CARDIOVASCULAR RISK FACTORS AND MASKED HYPERTENSION: THE JACKSON HEART STUDY

Samantha G. Bromfield, PhD[1], **Daichi Shimbo, MD**[2], **John N. Booth III, MPH**[1], **Adolfo Correa, MD, PhD**[3], **Gbenga Ogedegbe, MD**[4], **April P. Carson, PhD**[1], and **Paul Muntner, PhD**[1]

[1]Department of Epidemiology, University of Alabama at Birmingham, Birmingham, AL

[2]Department of Medicine, Columbia University Medical Center, New York, NY

[3]Department of Medicine, University of Mississippi Medical Center, Jackson, MS

[4]Department of Population Health, New York University School of Medicine, New York, NY

Abstract

Masked hypertension is associated with increased risk for cardiovascular disease. Identifying modifiable risk factors for masked hypertension could provide approaches to reduce its prevalence. Life's Simple 7 is a measure of cardiovascular health developed by the American Heart Association that includes body mass index, physical activity, diet, cigarette smoking, blood pressure (BP), cholesterol, and glucose. We examined the association between cardiovascular health and masked daytime hypertension in the Jackson Heart Study, an exclusively African-American cohort. Life's Simple 7 factors were assessed during a study visit and categorized as poor, intermediate, or ideal. Ambulatory BP monitoring was performed following the study visit. Using BP measured between 10am and 8pm on ABPM, masked daytime hypertension was defined as mean clinic systolic/diastolic BP (SBP/DBP) <140/90 mmHg and mean daytime SBP/DBP ≥ 135/85 mmHg. Among the 758 participants with SBP/DBP<140/90 mmHg, 30.5% had masked daytime hypertension. The multivariable-adjusted prevalence ratios for masked daytime hypertension comparing participants with 2, 3 and ≥ 4 versus ≤ 1 ideal Life's Simple 7 factors were 0.99 (95%CI: 0.74–1.33), 0.77 (95%CI: 0.57–1.03) and 0.51 (95%CI: 0.33–0.79), respectively. Masked daytime hypertension was less common among participants with ideal versus poor levels of physical activity (ratio: 0.74, 95% CI: 0.56–1.00), ideal or intermediate levels pooled together versus poor diet (prevalence ratio: 0.73, 95% CI: 0.58–0.91), ideal versus poor levels of cigarette smoking (prevalence ratio: 0.61, 95% CI: 0.46–0.82), and ideal versus intermediate levels of clinic BP (prevalence ratio: 0.28, 95% CI: 0.16–0.48). Better cardiovascular health is associated with a lower prevalence of masked hypertension.

Address for correspondence and reprint requests: Paul Muntner, PhD, Department of Epidemiology, University of Alabama at Birmingham, 1665 University Blvd, Suite 230J, Birmingham, AL 35294, (205) 975-8077, pmuntner@uab.edu.

Keywords

Life's Simple 7; cardiovascular risk factors; cardiovascular health; masked hypertension; hypertension; blood pressure; ambulatory blood pressure monitoring

Many adults have high blood pressure (BP) when measured outside of the clinic, despite having systolic/diastolic BP (SBP/DBP) <140/90 mmHg based on clinic measurements, a condition called masked hypertension.[1] In population-based studies, the prevalence of masked hypertension has been reported to be between 15% and 30%.[2] Masked hypertension is associated with a 2-fold higher risk of cardiovascular disease (CVD).[3,4] Identifying modifiable risk factors for masked hypertension may inform approaches for preventing or delaying its onset.

In 2009, the American Heart Association developed the Life's Simple 7 metric to monitor cardiovascular health in the US population.[5] This metric is based on seven modifiable health factors including body mass index (BMI), physical activity, diet, cigarette smoking, BP, cholesterol, and glucose. Several factors that comprise Life's Simple 7 have individually been associated with masked hypertension, but the association between overall cardiovascular health and masked hypertension is not well studied.[6,7] The objective of this analysis was to determine whether adults with better cardiovascular health are less likely to have masked hypertension. If a strong association is present, improving cardiovascular health may provide a holistic approach to prevent and treat masked hypertension.

