


# BMJ Open Relationship between social support and incident hypertension in the Jackson Heart Study: a cohort study

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## ABSTRACT

**Objectives** Social support may be an important mitigating factor against adverse cardiovascular outcomes by facilitating health-promoting behaviours or by buffering against the negative effects of stress. This study examined the association of social support with incident hypertension.

**Design** Prospective cohort study.

**Setting** We evaluated the association of social support with incident hypertension among participants in the Jackson Heart Study, a community-based cohort of African Americans.

**Participants** This study included African American adults, who were free of hypertension at baseline (2000–2004). Functional social support, structural social support and satisfaction with social support were assessed at baseline among 1516, 1240 and 1503 participants, respectively.

**Outcome measures** Incident hypertension was assessed at follow-up examinations in 2005–2008 and 2009–2013. Incident hypertension was defined by the first visit with systolic blood pressure  $\geq 140$  mm Hg, diastolic blood pressure  $\geq 90$  mm Hg or self-reported antihypertensive medication use. Multivariable Poisson regression was used to estimate the association of baseline social support with incident hypertension, adjusting for relevant confounders.

**Results** At baseline, the mean age of participants was 50 years and 64% were men. During a median follow-up time of 6.9 years, 54% of participants developed hypertension. A high level of functional social support was associated with lower risk of incident hypertension (incident rate ratio 0.64, (95% CI 0.41 to 0.97)), compared with a low level of functional social support. Level of structural social support and satisfaction with social support were not associated with hypertension risk.

**Conclusions** These results suggest that greater functional support may be associated with a lower risk of incident hypertension.

## INTRODUCTION

African American adults experience a disproportionately high prevalence of hypertension, worse blood pressure (BP) control and increased risk of hypertension-related morbidity when compared with similarly-aged white counterparts.<sup>1–4</sup> In the Reasons for Geographic And Racial Differences in Stroke cohort study, among adults  $\geq 45$  years

## Strengths and limitations of this study

- This study examines longitudinal relationships between functional, structural and satisfaction with social support and incident hypertension.
- This study used data from a large community-based cohort of African Americans.
- This study examined multiple aspects of social support, including not only the size of the social support network but also the ways in which relationships provide support and participant satisfaction with social support received.
- This observational study is subjected to residual confounding.
- We only had information on social support at baseline, so we were not able to examine how changes in social support over time may impact the development of hypertension.

of age, the cumulative incidence of hypertension over 10 years was 48% for black men versus 38% for white men and 54% for black women versus 36% for white women.<sup>5</sup> African American adults also experience a higher incidence of hypertension than Asians and Hispanics.<sup>6</sup> Psychosocial factors, including stress, contribute to the high risk for hypertension among African Americans. For example, African American adults report high levels of stress due in part to high levels of racial discrimination.<sup>7–9</sup> Prior research indicates that sustained exposure to psychosocial stress is particularly deleterious for cardiovascular health and is associated with a higher prevalence of hypertension.<sup>8</sup>

It is possible that social support may be a protective factor against stress-related adverse cardiovascular outcomes.<sup>10 11</sup> It has been hypothesised that social support may improve cardiovascular health directly by helping an individual with health management tasks<sup>12</sup> or indirectly by facilitating health-promoting behaviours (ie, promoting a healthy diet or improved engagement in health)<sup>13 14</sup> and by buffering against the negative long-term



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health effects of stress.<sup>15 16</sup> Social support is one of several factors considered to be psychosocial resource.<sup>17 18</sup> Psychosocial resource variables, especially when present at high levels, may protect individuals from adverse health effects of low socioeconomic status (SES) or high stress.<sup>19</sup> For example, studies have found that the association between SES and BP differs by level of social support.<sup>20 21</sup>

Given the high levels of chronic stress and hypertension among African American adults, determining the potential benefits of social support may provide opportunities for disease prevention in this population. Prior studies on this topic have been limited by small sample sizes, a cross-sectional design and a lack of inclusion of African American participants.<sup>22</sup> The Jackson Heart Study (JHS) is a prospective cohort study of cardiovascular disease in African American women and men with data on self-reported psychosocial factors and BP measured at three study examinations over approximately 10 years. Using these longitudinal data, we evaluated whether levels of three dimensions of social support at baseline were associated with incident hypertension during follow-up. We hypothesised that higher levels of social support would be associated with a lower incidence of hypertension.

