Atrial and ventricular arrhythmias in young, lifelong and retired elite endurance athletes

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Background: Whilst endurance athletes are known to have an overall higher prevalence of atrial fibrillation (AF), the prevalence of other non-sustained and sustained atrial arrhythmias (AAs) and ventricular arrhythmias (VAs) remains poorly defined.

Purpose: We aimed to define the prevalence of non-sustained and sustained AAs (including AF) and VAs in a healthy cohort of young, lifelong and retired elite endurance athletes. We also sought to assess associations between arrhythmias, fitness and measures of cardiac structure.

Methods: Holter monitors in healthy endurance athletes (n=288) from an international cohort of elite endurance athletes (the Pro@Heart consortium) were analysed for the presence of sustained and non-sustained AAs and VAs. Athletes were sub-divided into young elite athletes (n=176) and former elite athletes (n=112) of which 60 were lifelong (≥2.5 hours/week) and 52 retired (<2.5 hours/week) athletes (determined by current high-intensity exercise activity). Each athlete underwent cardio-pulmonary exercise testing, echocardiography and contrast-enhanced cardiac MRI. Participants with known structural or electrical cardiac disease were excluded. Independent T-test / One-Way ANOVA (parametric data) or Mann-Whitney U / Kruskal-Wallis Tests (non-parametric data) assessed for differences between the groups.

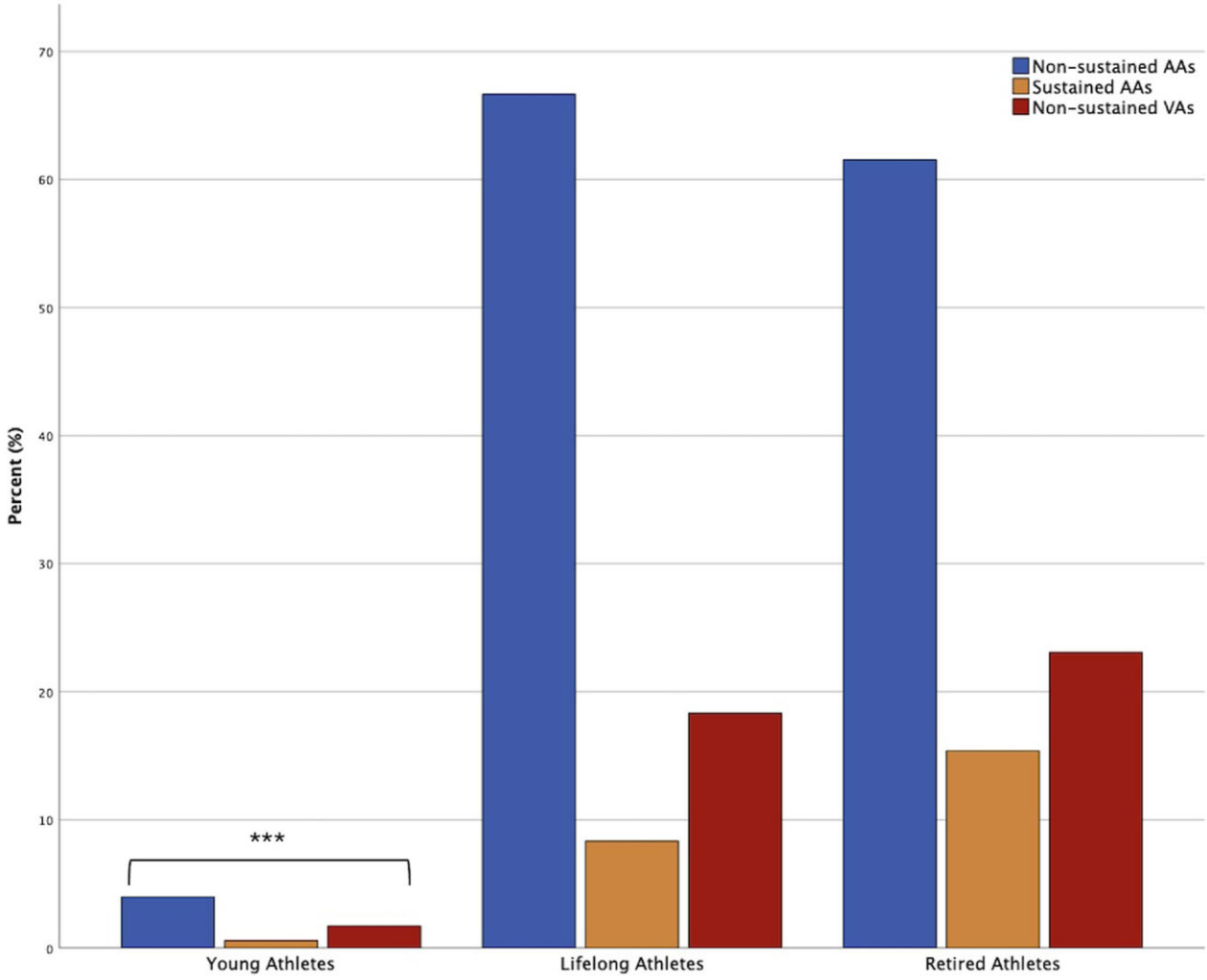
Results: Young athletes (n=176, 70.5% male) were significantly fitter with a greater degree of cardiac remodelling as compared with lifelong (n=60, 63.3% male) and retired (n=52, 82.7% male) athletes (Figure 1). The prevalence of non-sustained AAs (young: 4.0% vs lifelong: 66.7% vs retired: 61.5%, $p<0.001$), sustained AAs (young: 0.6% vs lifelong: 8.3% vs retired: 15.4%, $p<0.001$) and non-sustained VAs (young: 1.7% vs lifelong: 18.3% vs retired: 23.1%, $p<0.001$) was higher in lifelong and retired athletes compared with young athletes (Figure 2). Non-sustained VAs were predominately monomorphic (85%), short and moderate rate (median duration 2.8 seconds and heart rate 154 beats per minute). No athletes developed sustained VAs and/or sudden cardiac arrest. Young athletes had less VAs that were multifocal in origin compared with lifelong and retired athletes (young: 29.5%, lifelong: 37.3%, retired: 53.5%, $p=0.027$). There was no difference in prevalence of any arrhythmia between lifelong and retired athletes. There were no significant correlations between arrhythmias and fitness or cardiac imaging parameters.