METHODS

Study Population

The Jackson Heart Study (JHS) enrolled a population-based cohort of African Americans. It was designed to examine CVD risk in African-American men and women. Details of the design and conduct of the JHS have been published previously.[8,9] Participants were recruited from urban and rural areas of 3 counties (Hinds, Madison, and Rankin) that comprise the Jackson, Mississippi metropolitan area. The study enrolled 5,301 African Americans between 2000 and 2004. Participants were invited to complete a 24-hour ambulatory BP monitoring (ABPM) procedure following the baseline examination. A total of 1,146 participants completed this procedure. For the current analysis, we excluded participants with an incomplete ABPM reading (defined below, n=100) and missing data on clinic SBP and DBP (n=5). To focus on cardiovascular health in the context of primary prevention, we excluded 81 participants with a history of coronary heart disease (CHD) or stroke. As masked hypertension can only be present among individuals with clinic-measured SBP <140 mmHg and DBP < 90 mmHg, we excluded participants with SBP   140 mmHg or DBP   90 mmHg based on measurements obtained during the baseline examination (n=202) for a final sample size of 758 participants. The protocol for the JHS, including all procedures, was approved by the institutional review boards at the participating institutions. All participants provided written informed consent. The current data analysis was approved by the institutional review board at the University of Alabama at Birmingham.

Data Collection

Data for the current analyses were collected by questionnaires, a clinic examination and ABPM. Of relevance to the current analysis, data collected through the interview-administered questionnaires included age, sex, marital status, education, cigarette smoking, diet, physical activity, history of stroke and CHD, and self-reported use of antihypertensive, antidiabetes or lipid-lowering medication. Data collected during the clinic examination included BMI, clinic BP, fasting blood glucose, hemoglobin A1c (HbA1c), and total cholesterol.

Life's Simple 7—The factors that comprise Life's Simple 7 include BMI, physical activity, diet, cigarette smoking, clinic-measured BP, total cholesterol, and fasting glucose. These factors were categorized into ideal, intermediate, and poor levels of cardiovascular health (Table 1).[5] Standing height and weight were measured during the clinic examination. These measurements were used to calculate BMI as weight in kilograms divided by height in meters squared. Physical activity was assessed using a modified Baecke questionnaire.[10] Diet was assessed using a 158-item food frequency questionnaire (FFQ), which was validated in a subset of the JHS cohort.[11] The dietary components used in the current analysis include fruits and vegetables, fish, whole grains, sodium, and sugary beverages. Cigarette smoking status was assessed by the questions "Have you smoked more than 400 cigarettes in your lifetime?" and "Do you now smoke cigarettes?" Participants were categorized as current, former, and never smokers. Clinic BP was measured following a standardized protocol, using a Hawksley random zero sphygmomanometer and calibrated to a semi-automated oscillatory device as described below. The mean of the two measurements was used to define clinic SBP and DBP. Participants were considered to be taking antihypertensive medication if they self-reported use of medication to lower BP in the two weeks prior to their clinic visit. Participants were asked to fast overnight prior to their clinic visit. Fasting blood glucose, HbA1c, and total cholesterol were measured from blood samples taken during the clinic examination.[9] Participants were considered to be taking antidiabetes and lipid-lowering medication based on self-reported use in the two weeks prior to their clinic visit.

Clinic BP Measurements—Clinic BP was measured by trained and certified research staff at baseline.[12] Training was conducted by a study coordinator or blood pressure supervisor and included instruction in BP measurement, listening to recordings on audiotapes of Korotkoff sounds and live observation of BP measurements. Staff had to pass a test in which live recordings were taken simultaneously with the training supervisor using a Y-tube stethoscope. Quality control included biannual observation of blood pressure measurement by supervisors and frequent staff meetings to provide feedback. Recertification, which included live readings with a blood pressure supervisor using a Y-tube stethoscope, occurred every six months. Digit preference was also monitored for each staff member.

