J Am Coll Cardiol. Author manuscript; available in PMC 2015 October 24.

Published in final edited form as:
J Am Coll Cardiol. 2015 May 12; 65(18): 2048–2050. doi:10.1016/j.jacc.2015.01.060.

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Associations of central and peripheral blood pressure with cardiac structure and function in an adolescent birth cohort: the Avon Longitudinal Study of Parents and Children

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Keywords

brachial blood pressure; central blood pressure; cardiovascular disease risk factors; systolic function; diastolic function; heart structure; adolescents; ALSPAC

Most studies relating blood pressure (BP) to target organ damage measure BP at the brachial artery but pulse pressure (PP) and systolic BP (SBP) in the aorta are lower than the corresponding peripheral measures. In adults aortic (central) PP and SBP have been shown to be more closely related to left ventricular mass(1) and cardiovascular events(2) than peripheral pressures. We compared central and peripheral PP and their associations with concurrent measures of cardiac structure and function in a large, population-based cohort of adolescents.

The Avon Longitudinal Study of Parents and Children (ALSPAC) is a prospective population-based birth cohort study (http://www.alspac.bris.ac.uk). 1695 participants (45% male; mean age 17.7y) underwent echocardiography examinations. Exclusion criteria included pregnancy and congential heart disease. Ethical approval was obtained from the

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ALSPAC Law and Ethics Committee and the Local Research Ethics Committee. Participants provided written informed consent. Sitting peripheral BP was measured using an Omron 705-IT and central BP was assessed by radial artery tonometry (Sphygmocor). Echocardiography was performed using a HDI 5000 ultrasound machine (Phillips) equipped with a P4-2 Phased Array ultrasound transducer according to American Society of Echocardiography guidelines(3). Multivariable linear regression was used to assess associations. Data for sexes were pooled and models adjusted for age, sex and DXA-assessed fat mass. Bootstrapping (10,000 replications) was used to compare associations of central and peripheral PP.

Peripheral PP was higher than central (mean difference (SD): 19.7 (4.9) mm Hg) and the difference increased with increasing values of PP. Central and peripheral PP were positively associated with left ventricular (LV) mass indexed to height$^{2.7}$, LV internal diameter, left atrial size, mitral E/A ratio and peak myocardial wall velocities in diastole (e′); they were also inversely associated with peak myocardial wall velocities in systole (s′) (Table). Associations were significantly stronger for central compared with peripheral PP. Associations were slightly attenuated after adjustment for fat mass (model 2) but remained stronger for central PP. Neither central nor peripheral PP were associated with relative wall thickness, ejection fraction or E/e′.

Wave reflections account for higher peripheral than central PP (PP amplification)(4). This is particularly marked in young people and adolescents(4,5) and the difference is large and varies between individuals. Consequently previous studies employing peripheral BP may underestimate the strength of associations between BP and cardiac measures in youth. This may have important implications for diagnosis, prognosis and therapeutic management of elevated BP in pediatric populations. In adults, high central PP is associated with diastolic dysfunction(6). In adolescents, we demonstrate that higher PP (particularly central PP) is associated with increased LV mass and left atrial size. The latter suggests some early unfavourable impact on diastolic function. Positive associations between higher PP and lower early s′ also suggest an early adverse influence of high PP on systolic function(7) and ventricular-arterial coupling(8) even at this young age. In view of the current epidemic of obesity in youth this may have important implications for future cardiovascular risk.

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Table 1

Multivariate associations of central and peripheral pulse pressure with cardiac measures

Outcomes	Central Pulse Pressure, mmHg		Peripheral Pulse Pressure, mmHg		Bootstrap p value for the difference between central and peripheral PP
	Mean difference (95% confidence interval) per 10 mmHg	p	Mean difference (95% confidence interval) per 10 mmHg	p	
Left ventricular mass indexed to height$^{2.7}$, g/m$^{2.7}$ (N=1682)					
Model 1	2.17 (1.65, 2.70)	<0.001	1.32 (0.98, 1.66)	<0.001	<0.001
Model 2	1.54 (1.07, 2.02)	<0.001	0.97 (0.66, 1.28)	<0.001	
Left ventricular internal diameter in diastole, cm (N=1683)					
Model 1	0.13 (0.10, 0.16)	<0.001	0.08 (0.05, 0.10)	<0.001	<0.001
Model 2	0.09 (0.06, 0.13)	<0.001	0.05 (0.03, 0.07)	<0.001	
Relative wall thickness (N=1682)					
Model 1	0.0002 (−0.005,0.005)	0.96	0.001 (−0.002,0.005)	0.43	0.41
Model 2	−0.0004 (−0.006,0.005)	0.87	0.001 (−0.002,0.004)	0.56	
s′, cm/s (N=1645)					
Model 1	−0.21 (−0.37, −0.05)	0.01	−0.10 (−0.20, 0.01)	0.07	0.007
Model 2	−0.21 (−0.33, −0.05)	0.01	−0.10 (−0.21, 0.004)	0.06	
Ejection Fraction, % (N=1683)					
Model 1	0.16 (−0.40, 0.73)	0.57	0.16 (−0.21, 0.53)	0.44	0.98
Model 2	0.27 (−0.31, 0.84)	0.36	0.23 (−0.14, 0.61)	0.23	
Left atrial size indexed to height$^{2.7}$, cm/m$^{2.7}$ (N=1524)					
Model 1	0.03 (0.02, 0.04)	<0.001	0.01 (0.007, 0.02)	<0.001	<0.001
Model 2	0.02 (0.02, 0.03)	<0.001	0.01 (0.008, 0.02)	<0.001	
Mitral E/A (N=1636)					
Model 1	0.05 (0.02, 0.09)	0.003	0.02 (−0.005, 0.04)	0.06	<0.001
Model 2	0.07 (0.03, 0.10)	<0.001	0.03 (0.009, 0.05)	0.007	
Lateral E/e′ (N=1625)					
Model 1	0.02 (−0.07, 0.11)	0.66	0.02 (−0.04, 0.08)	0.55	0.82
Model 2	0.05 (−0.04, 0.15)	0.25	0.04 (−0.02, 0.10)	0.19	
Lateral e′, cm/s (N=1645)*					
Model 1	3.13 (1.25, 5.04)	0.001	1.56 (0.35, 2.80)	0.009	0.001
Model 2	3.05 (1.01, 5.13)	0.005	1.32 (0.10, 2.56)	0.03	

Model 1: includes age and gender. Model 2: as in model 1 plus fat mass.

*Results are percentage difference in outcome per 10 mmHg increase in exposure value.