## METHODS

### Overview and setting

The JHS has been described in detail elsewhere.<sup>23 24</sup> Briefly, the study enrolled 5306 African American adults 21 years of age and above from the Jackson, Mississippi metropolitan tricounty area including Hinds, Madison and Rankin counties who completed a baseline examination between 2000 and 2004 (exam 1). There have been two follow-up examinations; the first (examination 2) between 2005– and 2008 and the second (examination 3) between 2009 and 2013.

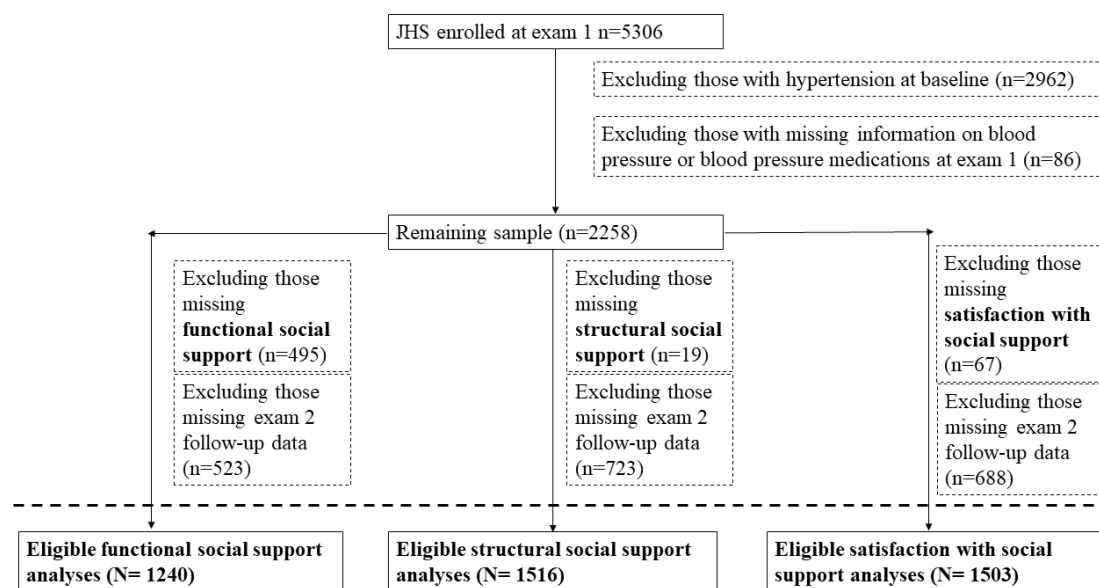
The present analysis was restricted to participants without hypertension at the baseline examination. Further exclusions were made for participants who did not have BP measurements or information on antihypertensive medication use at baseline, or who were missing information on social support at the baseline examination. Only participants who had a valid follow-up BP measurement at examination 2 were included in analyses, whether or not they had additional follow-up at examination 3. These inclusion and exclusion criteria are shown in figure 1.

### Exposure

We examined three aspects of social support: functional social support (the ways in which interpersonal relationships provide support), structural social support (social network size) and satisfaction with general social support.

Functional social support was assessed during the baseline examination using a short form of the Interpersonal Support Evaluation List (ISEL) instrument, a validated self-administered instrument consisting of questions pertaining to four domains of functional social support.<sup>25</sup> These domains include (a) appraisal, (b) belonging, (c) self-esteem and (d) tangible. Each of the four domains contributes 12 points, and summed ISEL scores range from 0 to 48. Primary analyses examined functional social support as a continuous variable providing effect estimates per one SD increase in the total score, and additional analyses examined functional social support as a dichotomous variable, where an ISEL score of <32 was used to indicate low functional social support, as done previously in JHS.<sup>26</sup>

Structural social support was assessed during the baseline examination from an adapted version of the Berkman Social Network Index, which combined information on number of friends and relatives and frequency



**Figure 1** Flowchart showing inclusion and exclusion criteria for the three social support exposure analyses including functional social support, structural social support and satisfaction with social support. JHS, Jackson Heart Study.