A BP comparability substudy was conducted in which BP was assessed simultaneously, using a Y connector, by random zero sphygmomanometer and an Omron HEM-907XL device. Since semi-automated devices are commonly used in the clinic setting, the random-

zero BP measurements were calibrated to a semi-automated device using robust regression as described previously.[13]

Ambulatory BP Measurements—ABPM was performed following the clinic examination using a SpaceLabs 90207 device. Measurements were taken every 20 minutes during the 24-hour monitoring period. Consistent with the International Database of Ambulatory Blood Pressure and Cardiovascular Disease (IDACO), daytime was defined as 10 am to 8 pm and nighttime was defined as 12 am (midnight) to 6 am.[14] For an ABPM measurement to be considered complete, participants were required to have at least 10 daytime and 5 nighttime SBP and DBP measurements.[14] On average, participants with a complete ABPM had 23 daytime measurements and 17 nighttime measurements.

Masked Hypertension—The primary outcome was masked daytime hypertension. Masked nighttime hypertension, masked 24-hour hypertension, and any masked hypertension were examined as secondary outcomes. Based on the mean of all measurements between 10am and 8pm, daytime hypertension was defined as SBP ≥ 135 mmHg and/or DBP ≥ 85 mmHg.[15] Based on the mean of all measurements between 12am and 6pm, nighttime hypertension was defined as SBP ≥ 120 mmHg and/or DBP ≥ 70 mmHg. Using the mean of all available measurements from ABPM, 24-hour hypertension was defined as SBP ≥ 130 mmHg and/or DBP ≥ 80 mmHg.[16] As the current study was restricted to participants with SBP < 140 mmHg and clinic DBP < 90 mmHg, those with daytime, nighttime and 24-hour hypertension had masked daytime, nighttime and 24-hour hypertension, respectively. Participants with masked daytime, masked nighttime, or masked 24-hour hypertension were categorized as having any masked hypertension.

Statistical Analysis

Participant characteristics and the prevalence of masked daytime hypertension were calculated by categories defined by the number of ideal Life's Simple 7 factors (i.e., 0 or 1, 2, 3, or ≥ 4 factors). There were too few participants with 0 (n=20), 5 (n=28), 6 (n=4) or 7 (n=0) ideal Life's Simple 7 factors to evaluate these groups separately. Poisson regression was used to calculate prevalence ratios for masked daytime hypertension associated with 2, 3, and ≥ 4 versus 0 or 1 (reference) ideal Life's Simple 7 factors. Model 1 adjusted for age and sex. Model 2 included additional adjustment for education, marital status, and alcohol consumption. Model 3 included the variables in Model 2 plus the use of antihypertensive medication. Secondary analyses were conducted stratified by antihypertensive medication use. Among those not taking antihypertensive medication, there were too few participants with 0 or 1 (n=28) ideal Life's Simple 7 factors to serve as the reference. Therefore, in these analyses, participants not taking antihypertensive medication who had 0, 1 or 2 ideal Life's Simple 7 factors were pooled together. We calculated prevalence ratios for any masked hypertension, masked nighttime hypertension, and masked 24-hour hypertension associated with number of ideal Life's Simple 7 factors.

Next, we evaluated the association between each Life's Simple 7 factor with masked daytime hypertension. The distribution of poor, intermediate, and ideal health for each of Life's Simple 7 factors was calculated for participants with and without masked daytime

