The effect of 12 weeks supervised exercise-based cardiac rehabilitation on resting and exercise blood pressure in males and females

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Background: Exercise is key in the prevention and management of hypertension. It remains unclear to what extent sex differences exist with regard to changes in blood pressure (BP) in patients following an exercise-based cardiac rehabilitation (CR) program.

Purpose: To investigate the effect of a 12 week supervised exercise-based CR program on resting BP (BPrest), peak exercise BP (BPmax) and systolic BP (SBP)/metabolic equivalents (MET)-slope and compare sex differences.

Methods: Of 2963 patients referred for CR at a singular test centre in Belgium during the years 2010-2019, those with missing BP data or with a submaximal (RER<1.1) cardiopulmonary exercise test (CPET) were excluded. Reasons for referral included post myocardial infarction, percutaneous coronary intervention, coronary artery bypass surgery and valve surgery. Patients underwent a bicycle CPET with BP measured at rest seated on the bike (BPrest) and throughout the test using an automated auscultatory BP machine at baseline and after 12 weeks of CR. BPrest, BPmax, peak oxygen uptake (VO2peak), peak workload (Wattpeak), resting heart rate (HRrest), maximal HR (HRmax) and the SBP/MET-slope were recorded from each test. CR incorporated 3 sessions of supervised aerobic and resistance exercise per week.

Results: A final sample of 2500 patients (20.4% females) were included for analysis with similar age (62±11 for males vs 61±11years for females, P=0.142). More males were on an ACE-inhibitor (55 vs 46% females, P<0.001) with a comparable prevalence of beta-blocker usage between sexes (75 vs 71% females, P=0.053).

At both baseline and 12 weeks, females had a significantly lower body mass index, VO2peak, Wattpeak, BPmax and HRmax compared to males (P<0.001 for all) but a higher HRrest (P<0.001). However, both sexes had similar BPrest and SBP/MET-slope at baseline and 12 weeks.

After 12 weeks of CR both males and females had a comparable mean±SD improvement in VO2peak (+4.1±3.2 and +3.1±2.6mL/kg/min), and Wattpeak (+33±22 and +22±15Watts), respectively (P<0.001 for all). This was associated with an increased SBPmax for males (171±30 to 181±30mmHg, P<0.001) and for females (159±29 to 167±30mmHg, P<0.001) from baseline to 12 weeks respectively.

No change was seen in SBPrest between baseline and 12 weeks for males (128±20 to 128±19mmHg, P=0.39) and females (129±21 to 128±19mmHg, P=0.21) respectively. The SBP/MET-slope also remained unchanged after 12 weeks CR for males (8.97±5.48 to 9.04±4.81mmHg/MET, P=0.63) and for females (8.68±7.11 to 9.19±6.16mmHg/MET, P=0.13) respectively.