of social contact. A composite score of structural social support ranging from 0 to 12 was determined. Higher scores indicated larger social networks.<sup>23 26</sup> Primary analyses examined structural social support as a continuous variable providing effect estimates per 1 SD increase in the total score, and additional analyses examined structural social support as a dichotomous variable, where a structural network score of <8 was used to indicate low structural social support, similar to research done previously in JHS.<sup>26</sup>

Satisfaction with social support was assessed using the response to a question from the annual follow-up questionnaire asking, 'How satisfied are you with the help or support that you've received from others over the past year?' Participants respond on a 6-point Likert scale with very dissatisfied, somewhat dissatisfied, a little dissatisfied, a little satisfied, somewhat satisfied or very satisfied. This item is similar to a previously validated single-item measure of social support.<sup>27</sup> Ratings of very dissatisfied to a somewhat satisfied were coded as low satisfaction, while ratings of very satisfied were coded as high satisfaction. We used participants' responses to this question on their earliest annual follow-up examination occurring closest to the baseline examination and before examination 2.

### Outcome

Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured (in mm Hg) at each examination, by trained study staff after a 5 min rest while participants were seated. Participants' right arms were fitted with an appropriately sized BP cuff and two measurements were taken, with a 1 min interval separating the measurements.<sup>24</sup> The two measurements were averaged for analyses. Staff used a random-zero sphygmomanometer (Hawksley and Sons, London, UK) at examinations 1 and 2, and a semiautomated oscillometric device (Omron HEM-907XL, Omron Healthcare, Lake Forest, Illinois) at examination 3. BP values at examinations 1 and 2 were calibrated to the corresponding Omron BP device values to ensure that BP measurements across all three examinations were compatible.<sup>28</sup> Incident hypertension was defined at the first of the two follow-up examinations (examination 2 or 3) when a participant met any of the following criteria: SBP  $\geq 140$  mm Hg, DBP  $\geq 90$  mm Hg or self-reported antihypertensive medication use.<sup>29</sup>

### Covariates

The following potential confounders, which were all assessed at baseline (examination 1), were included in the primary analyses: age (linear), sex (male/female), physical activity in categories of minutes/week of moderate or vigorous physical activity (MVPA) using information provided by participants on the frequency and duration of participation in the three most sport/exercise activities performed in the past year, which were then converted to 'minutes/week' as previously described<sup>30</sup> (categorical: poor (0 min/week of MVPA), intermediate (1–149 min/week of moderate activity or 1–74 min/week of vigorous

activity or 1–149 min/week of MVPA) or ideal ( $\geq 150$  min/week of moderate activity or  $\geq 75$  min/week of vigorous activity or  $\geq 150$  min/week of MVPA)), smoking status (never/former/current), alcohol use (yes/no), body mass index (linear) and estimated glomerular filtration rate (eGFR) calculated from calibrated serum creatinine<sup>31</sup> and the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) creatinine equation (linear).<sup>32</sup>

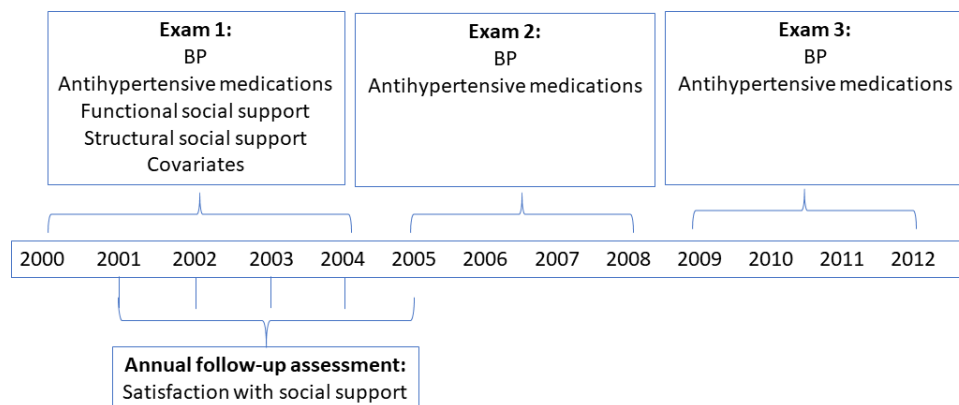
Additional baseline covariates were included in sensitivity analyses: albuminuria calculated using the albumin to creatinine ratio value<sup>33</sup> (binary <30 vs  $\geq 30$  mg/g), nutrition diet quality score constructed based on the American Heart Association (AHA) diet quality score<sup>34 35</sup> built from participant information from a semi-quantitative, 158-item food frequency questionnaire developed and validated for the JHS<sup>34</sup> (categorical based: poor (0–19 points), intermediate (20–39 points) or ideal (40–50 points)), education (categorical: <high school, high school graduate, some college or college degree obtained), depressive symptoms (binary using the Center for Epidemiologic Studies Depression Scale scale of  $\geq 16$  points for high depressive symptomatology) and perceived chronic stress using the Global Perceived Stress scale, which is an 8-item measure developed for the JHS and adapted from standardised stress scales<sup>23 36</sup> (linear).