hypertension. With the exception of diet and BP, the prevalence and adjusted prevalence ratios for masked daytime hypertension associated with intermediate and ideal, versus poor (reference) levels of each Life's Simple 7 factor was calculated using Poisson regression models. For diet, participants with ideal and intermediate levels were grouped and compared to those with poor diet because there were few participants with an ideal level of diet (n=5). For BP, participants in the ideal BP category were compared to those in the intermediate BP category because participants with poor BP level (clinic SBP 140 mmHg or clinic DBP 90 mmHg) were excluded from the current analyses. In a final analysis, we calculated a Life's Simple 7 score by assigning each participant 2 points for each factor with an ideal level, 1 point for each factor with an intermediate level, and 0 points for each factor with a poor level. All 7 factor scores were then summed for a composite score ranging from 0–14 points. We calculated the prevalence and hazard ratios for masked daytime hypertension, any masked hypertension, masked nighttime hypertension, and masked 24-hour hypertension associated with the Life's Simple 7 score, categorized into quartiles (0–6, 7, 8, and 9–14 points). To account for missing data (Supplemental Table S1), we used multiple imputation to replace missing values with a set of plausible values. We conducted 10 imputations using chained equations, resulting in 10 data sets, which were combined to obtain an overall estimate.[17] All analyses were conducted using STATA/IC 13 (Stata Corporation, College Station, Texas).

RESULTS

Characteristics of JHS participants with clinic SBP/DBP < 140/90 mm Hg who completed and did not complete ABPM are presented in Supplemental Table S2. The mean age of the 758 participants who completed ABPM and were included in the current analyses was 57.7 years and 30.1% were male. Participants with more ideal Life's Simple 7 factors were younger and less likely to be taking antihypertensive medication (Table 2). Mean clinic, daytime, nighttime, and 24-hour SBP were lower among participants with more ideal Life's Simple 7 factors. No association was present between the number of ideal Life's Simple 7 factors and mean clinic, daytime, nighttime, or 24-hour DBP.

Number of Ideal Life's Simple 7 Factors and Masked Daytime Hypertension

The prevalence of masked daytime hypertension was lower among participants with more ideal Life's Simple 7 factors (Table 3). This association remained present after multivariable adjustment. The prevalence ratios for masked daytime hypertension comparing participants with 2, 3, 4 versus 1 ideal Life's Simple 7 factors were 0.99 (95% CI: 0.74–1.33), 0.77 (95% CI: 0.57–1.03) and 0.51 (95% CI: 0.33–0.79), respectively, after multivariable adjustment. More ideal Life's Simple 7 factors were associated with lower prevalence ratios for masked daytime hypertension among participants taking and not taking antihypertensive medication in stratified models (Supplemental Table S3).

Individual Life's Simple 7 Factors and Masked Daytime Hypertension

Participants with masked daytime hypertension were less likely to have ideal levels of physical activity, smoking, clinic BP, cholesterol, or glucose than their counterparts without masked daytime hypertension (Figure 1). Having better levels of physical activity, diet,

cigarette smoking, and clinic BP were associated with a lower prevalence of masked daytime hypertension after each level of adjustment (Table 4). After multivariable adjustment, the prevalence ratios for masked daytime hypertension comparing ideal versus poor levels was 0.86 (95% CI: 0.62–1.19) for cholesterol and 0.86 (95% CI: 0.63–1.17) for glucose.

Number of Ideal Life's Simple 7 Factors and Any Masked Hypertension, Masked Nighttime Hypertension, and Masked 24-hour Hypertension

The prevalence of any masked hypertension, masked nighttime hypertension, or masked 24-hour hypertension was progressively lower among participants with more ideal Life's Simple 7 factors (Supplemental Table S4). These associations remained present after multivariable adjustment.

Life's Simple 7 Score and Masked Daytime Hypertension

Having a higher Life's Simple 7 score was associated with a lower prevalence of masked daytime hypertension (Supplemental Table S5). After multivariable adjustment, the prevalence ratios for masked daytime hypertension were 0.86 (95% CI: 0.66–1.14), 0.67 (95% CI: 0.48–0.93), and 0.62 (95% CI: 0.43–0.90) for participants with Life's Simple 7 scores of 7, 8 and 9 to 14 each compared to scores of 0 to 6. Higher Life's Simple 7 scores were associated with a lower prevalence for any masked hypertension, masked nighttime and masked 24-hour hypertension.

