

Gender differences in morphological and functional aspects of athletes heart in a rat model

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Background: Long-term exercise training is associated with characteristic morphological and functional changes of the myocardium, resulting in a condition called athlete's heart. Referring to the latest studies, sex hormones may be involved in the regulation of exercise-induced left ventricular (LV) hypertrophy.

Purpose: We aimed at understanding the gender-specific functional and morphological alterations in the LV and the underlying molecular changes in a rat model of athlete's heart.

Methods: We divided our young, adult male and female rats into control and exercised groups. Athlete's heart was induced by swim training. The exercised rats were exposed to 200 min/day swimming for 12 weeks. Control rats were taken into the water for 5 min/day. Following the training period we assessed LV hypertrophy with echocardiography. LV pressure-volume (P-V) analysis was performed to investigate in vivo LV function. Additionally, molecular biological studies (qRT-PCR, Western blot) were performed. Interaction between gender and training was tested by two-way ANOVA.

Results: Echocardiography showed LV hypertrophy which was confirmed by LV wall thickness and mass values, nevertheless it was more pronounced in females. Post-mortem measured heart weight/tibial length ratio (+31.2% female vs. +14.5% male, $p < 0.05$) also verified gender differences in LV hypertrophy. The induction of Akt signaling was more significant in females compared to the males (p-Akt/Akt ratio: +57.7% female vs. +21.4% male, $p < 0.05$). There is also a characteristic difference in the mitogen-activated protein kinase (MAPK) pathway as suppressed phosphorylation of p44/42 MAPK (Erk) was observed in female exercised rats, but not in male ones. α -myosin heavy chain (MHC)/ β -MHC ratio did not differ in males, but increased markedly in females (+140.6% female vs. +16.9% male, $p < 0.05$). Despite the more significant hypertrophy in females, characteristic functional parameters of athletes's heart did not show notable differences between the genders during invasive hemodynamic measurements. LV P-V analysis showed increased stroke volume and stroke work, improved contractility and mechanoenergetics and unaltered LV stiffness in both males and females.

Conclusions: Our results confirm that there is a more pronounced exercise-induced LV hypertrophy in females that has no functional consequence compared to the males. The gender-specific response of the LV to exercise is modulated by characteristic molecular pathways.