

# Performance and stroke volume during marathon in recreational middleaged runners

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## Abstract

**Background :** Despite the increasing popularity of marathon running in recreational athletes and scientific research on physiological performance during races, no information is available on the stroke volume and cardiac output responses to exercise.

**Methodology/Principal Findings :** To test the hypothesis that: 1) stroke volume, heart rate and cardiac output values during a marathon race are in sub maximal steady states while speed decreases and; 2) cardiac endurance i.e. the ability to run at a high fraction of the speed at the maximal stroke volume and the upward drift of the cardiac output/speed ratio could be respectively positively and inversely related with the performance (i.e. mean speed over the race), we measured the stroke volume (SV), heart rate (HR) and running speed of 14 recreational runners (3h30min±45min) in an incremental maximal test and during a real marathon race. Results showed: 1) that HR, SV and cardiac output (CO) were in steady state at high but submaximal values (87.0±1.6%, 77.2±2.6%, and 68.7±2.8% of maximal values of HR, SV and CO respectively). In addition, the cardiac steady state was in response to a constant speed linear decrease after the 14th kilometer from 81.1 ± 7.3 to 66.8 ± 10.2 of the speed at the maximal oxygen uptake determined in the incremental test ( $r = 0.94$ ;  $p < 0.001$ ); 2) marathon performance, was inversely correlated with this upward drift of the cardiacoutput/speed ratio (ml of  $CO \times m^{-1}$ ) ( $r = -0.65$ ,  $p < 0.01$ ) and positively related to the ability of the runner to complete the marathon at a high percentage of the speed at the maximal stroke volume ( $r = 0.83$ ,  $p < 0.0002$ ).

**Conclusion/significance :** Overall, the results show that marathon performance is associated with an index of cardiac endurance and cost. In association with VO<sub>2</sub>max, these factors could be considered to be classical determinants of performance in the global endurance and energy cost in marathon running.

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