DISCUSSION

In the current study, the prevalence of masked daytime hypertension was lower among participants with better cardiovascular health as assessed using the Life's Simple 7 metric. Having more physical activity, better diet, not smoking, and having ideal clinic BP were each associated with a lower prevalence of masked daytime hypertension. Also, better cardiovascular health was associated with a lower prevalence of any masked hypertension, masked nighttime hypertension and masked 24-hour hypertension. These data suggest that improving modifiable cardiovascular health factors may prevent masked hypertension.

Masked hypertension is associated with an increased risk for CVD.[3,18] However, few studies have evaluated modifiable factors that may be associated with a reduced prevalence of masked hypertension. In a meta-analysis, current smoking (odds ratio: 1.32, 95% CI: 1.13–1.50) and higher clinic SBP (odds ratio: 1.10, 95% CI: 1.01–1.19 per 1 mmHg higher clinic SBP) were associated with an increased prevalence of masked hypertension.[19] In contrast, in a study of 254 adults, high dietary sodium intake and high fruit and vegetable consumption were not associated with masked hypertension.[6] This latter study only included 44 participants with masked hypertension and the association of diet with masked hypertension was not investigated after multivariable adjustment. In the current study, better diet, not smoking, and lower clinic BP were each associated with a lower prevalence of masked daytime hypertension.

Studies have reported associations between having more physical activity and lower glucose with masked hypertension.[20–22] However, there are few studies evaluating the association of cholesterol and masked hypertension. In a study by Hänninen et. al., high cholesterol was

not associated with masked hypertension.[21] The prevalence ratios in the current study suggested a protective association between lower cholesterol and lower glucose and reduced prevalence of masked daytime hypertension but these results were not statistically significant. The lack of a statistically significant association for masked hypertension with cholesterol and glucose may reflect low statistical power to detect these associations in the current study.

Having more ideal cardiovascular health factors is associated with a lower risk of cardiovascular morbidity and mortality.[23,24] However few US adults have ideal cardiovascular health, as defined by Life's Simple 7. Of 12,744 participants from the Atherosclerosis Risk in Communities (ARIC) study without a history of CVD, only 0.1% had ideal levels of all Life's Simple 7 factors.[23] A low prevalence was also present in 15,647 US adults in the 2005–2010 National Health and Nutrition Examination Survey (NHANES), where only 1.2% of participants had ideal levels for all Life's Simple 7 factors.[25] These data suggest that there is a substantial opportunity to improve cardiovascular health among US adults.

In the current study, participants with better cardiovascular health had a lower prevalence of masked hypertension. In 2011, the Department of Health and Human Services launched a national initiative known as the Million Hearts.[26] This initiative addresses clinical prevention of cardiovascular events and also aims to increase community prevention efforts which include reducing smoking, improving nutrition, and reducing BP. Findings from the current study suggest that interventions directed towards improving cardiovascular health, such as the Million Hearts initiative, may be helpful for lowering the prevalence of masked hypertension.

The 2013 European Society of Hypertension and European Society of Cardiology task force recommended that both lifestyle and antihypertensive medication be considered in treating masked hypertension.[15] However, there are no empiric data to support this recommendation. The current study supports the use of lifestyle modification by demonstrating the potential benefits of better cardiovascular health on masked hypertension. However, randomized controlled trials are needed to confirm this finding.

This study has several strengths including the availability of data from a large population-based sample. Additionally, ABPM and clinic BP were measured following standardized protocols. The availability of extensive data allowed us to adjust for potential confounders. Despite these strengths, the findings from this study should be interpreted within the context of potential limitations. ABPM was only performed in a sub-group of JHS participants which resulted in the need to group some of the Life's Simple 7 categories. Clinic BP was measured at a single visit and ABPM was only performed a single time. However, masked hypertension has been reported to have a high degree of reproducibility.[27,28] Finally, physical activity, diet, and cigarette smoking were self-reported and objective measures of these factors were not available.