Conclusion: Healthy athletes have a significant prevalence of non-sustained atrial and ventricular arrhythmias and sustained atrial arrhythmias that is more prevalent in older athletes. In older athletes, the prevalence of arrhythmias is similar regardless of whether athletes are actively engaged in training or retired suggesting that pro-arrhythmic remodelling in athletes is sustained, not immediately reversible and may be minimally responsive to detraining.

Variable	Young Athletes n = 176	Lifelong Athletes n = 60	Retired Athletes n = 52	*p* value*	*p* value (post-hoc)#
Age (years)	22 [18-32]	60 [52-68]	64 [55-70]	<0.001	0.421
Gender (male)	70.5%	63.3%	82.7%	0.074	0.022
BMI (kg/m^2)	22.3 ± 2.3	24.8 ± 2.5	26.9 ± 3.0	<0.001	<0.001
BSA (m^2)	1.9 ± 0.2	2.0 ± 0.2	2.1 ± 0.2	<0.001	<0.001
VO_2 Max (ml/kg/min)	58.9 ± 10.0	38.9 ± 8.0	30.4 ± 7.9	<0.001	<0.001
Atrial Arrhythmias					
PAC Burden (beats/24hrs)	10.6 [5.0-36.0]	37.2 [12.4-254.1]	29.2 [8.4-121.1]	<0.001	0.131
Non-sustained AA (%)	4.0%	66.7%	61.5%	<0.001	0.572
Sustained AA (%)	0.6%	8.3%	15.4%	<0.001	0.245
Ventricular Arrhythmias					
Any PVC (%)	50.0%	85.0%	86.5%	<0.001	0.816
PVC Burden (beats/24hrs)	4.1 [1.4-15.1]	22.1 [3.2-199.4]	74.5 [8.3-226.6]	<0.001	0.266
Multifocal Origin (%)	29.5%	37.3%	53.5%	0.027	0.113
Non-sustained VA (%)	1.7%	18.3%	23.1%	<0.001	0.535
Sustained VA (%)	0.0%	0.0%	0.0%	-	-
CMR					
LVEDV (ml/m^2)	114.9 ± 18.4	92.1 ± 14.5	86.9 ± 14.8	<0.001	0.069
LVESV (ml/m^2)	48.2 ± 11.7	40.3 ± 8.2	39.7 ± 9.0	<0.001	0.717
LV Mass (g/m^2)	77.1 ± 15.7	59.1 ± 9.5	57.9 ± 9.9	<0.001	0.533
LVEF (%)	58.3 ± 5.9	56.4 ± 5.0	54.5 ± 6.0	<0.001	0.090
RVEDV (ml/m^2)	125.9 ± 21.9	110.1 ± 19.9	103.8 ± 21.1	<0.001	0.119
RVESV (ml/m^2)	59.6 ± 15.6	57.6 ± 13.9	55.8 ± 15.7	0.304	0.532
RVEF (%)	53.2 ± 6.1	48.0 ± 5.5	46.8 ± 6.9	<0.001	0.334
TTE					
RA Area (cm^2)	27.1 ± 11.8	35.3 ± 12.1	36.4 ± 15.2	<0.001	0.108
LA Volume (ml/m^2)	42.2 ± 9.8	43.2 ± 10.2	42.9 ± 12.8	0.770	0.901

p value*: comparison between the three groups. *p* value (post-hoc)#: analysis of lifelong vs retired athletes.

Arrhythmias and cardiac imaging



Lifelong Athletes: former elite athletes with current high-intensity exercise activity ≥ 2.5 hours/week. Retired Athletes: former elite athletes with current high-intensity exercise activity < 2.5 hours/week. Non-sustained AAs: any atrial arrhythmia (including atrial fibrillation) ≥100bpm & <30 seconds duration. Sustained AAs: any atrial arrhythmia (including atrial fibrillation) ≥ 100bpm & ≥ 30 seconds duration. Non-sustained VAs: any ventricular arrhythmia ≥ 100bpm & < 30 seconds duration. $^{***}p$ values for differences in non-sustained AAs, sustained AAs and non-sustained VAs between young vs lifelong and young vs retired athletes are <0.001. No significant difference for any arrhythmia between lifelong and retired athletes.

Arrhythmias amongst athlete groups