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Blood Pressure and Cardiovascular Health Has Relationship with Age in Adults During Adulthood

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ABSTRACT

International Journal of Exercise Science 10(5): 798-806, 2017. Efforts to combat cardiovascular disease (CVD) have proven effective, especially in the population aged 55-74 years. However, less research has been conducted in younger populations to determine at what age CVD risk develops. The purpose of this study is to compare cardiovascular health markers in adults, specifically CVD risk between younger adults aged 18-22 and a slightly older group of adults in middle adulthood aged 23-54. Cardiovascular health measures were collected from a group of adults; 13 younger adults (20.2±0.9 yrs) and 10 adults in middle adulthood (42.9±10.1 yrs). All participants were free of CVD and diabetes, taking no cholesterol medication, and no more than one blood pressure (BP) medication. Cardiovascular measures included clinical and 24-hour BP, body mass index (BMI), fasted plasma glucose and cholesterol levels, and VO_{2max}. There was no difference in VO_{2max}, glucose and cholesterol levels, or clinical BP measures between the groups, but there were differences in diastolic 24-hour BP, daytime diastolic BP, and nighttime diastolic BP ($p<0.05$ for all). No relationship between 24-hour BP and cardiovascular health variables were observed in the younger group of adults. However, there was a relationship between 24-hour systolic BP and daytime systolic BP with glucose, HDL, and triglycerides in the group of adults aged 23-54 ($p<0.05$ for all). The results of the present study suggest that systolic BP may have an effect on CVD risk in adults over the age of 23 years.

KEY WORDS: Age, blood pressure, cardiovascular, CVD, glucose, triglycerides, VO_2

INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of death in the United States and worldwide and is often associated with atherosclerosis as well as other vascular changes (14). The stiffening of arteries and arterioles that occurs as one ages causes blood pressure (BP) to rise and increases one's risk for CVD (11, 21). However, these changes may not be solely related to aging. It has been suggested that these structural changes occur as a result of changes in diet, exercise, and stress levels (21).

Research has shown that BP-related vascular changes can occur as early as adolescence with moderate increases in BP; therefore, it is important to be proactive in protecting one's cardiac health from an early age (17). Data collected from the Framingham Heart Study showed that systolic BP continually increases with age, whereas diastolic BP increases until the fifth decade of life and then gradually decreases (4, 11, 12, 21). A theory for this trend is that both large artery stiffness and peripheral vascular resistance in the smaller vessels contribute to the increases in systolic BP, whereas diastolic BP increases as peripheral vascular resistance increases, but decreases as the arteries become stiffer (21).

Research continually shows that there is an inverse relationship between physical activity levels and CVD, and increased physical activity continues to be the lifestyle recommendation to improve BP levels (1, 8, 18, 30, 32). Various genetic factors contribute to one's risk; however, research on monozygotic twins has shown that one's environment and lifestyle have a larger impact (26).

Resting BP is an accepted indicator of cardiovascular health; however, it is debated whether diastolic or systolic BP is a better indicator. Clinical and ambulatory blood pressure (ABP) measurements are both important indicators of cardiovascular health. While clinical BP (measured in an office) is quick and convenient, ABP highlights fluctuations in BP throughout the day and allows for context on the diurnal change (20). A lack of drop in BP at night, is considered a risk factor for cardiovascular events, and target organ damage (3). Studies have shown that level of physical activity during the daytime, body position while sleeping, and sodium sensitivity in conjunction with sodium levels in the body all affect the nighttime BP (5, 19, 28).

An emphasis on evidence-based medical therapies and lifestyle modifications resulted in a drastic decline in mortality from heart disease from 2000 to 2011. Unfortunately, this deceleration has decrease in recent years, and as a result, the AHA is directing more focus to the prevention of CVD along with educating Americans and promoting good cardiovascular health (14, 25). These efforts to combat CVD have proven effective, especially in the population aged 55-74 years old which has been found to have a 24% decrease in mortality rate for men and 38% for women (29). However, other research has found no change in mortality rates for 35-54 year old adults (29). Most studies examining effects of aging on cardiovascular health are performed on older adults with a mean age above 50 years (13, 15, 16, 23). This suggests that research is needed in younger adults to determine what age CVD risk develops.