Perspectives

In the current population-based study, masked daytime, nighttime and 24-hour hypertension were less prevalent among participants with better cardiovascular health. Ideal levels of physical activity, diet, cigarette smoking, and clinic BP were associated with a lower prevalence of masked daytime hypertension. These data suggest that improving cardiovascular health may reduce the prevalence of masked hypertension.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.
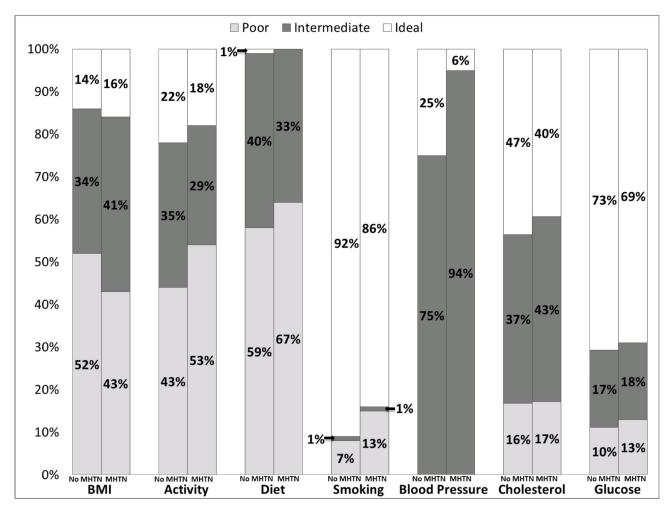
Acknowledgments

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Novelty and Significance

What Is New?

- Although individual cardiovascular risk factors have been associated with masked hypertension in prior studies, there are few data on the association between overall cardiovascular health and masked hypertension.

- We examined the association between cardiovascular health and masked daytime hypertension among a population-based cohort of African Americans.

What Is Relevant?

- The prevalence of masked hypertension is 15% to 30%.

- There is a strong association of masked hypertension with CVD events.

- There is a need to identify modifiable risk factors to prevent mask hypertension.

Summary

- Having better cardiovascular health was associated with a lower prevalence of masked daytime hypertension, masked nighttime hypertension, and masked 24-hour hypertension.

- These results suggest the importance of improving cardiovascular health to reduce the prevalence of masked hypertension.

Figure 1.

Prevalence of poor, intermediate, and ideal health for each Life's Simple 7 component among Jackson Heart Study participants with and without masked daytime hypertension. MHTN indicates masked daytime hypertension, which is defined as non-elevated clinic blood pressure and elevated daytime blood pressure; and BMI: body mass index.

Table 1

Definition of poor, intermediate, and ideal cardiovascular health for each factor of the American Heart Association's Life's Simple 7

Life's Simple 7 Factor	Poor Health	Intermediate Health	Ideal Health
Body Mass Index	30 kg/m^2	25–29.9 kg/m^2	< 25 kg/m^2
Physical Activity	**1** 0 minutes of moderate physical activity and **2** 0 minutes of vigorous physical activity	**1** 0 < minutes of moderate physical activity < 150; or **2** 0 < minutes of vigorous physical activity < 75; or **3** 0 < minutes of combined moderate and vigorous physical activity < 150	**1** 150 minutes of moderate physical activity; or **2** 75 minutes of vigorous physical activity; or **3** 150 minutes of combined moderate and vigorous physical activity
Healthy Diet Score[*]	0–1 components	2–3 components	4–5 components
Cigarette Smoking	Current	Quit <12 months ago	Never or quit 12 months ago
Blood Pressure[†]	SBP 140 mmHg or DBP 90 mmHg	SBP 120–139 mmHg or DBP 80–89 mmHg or SBP <120 mmHg and DBP <90 mmHg with medication	SBP < 120 mmHg and DBP < 80 mmHg, without medication
Total Cholesterol	240 mg/dL	200–239 mg/dL or < 200 mg/dL, with medication	<200 mg/dL, without medication
Fasting Blood Glucose[†]	126 mg/dL or HbA1c 6.5% or taking diabetes medication	100–125 mg/dL or HbA1c 5.7–6.4%, and not taking diabetes medication	<100 mg/dL, HbA1c < 5.7%, and not taking diabetes medication

[*]Dietary components of the Healthy Diet Score include fruits and vegetable (4.5 cups per day), fish (3.5 ounces, twice per week), whole grains (3 servings per day), sodium (< 1,500 mg per day), sugary beverages (450 kcal per week).