### Statistical analysis

We described characteristics of participants with low and high baseline functional social support (<32 vs  $\geq 32$ ), and low and high baseline structural social support (<8 vs  $\geq 8$ ).

We used Poisson regression with an offset for follow-up time to estimate the incident rate ratios (IRRs) for the association of baseline functional and structural social support with incident hypertension. The development of incident hypertension was assessed only at the time of follow-up examinations, when BP measurements and a medication inventory were conducted. Therefore, there were two time intervals in these analyses. First, participants who developed hypertension at examination 2 or were censored at this time only contributed person-time between examination 1 and examination 2 and information on hypertension events at the time of examination 2. Second, participants with follow-up through examination 3 and who did not develop hypertension at examination 2 contributed person-time between examination 1 and examination 3 and information on hypertension events at the time of examination 3. [Figure 2](#) provides a schematic representing the time periods of follow-up.

Four per cent of participants were missing data on one or more of the following variables: physical activity, smoking, alcohol use, BMI or eGFR. In primary analyses, we used multiple imputation with chained equations (MICE)<sup>37 38</sup> to generate 20 sets of complete data with imputed values for variables with missingness. The imputation model included all variables used in the primary model. We assumed that data were missing at random. We generated quantile–quantile plots, trace plots and density plots as diagnostic tools for the imputed values. Finally,



**Figure 2** Timing of follow-up and relevant data points for exposures (functional, structural and satisfaction with social support), covariates and blood pressure and antihypertensive medication use for incident hypertension assessment. BP, blood pressure.

analyses were run on the imputed data and pooled summary results were produced from these 20 complete data sets.

### Secondary and sensitivity analyses

In secondary analyses, we examined the risk of incident hypertension associated with satisfaction with social support and with each domain of functional social support (appraisal, belonging, self-esteem and tangible). We also tested whether there was evidence that the association of social support with incident hypertension varied by marital status (married vs unmarried) or by sex by including a multiplicative interaction term in the primary models.

In addition, we conducted a sensitivity analysis that adjusted for albuminuria, nutrition, education, depressive symptoms and perceived chronic stress at baseline, since these additional factors may confound the relationship between social support and hypertension. Again, we used MICE to impute values for variables with missing data (education missing for <1%, perceived stress missing for 1%, diet missing for 7%, depressive symptoms missing for 28% and albuminuria missing for 32%).

### Patient and public involvement

There was no patient or public participation in the present study.

### Data sharing

Requests for data from the JHS require approval of a JHS manuscript proposal or an ancillary study proposal. You will be asked to submit a data and materials distribution agreement prior to obtaining any data. Requests can be made on the JHS website: <https://www.jacksonheartstudy.org/Research/Study-Data/Data-Access>.

## RESULTS

Overall, 1516 participants had data available for the structural social support analyses and 1240 for the functional social support analyses. Those with low structural social support exercised less than participants

with high structural social support (table 1). Functional social support scores ranged from 2 to 38 with a mean functional social support score of 26 ( $\pm$ SD 5). During a median follow-up time of 6.9 years (25th–75th percentiles 4.7–8.0), 54% of participants developed incident hypertension. In primary analyses, a high level of functional social support was associated with a lower risk of incident hypertension (IRR 0.64 (95% CI 0.41 to 0.97), compared with a low level of functional social support.