While previous research has shown that cardiovascular risk and BP increase with aging, the majority of research focuses on older populations (4, 7, 11, 21). Therefore, the purpose of this study was to compare cardiovascular health markers and CVD risk in younger populations, specifically between younger adults aged 18-22 and a group of adults in middle adulthood aged 23-54.

METHODS

Participants

Participants were recruited via word of mouth in the greater Philadelphia area. Participants were required to be seemingly healthy, which was defined as being free of CVD and diabetes, on no more than one BP medication, and on no cholesterol medications. Sixty-one adults were recruited for our study, but based on inclusion criteria, only twenty-three adults (N=13, adults aged 18-22 placed in group named "Younger"; N=10, adults aged 23-54 placed in group named "Older") were included in this study. These ages were selected based on previous studies that examine cardiovascular health in adults. All participants gave written informed consent and completed a health history form. The study and protocol are in accordance with the ethical standards of the Helsinki Declaration, and were approved by the Ursinus College Institutional Review Board (31).

Protocol

Participants came into the lab for three appointments: 24-hour ABP monitor set-up, a fasted study, and a maximal treadmill test. Clinic BP measurements were collected using an aneroid sphygmomanometer following the JNC-7 guidelines on each of the three separate visits in a quiet (5 min rest), temperature controlled room (6) (Medline Industries, Mundelein, IL). Three BP measurements were obtained at each appointment and the average of the values was used as the representative BP for that visit. Clinic BP is reported as the mean systolic and diastolic BP across the three visits.

A noninvasive, portable BP monitor was used to measure 24-hour ABP (SpaceLabs, Redmond, WA), as previously described (9). Monitors were worn during the participant's typical day. Readings were obtained every 30 mins during the day and every 60 mins at night. Participants were asked to refrain from exercise, alcohol, and excessive amounts of salty foods in order to measure the natural BP changes throughout the day without the added effects of these factors. Participants were asked to record their awake (daytime BP) and sleep (nighttime BP) hours the following morning. More than 80% of the BP measurements had to be successfully completed in order to be included in the final analysis. Mean values for 24-hour average and for day/night time-frames were calculated.

Fasted plasma cholesterol and glucose levels were collected during the fasted appointment following a 10-hour overnight fast using the Alere Cholestech LDX® lipid profile system (San Diego, CA). Blood was obtained by finger stick using a 35 µL lithium heparin-coated capillary tube, and tested immediately. Lipid profile test cassettes were inserted into the Cholestech

system to analyze blood samples. Previously, finger stick Alere Cholestech LDX® lipid profile values were correlated (r>0.95) with venous plasma values measured in clinical diagnostic laboratories (Alere), and this meets the National Cholesterol Education Program criteria for agreement between methods (10).

A symptom-limited maximal graded exercise test following the Bruce protocol was performed to determine the participant's level of cardiorespiratory fitness using continuous breath-by-breath gas sampling to measure oxygen consumption (VO_2) with a calibrated metabolic cart (TrueOne 2400, ParvoMedics, Sandy, UT). ECG was continuously monitored (Nasiff CardioCard, Nasiff Associates, Central Square, NY). Also, during each stage of exercise, BP was measured using an aneroid sphygmomanometer, heart rate (HR) was assessed through the ECG, and perceived exertion was reported using the Borg CR-10 scale. The treadmill test was terminated according to the American Heart Association and the American College of Sports Medicine termination criteria (10).

Statistical Analysis

Data are expressed as mean ± the standard deviation (SD). The Shapiro-Wilk test of normality was used to examine the distribution of all variables. Independent t-tests were used to compare differences between the two groups. Pearson correlation was used to determine if there were relationships between the variables. Statistical significance was set a priori at $P < 0.05$. All statistical analyses were performed using SPSS version 19.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

Participant characteristics are presented in Table 1. Thirteen younger adults (20.2±0.9 yrs) and ten adults who were older (42.9±10.1 yrs) were included in the study. Upon recruitment, participants in the younger group exercised an average of 5 days per week, compared to those in the older group who exercised an average of 4 days per week. No significance between groups existed in this activity level.