[†]Participants who met part of the criterion for poor health in addition to part of the criterion for intermediate health were categorized as having poor health.

SBP: systolic blood pressure; DBP: diastolic blood pressure; and HbA1c: Hemoglobin A1c.

Table 2

Characteristics of Jackson Heart Study participants by number of ideal Life's Simple 7 factors.

Characteristic	Overall (n=758)	Number of Ideal Life's Simple 7 Factors				p-trend
		0 or 1 (n=117)	2 (n=230)	3 (n=270)	4 (n=141)	
Age, years	57.7 (0.40)	60.6 (0.90)	60.0 (0.69)	57.7 (0.67)	51.7 (1.03)	<0.001
Men, %	30.1	26.6	27.1	30.2	37.5	0.360
Married, %	57.2	57.3	50.8	62.3	57.7	0.952
More than high school education, %	83.4	78.9	78.3	85.7	91.3	0.149
Antihypertensive Medication Use, %	52.6	73.9	62.6	49.0	20.9	<0.001
Life's Simple 7 Factors, %						
Ideal BMI	14.5	1.5	3.6	14.3	43.6	0.002
Ideal Physical Activity	20.8	0.0	10.5	26.1	45.0	<0.001
Ideal Diet	0.5	0.0	0.4	0.4	1.4	0.127
Ideal Smoking	90.0	76.7	90.3	92.5	95.5	<0.001
Ideal BP	19.1	0.0	3.0	18.8	62.3	<0.001
Ideal Cholesterol	45.2	6.4	26.5	56.7	85.9	<0.001
Ideal Glucose	72.0	8.0	65.8	91.1	98.4	<0.001
Clinic BP, mean (SD)						
SBP, mmHg	121.9 (0.38)	124.7 (0.93)	124.0 (0.65)	122.0 (0.66)	115.9 (0.90)	<0.001
DBP, mmHg	73.2 (0.30)	72.6 (0.73)	73.5 (0.50)	73.8 (0.46)	71.9 (0.67)	0.530
Daytime BP, mean (SD)						
SBP, mmHg	126.6 (0.43)	130.5 (1.25)	128.4 (0.81)	125.7 (0.70)	122.2 (0.88)	<0.001
DBP, mmHg	77.3 (0.32)	78.3 (0.92)	77.0 (0.61)	77.1 (0.55)	77.4 (0.68)	0.560
Nighttime BP, mean (SD)						
SBP, mmHg	117.6 (0.51)	122.7 (1.41)	118.9 (1.04)	117.0 (0.80)	112.2 (1.03)	<0.001
DBP, mmHg	67.3 (0.34)	68.9 (0.95)	66.6 (0.65)	67.6 (0.59)	66.8 (0.77)	0.296
24-Hour BP, mean (SD)						
SBP, mmHg	123.1 (0.43)	127.4 (1.21)	124.9 (0.83)	122.3 (0.69)	118.3 (0.89)	<0.001
DBP, mmHg	73.3 (0.30)	74.2 (0.87)	72.9 (0.58)	73.3 (0.52)	73.3 (0.67)	0.594

Numbers reported in table are mean (standard error) or percent.

BMI: body mass index; BP: blood pressure; SBP: systolic blood pressure, and DBP: diastolic blood pressure.

Table 3

Prevalence ratios for masked daytime hypertension associated with the number of ideal Life's Simple 7 factors among Jackson Heart Study participants.

Outcome	Number of Ideal Life's Simple 7 Factors				p-trend
	0 or 1	**2**	**3**	**4**	
Masked Daytime Hypertension					
N	117	230	271	140	
Prevalence	37.7%	36.0%	28.6%	17.3%	<0.001
Adjusted Models	Prevalence ratio (95% CI)				
Model 1	1 (ref)	0.96 (0.71–1.30)	0.75 (0.56–1.01)	0.48 (0.32–0.73)	<0.001
Model 2	1 (ref)	0.98 (0.73–1.31)	0.74 (0.55–1.00)	0.48 (0.31–0.73)	<0.001
Model 3	1 (ref)	0.99 (0.74–1.33)	0.77 (0.57–1.03)	0.51 (0.33–0.79)	<0.001

Masked daytime hypertension is defined as mean clinic SBP <140 mmHg and clinic DBP <90 mmHg blood pressure and mean daytime SBP and/or daytime DBP ≥135/85 mmHg blood pressure.