Participants with low functional social support were more likely to be men and less likely to be smokers and exercised less than participants with high levels of functional social support (table 1). Furthermore, structural social support scores ranged from 0 to 12 and participants had a mean structural social support score of 6 ( $\pm$ SD 3). Higher levels of structural social support were not associated with incident hypertension (table 2). Additional adjustment for nutrition, albuminuria, education, depressive symptoms and chronic stress did not affect the results.

In secondary analyses, 1503 participants were included in analyses examining the association between satisfaction with social support and incident hypertension. No association was present between satisfaction with social support and incident hypertension (table 2). There was no evidence of an association between any of the four domains of functional social support separately and the risk of hypertension (online supplemental material 1). Furthermore, there was no evidence of an interaction between either marital status or sex and structural, functional or satisfaction with social support.

## DISCUSSION

In this cohort study of African American adults, participants who reported a high level of functional social support experienced a 36% lower risk of incident hypertension during follow-up than those with a low level of functional social support. Other measures of social support were not associated with hypertension risk.

**Table 1** Participant characteristics overall and by low versus high structural social support

Characteristic	Overall n=1516	Low structural social support (<8/12) n=1132	High structural social support (≥8/12) n=384
Age, mean (SD)	50 (12)	50 (12)	51 (12)
Male, n (%)	964 (64)	715 (63)	249 (65)
Alcohol use, n (%)*	821 (54)	627 (56)	194 (51)
Smoking, n (%)			
Never	1102 (73)	837 (75)	265 (70)
Former	206 (14)	136 (12)	70 (18)
Current	196 (13)	151 (13)	45 (12)
BMI, mean (SD)	31 (7)	31 (7)	31 (7)
eGFR, mean (SD)	102 (19)	102 (19)	100 (19)
Physical activity, n (%)†			
Poor	639 (42)	451 (44)	142 (37)
Intermediate	534 (35)	355 (35)	140 (37)
Ideal	343 (23)	226 (21)	102 (26)

Characteristic	Overall n=1240	Low functional social support (<32/48) n=1173	High functional social support (≥32/48) n=67
Age, mean (SD)	50 (12)	50 (12)	49 (11)
Male, n (%)	801 (65)	762 (65)	39 (58)
Alcohol use, n (%)*	680 (55)	642 (55)	38 (57)
Smoking, n (%)			
Never	913 (74)	865 (74)	48 (72)
Former	166 (14)	158 (14)	8 (12)
Current	151 (12)	140 (12)	11 (16)
BMI, mean (SD)	30.8 (7)	30.8 (7)	30.2 (6)
eGFR, mean (SD)	102 (19)	102 (19)	98 (18)
Physical activity, n (%)†			
Poor	507 (41)	482 (41)	25 (37)
Intermediate	442 (36)	422 (36)	20 (30)
Ideal	290 (23)	268 (23)	22 (33)

\*Alcohol use considers use in the past 12 months.

†Physical activity categories: poor [0 minutes/week of moderate or vigorous physical activity (MVPA)], intermediate [1–149 minutes/week of moderate activity or 1–74 minutes/week of vigorous activity or 1–149 minutes/week of MVPA], ideal [≥150 minutes/week of moderate activity or ≥75 minutes/week of vigorous activity or ≥150 minutes/week of MVPA].

BMI, body mass index; eGFR, estimated glomerular filtration rate; SD, standard deviation.

Few studies have evaluated whether potentially protective psychosocial resources, such as social support, may help individuals achieve or maintain a healthier BP, particularly among African Americans. A previous analysis of psychosocial correlates of apparent treatment-resistant hypertension (aTRH) in JHS found that larger social networks were associated with less aTRH, further suggesting the importance of social support.<sup>39</sup> Another study in a predominately white (87%) population found that the lowest levels of social integration, defined by the number and nature of one's social ties, were associated with a 75% greater risk of hypertension, but that there

was no evidence of a linear relationship between other aspects of social support and hypertension risk.<sup>22</sup>

Findings from the present study provide further evidence that certain types of social support are associated with better BP outcomes. However, the results of the current study differed from the two studies mentioned above as there was no evidence of a meaningful difference in incident hypertension based on the size of one's social support network (structural social support). We found that only functional social support was associated a reduction in incident hypertension. The finding that functional but not structural social support may be important

