

Cardiac magnetic resonance characteristics of the athlete's heart: deeper insights into cardiac remodelling

D. Balla¹, L. Szabo¹, V. Juhasz¹, C.S. Mesko¹, Z.S. Dohy¹, N. Sydo¹, F. Graziano¹, E. Csulak¹, B. Merkely¹, H. Vago¹

¹Semmelweis University Heart and Vascular Center, Budapest, Hungary

Funding Acknowledgements: Type of funding sources: Public grant(s) – National budget only. Main funding source(s): NKFIH

Cardiac magnetic resonance (CMR) offers precise quantification for myocardial parameters. Understanding the effects of different training volumes on the athlete's heart could be the key to distinguishing between cardiac conditions. This study aims to investigate CMR parameters including T1- and T2 mapping in healthy athletes and less active individuals and explore their relationship with training volumes in both sexes.

We included healthy athletes (weekly training hours >7) and less active age- and sex-matched control individuals (weekly training hours ≤6), and performed CMR examinations. We assessed ventricular volumes, masses, and function, and conducted T1- and T2-mapping on non-contrast short-axis images.

A total of 270 CMR examinations were conducted, comprising 185 athletes (119 males, mean age 22±6 years, weekly training hours: 19±7) and 85 controls (50 males, mean age 26±3 years, weekly training hours: 3±2). In male athletes compared to less active individuals, we observed pronounced signs of sports-related cardiac remodeling, including increased end-diastolic volume and mass index (Left ventricular end-diastolic volume index (LVEDVi): 120±16 vs 97±12 ml/m², p<0.001; left ventricular mass index (LVMI): 70±14 vs 53±9 g/m², p<0.001). Similarly, female athletes exhibited significant sports adaptations compared to controls (LVEDVi: 103±12 vs 86±11 ml/m², p<0.001; LVMI: 54±9 vs 39±5 g/m², p<0.001). T1-mapping values in athletes were lower than in the control group for both sexes (males: 939±25 vs 961±20 p<0.001, females: 966±21 vs 985±17, p<0.001). T1 values showed negative correlations with training hours (r=-0.362, p<0.001), LVEDVi (r=-0.411, p<0.001), and LVMI (r=-0.546, p<0.001). A significant association between T1 values and training hours persisted across various models. In the raw model, every additional training hour correlated with a T1 reduction of 0.946 ms (p<0.001). Adjusting for age, sex, and heart rate (HR) in model 2, the association remained significant, with each additional training hour corresponding to a T1 reduction of 0.825 ms (p<0.001). Further adjustments for LVMI in model 3 revealed a significant association, with a decrease of 0.565 ms in T1 values for each additional training hour (p=0.002). Among athletes, training years associated with decreased T1 and increased ventricular end-diastolic volumes and myocardial mass indices (LVEDVi: r=0.232, p=0.002; p<0.001; LVMI: r=0.279, p<0.001; T1-mapping: r=-0.169; p=0.026). Examining the differences between sexes we found that female athletes respond slightly less to a unit of exercise compared to males.

Our findings underscore that different training hours and invested years have a meaningful impact on physiological adaptation. Female athletes' heart responds slightly less to these effects. But in both sexes, higher training hours resulted in lower T1 and this relationship persisted independent of the influences of age, HR, and LVMI.