Conclusion: Twelve weeks of exercise-based CR was associated with an increase in SBPmax, although this was largely proportional to the improvement in exercise capacity demonstrated by the unchanged SBP/MET-slope and this was similar in both sexes. These routine clinical markers require further interrogation as to whether they parallel improvements in vascular health associated with exercise training.
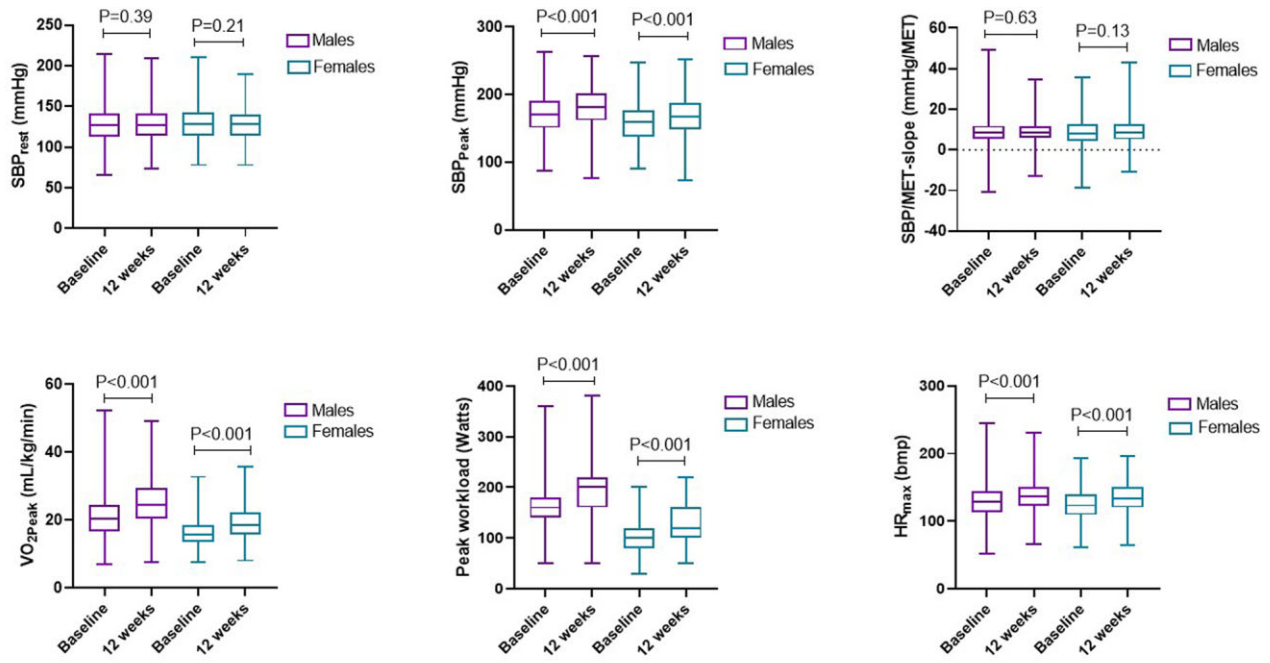
Figure 1: Changes in resting systolic blood pressure (SBP), peak SBP, SBP/metabolic equivalents (MET)-slope, peak oxygen uptake (VO$_2$), peak workload and maximum heart rate (HR) between baseline and 12 weeks of exercise-based cardiac rehabilitation in males and females.

Table 1: Comparison of clinical characteristics between males and females referred for cardiac rehabilitation at baseline and 12 weeks. Values are mean±SD.

	Males n=1989	Females n=511	P value
Indication, n (%)			
AMI	729 (36.7)	135 (26.4)	<0.001
CABG	423 (21.3)	51 (10)	<0.001
PCI	364 (18.3)	84 (16.4)	<0.001
Valve surgery	261 (13.1)	128 (25)	<0.001
Other	212 (10.7)	113 (22.1)	<0.001
Cardiovascular medications, n (%)			
ACE Inhibitor	1088 (54.7)	234 (45.8)	<0.001
Beta-blocker	1495 (75.2)	362 (70.8)	0.053
Age baseline, years	62±11	61±11	0.14
Body mass index, kg/m²			
Baseline	27±4	26±5	<0.001
12 weeks	27±5	26±5	<0.001
Rest heart rate, beats/min			
Baseline	68±13	72±13	<0.001
12 weeks	65±12	69±12	<0.001
Rest diastolic BP, mmHg			
Baseline	76±12	76±12	0.52
12 weeks	75±12	75±12	0.43
Rest systolic BP, mmHg			
Baseline	128±20	129±21	0.19
12 weeks	128±19	128±19	0.86
Peak VO$_2$, ml/min/kg			
Baseline	21.0±6.0	16.0±4.0	<0.001
12 weeks	25.1±7.0	19.4±5.0	<0.001
%pred VO$_{2\,Peak}$, %			
Baseline	79±19	76±15	<0.001
12 weeks	95±21	91±18	<0.001
Max workload, Watts			
Baseline	163±46	106±30	<0.001
12 weeks	196±52	128±35	<0.001
Max heart rate, beats/min			
Baseline	129±23	124±22	<0.001
12 weeks	137±22	134±22	0.02
Max diastolic BP, mmHg			
Baseline	82 (±16)	80 (±15)	0.02
12 weeks	83 (±15)	80 (±16)	0.01
Max systolic BP, mmHg			
Baseline	171±30	159±29	<0.001
12 weeks	181±30	167±30	<0.001
Systolic BP/MET-slope, mmHg/MET			
Baseline	8.97±5.48	8.68±7.11	0.31
12 weeks	9.04±4.81	9.19±6.16	0.54

AMI: acute myocardial infarction; CABG: coronary artery bypass graft; PCI: percutaneous coronary intervention; ACE: angiotensin-converting-enzyme; Max; maximum; BP: blood pressure; VO2: volume of oxygen; MET: metabolic equivalent of task; %pred: % predicted.