female; age 44±17 years; BMI 24±2) completed a one-kilometer swim (22 laps × 75-foot lengths) under free-living indoor (25.5°C water and 25.0°C air) and cold outdoor (10.9°C water and 6.5°C) conditions. Continuous ECGs were obtained with a waterproof recording system (Actiwave, CamNtech Inc., Boerne, TX). ECG PR-, QT-, and RR-intervals (sec), ventricular diastole (sec), and heart rate (beats/minute) were measured 8.7±1.7 minutes before the swim, then 0.6±0.2, 3.0±0.0 and 6.4±2.1 minutes after the swim. Data (mean±SD) was analyzed with repeated measures ANOVA with significance if $P<0.05$. Swimmers completed the indoor and outdoor swim events in 20.7±1.7 and 21.8±1.1 minutes, respectively. For the indoor swim, PR-interval (sec) at −8.7, +0.6, +3, and +6.4 minutes was 0.12±0.01, 0.12±0.01, 0.11±0.01, and 0.12±0.01, and PR-interval for the outdoor swim at −8.7, +0.6, +3.0 and +6.4 minutes was 0.13±0.01, 0.13±0.01, 0.13±0.01, and 0.14±0.01 (sec). PR-interval was significantly longer at +6.4 minutes post cold-water swim. For the indoor swim, ventricular diastole (sec) at −8.7, +0.6, +3, and +6.4 minutes was 0.37±0.06, 0.22±0.04, 0.30±0.01, and 0.32±0.05 (sec), and for the outdoor swim at −8.7, +0.6, +3.0 and +6.4 minutes ventricular diastole was 0.35±0.08, 0.19±0.02, 0.30±0.04, and 0.24±0.06 (sec). Ventricular diastole was significantly shorter at +6.4 minutes post cold-water swim. No significant changes were observed for QT-interval, RR-interval, and heart rate between swim conditions. These parameters were also assessed for the ECG recordings collected during the 20.7±1.7-minute normal and 21.8±1.1-minute cold-water swims to characterize the physiological response during swim exercise. This study of normal and cold-water one-kilometer recreational swimmers determined that a waterproof ECG could generate a continuous record of changes in cardiac function. During cold-water swim recovery (+6.4 minutes) PR interval was lengthened and ventricular diastole was shortened suggesting an influence of temperature on cardiac function.