Clinic, 24-hour, and average daytime diastolic BP differed significantly across groups (Table 1, Table 2). The Older group had higher clinic diastolic BP (78.5±5.6 vs. 73.4±4.2 mmHg, p = 0.021), 24-hour diastolic BP (76.8±6.7 vs. 69.1±4.3 mmHg, p = 0.003), and average daytime diastolic BP (79.6±6.1 vs. 71.0±5.3 mmHg, p = 0.002).

In the present study, the older group had higher total cholesterol (188.9±30.0 vs. 141.9±55.9 mg/dL, p = 0.026) and LDL levels (116.2±31.2 vs. 64.9±50.9 mg/dL p = 0.011) (Table 1). We found a direct relationship between glucose levels and 24-hour systolic BP in the older group of adults. (Figure 1). In this group, a direct relationship between 24-hour systolic BP average and triglyceride levels was also found (Figure 2).

Table 1. Baseline participant characteristics.

	Younger (N=13)	Older (N=10)
Age	20.2 ± 0.9 *	42.9 ± 10.1
Height (in)	68.4 ± 3.1	69.5 ± 4.3
Body Weight (lb)	183.0 ± 38.0	185.5 ± 34.9
BMI (kg/m²)	27.7 ± 4.7	27.1 ± 3.8
SBP (mmHg)	121.4 ± 8.3	121.0 ± 7.2
DBP (mmHg)	73.4 ± 4.2 *	78.5 ± 5.6
Glucose (mg/dL)	88.5 ± 6.3	88.2 ± 5.0
CHO (mg/dL)	141.9 ± 55.9 *	188.9 ± 30.0
HDL (mg/dL)	45.3 ± 13.6	52.0 ± 13.1
TRG (mg/dL)	85.9 ± 78.4	103.4 ± 45.7
LDL (mg/dL)	64.9 ± 50.9 *	116.2 ± 31.2
LDL/HDL	1.4 ± 1.2	2.5 ± 1.3
$VO_{2\ max}$	44.6 ± 9.4	37.5 ± 7.6

Data are presented as mean ± SD. *Significance at p <0.05 between groups. Abbreviations: BMI = body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure CHO = total cholesterol; HDL = high density lipoprotein; TRG = triglycerides; LDL = low density lipoprotein; VO2 max = maximum oxygen consumption

Table 2. 24-hour blood pressure variables by age.

	Younger (N=13)	Older (N=10)
24 Hr SBP Avg	120.5 ± 9.6	124.6 ± 10.6
24 Hr DBP Avg	69.1 ± 4.3 *	76.8 ± 6.7
24 Hr MAP Avg	85.9 ± 5.2 *	91.6 ± 7.3
24 Hr PP Avg	51.4 ± 7.6	47.8 ± 7.0
24 Hr HR Avg	68.9 ± 9.3	66.2 ± 7.5
Daytime SBP Avg	122.6 ± 10.0	127.4 ± 11.4
Daytime DBP Avg	71.0 ±5.3 *	79.6 ± 6.1
Daytime MAP Avg	87.8 ± 6.0 *	94.1 ± 7.6
Daytime PP Avg	5.6 ± 7.5	47.8 ±7.3
Nighttime SBP Avg	109.4 ± 13.6	108.6 ± 9.6
Nighttime DBP Avg	58.9 ± 6.5	62.1 ± 8.1
Nighttime MAP Avg	76.5 ± 6.5	78.0 ± 7.7
Nighttime PP Avg	50.6 ± 8.8	46.5 ± 7.9

Data are presented as mean ± SD. *Significance at p <0.05 between groups. Abbreviations: SBP = systolic blood pressure; DBP = diastolic blood pressure; MAP = mean arterial pressure; PP = pulse pressure; HR = heart rate

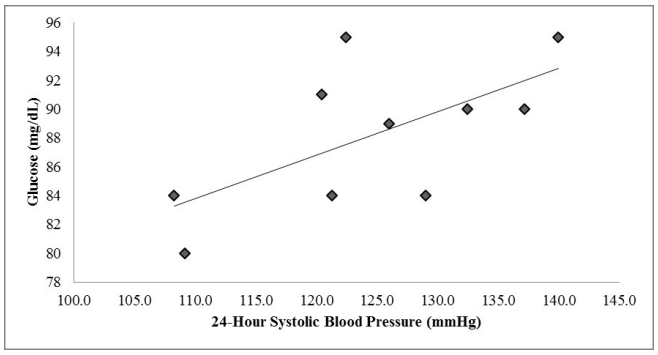

Figure 1. Relationship between 24-hour systolic blood pressure average and glucose levels in the Older group. R= 0.638, P=0.04.