**Table 2** Incidence rate ratios for hypertension associated with structural, functional and social support

Exposure	Minimally adjusted*		Primary analysis†		Fully adjusted‡	
	Incidence rate ratio	95% CI	Incidence rate ratio	95% CI	Incidence rate ratio	95% CI
Structural social support (n=1516)						
Continuous per five point increase§	1.01	0.94 to 1.09	1.02	0.95 to 1.10	1.03	0.96 to 1.11
Binary (<8 vs ≥8)	1.03	0.80 to 1.19	1.03	0.88 to 1.20	1.06	0.90 to 1.24
Functional social support (n=1240)						
Continuous per three point increase§	0.93	0.86 to 1.00	0.96	0.89 to 1.04	0.97	0.89 to 1.05
Binary (<32 vs ≥32)	0.64	0.40 to 0.95	0.64	0.41 to 0.97	0.65	0.42 to 0.98
Satisfaction, binary (high vs low) (n=1503)	0.94	0.82 to 1.08	0.97	0.83 to 1.09	0.97	0.84 to 1.12

\*Adjusted for: age and sex.

†Adjusted for: age, sex, physical activity, smoking, alcohol use, BMI, eGFR with imputed values using MICE for those missing covariates.

‡Additional adjustment for: nutrition, albuminuria, education, depressive symptoms, chronic stress with imputed values using MICE for those missing covariates.

§Estimates for continuous measures of structural and functional social support are reported per one SD increase in the structural social support score or the functional social support score.

BMI, body mass index; eGFR, estimated glomerular filtration rate; MICE, multiple imputation with chained equation.

for incident hypertension is similar to findings from a meta-analysis by Magrin *et al*,<sup>40</sup> where it was reported that functional but not structural social support was associated with adherence to antihypertensive medication, indicating that the sheer presence of other people may not be as meaningful as the quality of support provided by one's social network.<sup>41</sup>

There are limitations of the present study. First, there was the potential for residual confounding due to the observational design and the inability to make causal inference. Second, data on structural and functional social support was only available at baseline, which did not allow for the examination of how longitudinal changes in social support impact incident hypertension. Since social support is a dynamic quality, which may be more important for particular age groups, it would be important for future studies to examine this longitudinal relationship. Finally, although we examined if any particular domains of functional social support were associated with lower risk of incident hypertension, we did not detect any meaningful difference. This may have been due to a lack of power in our secondary analyses.

This study has several strengths. First, the data were from a large community-based African American cohort. Also, we had information on multiple aspects of social support, including not only the size of the social support network but also the ways in which relationships provided support. In addition, we had a measure of how satisfied participants were with the social support they had received. This allowed for an in-depth examination of whether and how social support may influence hypertension risk. Finally, because we had longitudinal data on BP collected at three separate time points over the course of a decade,

we were able to examine how social support impacted the development of incident hypertension.

In conclusion, the current results suggest that high levels of functional support are associated with a lower risk of hypertension. Given the high incidence of hypertension among African American men and women, interventions designed to leverage and increase functional social support may provide opportunities for cardiovascular disease prevention in African Americans.

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**Correction notice** This article has been corrected since it was published. Author's name (Bessie A Young) has been corrected.

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**Contributors** Conceptualising and designing the study: BNH, CNH, JSF. Performing analyses: BNH. Interpreting the data: BNH, PM, SRH, JSF. Drafting the manuscript: BNH. Critically revising the manuscript: BNH, CNH, JK, MS, PM, BAYM, SRH, JSF. Responsible for the overall content as the guarantor of the manuscript: BNH

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**Competing interests** JSF has consulted for Shionogi. Other authors have nothing to disclose.

**Patient consent for publication** Not applicable.

**Ethics approval** This study involves human participants but approval for the Jackson Heart Study was obtained from the institutional review boards at the University of Mississippi Medical Center, the Jackson State University, and Tougaloo College. All participants provided written informed consent at each study visit. exempted this study. Participants gave informed consent to participate in the study before taking part.

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**Data availability statement** Data may be obtained from a third party and are not publicly available. Requests for data from the JHS require approval of a JHS manuscript proposal or an ancillary study proposal. You will be asked to submit a data and materials distribution agreement prior to obtaining any data. Requests can be made on the JHS website: <https://www.jacksonheartstudy.org/Research/Study-Data/Data-Access>

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