

Wide Pulse Pressure Associated with Low Bone Mineral Density among Adult USA Population: Analysis of the National Health and Nutritional Examination Survey

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Background/Purpose

Accumulating evidence indicates an association between osteoporosis and cardiovascular disease (CVD) above and beyond advanced age and estrogen deficiency. Hypertension, a known risk factor for CVD is also associated with low bone mineral density (BMD) in both men and women likely related to increased urinary calcium excretion. Brachial-ankle pulse wave velocity is significantly associated with low BMD. In the Rotterdam study and other prospective studies, low BMD was associated with peripheral arterial disease and an age-independent progressive atherosclerosis. In the Multi-Ethnic Study of Atherosclerosis (MESA), low BMD was associated with greater coronary artery calcification as well as increased aortic calcification.

We hypothesize that wide pulse pressure (PP), a strong indicator of CVD risk, will be independently associated with low BMD.

Results

A total of 8,179 NHANES participants were included in the study. They were 55.2% female. For the entire cohort the mean age (\pm SEM) 53.3 years \pm 0.19, mean BMI (\pm SEM) 29.6 kg/m² \pm 0.07, and mean PP (mmHg) = 57.2 \pm 0.12 and was significantly higher with increased age, among Blacks (58.7 \pm 0.18) and Hispanics (57.5 \pm 0.19) compared to Whites (53.6 \pm 0.16), and for men (57.2 \pm 0.16) when compared to women (54.1 \pm 0.17), $p < 0.05$. BMD (g/cm²) at the lumbar spine was 1.064 \pm 0.0026 for men, and 1.00 \pm 0.0023 for women. At the femoral neck, BMD was 0.86 \pm 0.0026 for men and 0.79 \pm 0.0023 for women. After adjusting for age, sex, race, menopause, body mass index, and family history of osteoporosis, PP was associated with femoral neck BMD, $\beta = -0.0005$, $p < 0.05$ but was not significantly associated with lumbar spine BMD, $\beta = -0.0002$, $p = 0.07$.

Table 1: Study Demographics

N (8179)	Lumbar Total BMD	Std Err	Femoral Neck BMD	Std Err	Pulse Pressure mmHg	Std Err
Male (44.8%)	1.064	0.0026	0.85	0.0026	57.2	0.16
Female (55.2%)	1.00	0.0023	0.79	0.0023	54.1	0.17
Age (years)						
20-39	1.06	0.0029	0.90	0.0034	45.54	0.29
40-59	1.04	0.0028	0.83	0.0026	48.83	0.30
60-79	1.00	0.0032	0.77	0.0029	65.16	0.27
≥ 80	1.01	0.0098	0.71	0.0062	73.71	0.30
Race						
White	1.03	0.0024	0.80	0.0023	53.90	0.29
Mexican	1.00	0.0039	0.83	0.0036	57.87	0.48
Other Hispanic	1.01	0.0056	0.81	0.0055	55.99	0.75
Black	1.09	0.0048	0.90	0.0048	57.43	0.52
Others	0.99	0.0077	0.80	0.0078	50.88	1.01
Smoking :						
Current	1.04	0.0039	0.82	0.0029	53.29	0.24
Former	1.04	0.0037	0.79	0.0024	62.03	0.23
Never	1.02	0.0021	0.80	0.0021	57.95	0.18
Mean Age (all)	53.33	0.1868				
Mean BMI (all)	29.61	0.0692				

Table 2: Quartile Distribution of Mean Pulse Pressure by Age, Sex and Race

	Q1	Q2	Q3	Q4	p
ALL	36.2 \pm 5.26	47.9 \pm 2.87	59.9 \pm 4.36	87.2 \pm 16.4	<0.05
Sex :					
Male	36.0 \pm 5.17	48.0 \pm 2.91	59.9 \pm 4.31	84.7 \pm 15.23	
Female	35.4 \pm 5.66	47.8 \pm 2.93	60.2 \pm 4.41	87.4 \pm 17.46	
Age :					
20-39 years	35.7 \pm 5.26	47.5 \pm 2.85	58.9 \pm 4.12	78.5 \pm 9.57	
40-59 years	35.3 \pm 5.76	47.7 \pm 2.93	59.2 \pm 4.10	83.8 \pm 16.40	
60-79 years	36.9 \pm 4.87	48.2 \pm 2.89	60.7 \pm 4.46	84.8 \pm 15.04	
≥ 80 years	37.0 \pm 4.17	49.4 \pm 2.72	61.0 \pm 4.20	91.9 \pm 19.43	
Race/Ethnicity:					
Mexican American	36.2 \pm 5.26	47.9 \pm 2.87	59.9 \pm 4.36	87.2 \pm 16.42	
Other Hispanic	35.8 \pm 5.23	47.6 \pm 2.94	60.0 \pm 4.33	86.1 \pm 16.72	
Non-Hispanic White	35.6 \pm 5.40	48.0 \pm 2.90	60.1 \pm 4.40	85.8 \pm 15.98	
Non-Hispanic Black	35.4 \pm 5.91	48.1 \pm 2.99	60.2 \pm 4.33	87.2 \pm 18.09	
Other	35.7 \pm 5.23	47.5 \pm 2.88	59.6 \pm 4.28	83.2 \pm 13.65	

Table 3: Linear Regression Results of the Pulse Pressure, Lumbar Spine, and Femoral neck Bone Mineral Density

	β Estimate	Standardized Estimate	P-value
Lumbar Spine			
Mean Pulse Pressure	-0.0002	-0.0305	0.07
Sex	0.000	0.000	1.00
Age	-0.0185	-0.1001	<0.05
Race	0.0036	0.0299	<0.05
Body Mass Index	0.0066	0.2948	<0.05
Family History of Osteoporosis	-0.0107	-0.0230	0.11
Menopause (past 12 months)	-0.0864	-0.2669	<0.05
Femoral Neck			
Mean Pulse Pressure	-0.0005	-0.0788	<0.05
Sex	0.000	0.000	1.00
Age	-0.0374	-0.2284	<0.05
Race	0.0138	0.1187	<0.05
Body Mass Index	0.0078	0.3462	<0.05
Family History of Osteoporosis	0.0119	0.0275	<0.05
Menopause (past 12 months)	-0.0777	-0.2439	<0.05

Methods

The study used data from two (2) consecutive cycles of NHANES US national health data from 2009-2010 and 2011-2012. NHANES is a complex, multistage, area probability sample representative of the US non-institutionalized civilian population. Point estimates of demographic variables were calculated using descriptive method. Study participants were divided into 4 groups based on quartile distribution of PP. Multivariate linear regression analysis was performed to assess the relationship between BMD and PP.

Conclusion

Our study indicates a negative association between PP and BMD at the femoral neck (high cortical bone content; indicator of senile osteoporosis). This association was not shown at the lumbar spine (high trabecular bone; indicator of postmenopausal osteoporosis). These findings were demonstrated after adjusting for major risk factors for atherosclerosis and osteoporosis; thus, indicating an independent association between wide PP and low BMD. Our data have the potential for using PP, a readily available clinical measurement to identify patients at risk of low BMD and osteoporosis that is affecting our aging population leading to increased fractures, disability and overall mortality.

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