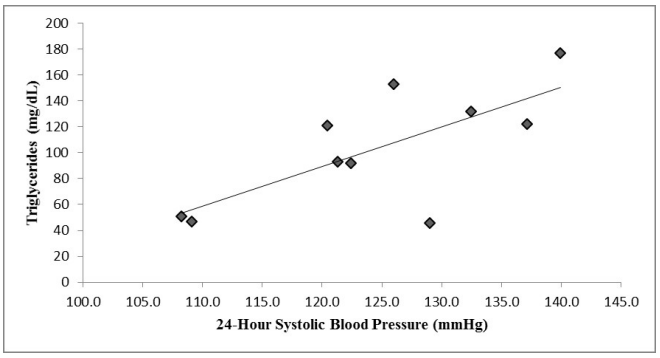

Figure 2. Relationship between 24-hour systolic blood pressure average and triglyceride levels in the Older group. R=0.714. P= 0.020.

DISCUSSION

The results of the present study suggest that the beginning stages of the age-related decline in cardiovascular health may be visible in younger populations.

Hypertension results from the heart having to work harder in order to deliver blood to the body, and studies have shown that this increases CVD risk and reduces life expectancy (14, 18, 27). Systolic BP typically increases with age as arteries stiffen and plaque builds up; however, diastolic pressures stop increasing and begins decreasing between the ages of 50 and 60 because, although peripheral resistance is still increasing, the arteries have become stiffer, resulting in decreases in diastolic BP (4, 7, 11). Previous research has found diastolic BP to be the strongest predictor of coronary artery disease in individuals under the age of 50 (4, 7, 11). Therefore, diastolic BP may be a stronger indicator of cardiovascular health in the Younger group and in most of the individuals in the Older group. While systolic BP and pulse pressure may be better predictors of CVD risk in adults over the age of 60 years, research has found diastolic BP to be a strong predictor of CVD risk in men under the age of 60 years (24). Both the Younger and Older groups in the present study are under the age of 60; therefore, the higher diastolic BPs observed in the older group of the present study may reflect the beginning stages of the decline in cardiac health resulting from age.

A previous study followed non-diabetic men aged 44-55 for 20 years and found that those with higher blood glucose levels were at higher risk of death from CVD (2). Another study found high blood triglyceride counts to be a risk factor of CVD independent of high HDL cholesterol (22). In the present study, a positive correlation was observed between systolic BP and blood glucose and triglyceride levels. These findings are in accordance with the concept that all of these are risk factors of CVD, and may suggest that perhaps these are early signs of decline in cardiovascular health young adults.

Limitations of the present study include the participant population and size. All participants were recruited from a small, suburban, liberal arts college and from the surrounding community. The lack of diversity coupled with the small population size make these findings less generalizable to the population at large. In addition, the participants in the younger age group self-reported that they exercised one more day per week, on average, compared to the older study group. Despite no significance between groups in this variable, these differences in physical activity levels may have impacted the physiological results since exercise is known to improve cardiovascular health. Another limitation to this study is that, while significant differences were observed, it is currently beyond the scope of this cross-sectional analysis to determine whether or not these differences show clinical significance.

The results of this study suggest that diastolic BP may have an effect on CVD risk in adults over the age of 23 years. Increased BP and lipid levels are primary risk factors for CVD, therefore these findings may suggest that changes in BP or cholesterol levels may indicate changes in cardiovascular health in adults younger than 55 years of age. Further research is

needed to confirm these findings, as well as to provide more insight into risk factors for CVD among different age groups.

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