CI: confidence interval.

Model 1 is adjusted for age and sex.

Model 2 is adjusted for variables in Model 1 and education and marital status.

Model 3 is adjusted for variables in Models 1 and 2 and antihypertensive medication use.

Table 4

Prevalence ratios for masked daytime hypertension associated with each Life's Simple 7 factor among Jackson Heart Study participants.

Life's Simple 7 Factors	Poor	Intermediate	Ideal	p-trend
		Prevalence ratio (95% CI)		
Model 1				
BMI	1 (ref)	1.14 (0.90–1.45)	1.18 (0.86–1.61)	0.221
Physical Activity	1 (ref)	0.83 (0.65–1.07)	0.78 (0.58–1.05)	0.063
Diet [*]	1 (ref)	0.77 (0.61–0.96)		0.023
Cigarette Smoking	1 (ref)	0.62 (0.17–2.21)	0.63 (0.47–0.85)	0.003
BP [†]		1 (ref)	0.28 (0.16–0.47)	<0.001
Cholesterol	1 (ref)	1.03 (0.75–1.42)	0.89 (0.64–1.23)	0.325
Glucose	1 (ref)	0.80 (0.55–1.16)	0.80 (0.58–1.09)	0.242
Model 2				
BMI	1 (ref)	1.13 (0.89–1.43)	1.18 (0.87–1.61)	0.227
Physical Activity	1 (ref)	0.82 (0.64–1.05)	0.76 (0.56–1.02)	0.041
Diet [*]	1 (ref)	0.76 (0.60–0.95)		0.017
Cigarette Smoking	1 (ref)	0.60 (0.17–2.15)	0.61 (0.45–0.82)	0.001
BP [†]		1 (ref)	0.28 (0.16–0.47)	<0.001
Cholesterol	1 (ref)	1.04 (0.76–1.42)	0.89 (0.64–1.24)	0.347
Glucose	1 (ref)	0.80 (0.55–1.17)	0.80 (0.59–1.09)	0.244
Model 3				
BMI	1 (ref)	1.17 (0.92–1.48)	1.26 (0.92–1.73)	0.105
Physical Activity	1 (ref)	0.83 (0.64–1.06)	0.74 (0.56–1.00)	0.031
Diet [*]	1 (ref)	0.73 (0.58–0.91)		0.006
Cigarette Smoking	1 (ref)	0.60 (0.18–2.00)	0.61 (0.46–0.82)	0.001
BP [†]		1 (ref)	0.28 (0.16–0.48)	<0.001
Cholesterol	1 (ref)	1.00 (0.73–1.36)	0.86 (0.62–1.19)	0.262
Glucose	1 (ref)	0.81 (0.56–1.18)	0.86 (0.63–1.17)	0.518

Masked daytime hypertension is defined as mean clinic SBP <140 mmHg and clinic DBP <90 mmHg blood pressure and mean daytime SBP and/or daytime DBP 135/85 mmHg blood pressure.

[*] For diet, the ideal and intermediate categories were combined and compared to poor diet.

[†] Individuals with poor blood pressure (SBP 140 mmHg or DBP 90 mmHg) were excluded from the analysis based on the definition of masked daytime hypertension, making the intermediate category the reference for blood pressure.

CI: confidence interval; BMI: body mass index; BP: blood pressure; SBP: systolic blood pressure; and DBP: diastolic blood pressure.

Model 1 is adjusted for age and sex.

Model 2 is adjusted for variables in Model 1 and education and marital status.

Model 3 is adjusted for variables in Models 1 and 2 and antihypertensive medication use.