



Depressive symptoms are associated with worsened severity of the metabolic syndrome in African American women independent of lifestyle factors: A consideration of mechanistic links from the Jackson heart study

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ABSTRACT

Background: Depression and the metabolic syndrome (MetS) are both risk factors for cardiovascular disease and type 2 diabetes mellitus. Prior studies in predominantly White populations demonstrated that individuals with depressive symptoms at baseline are more likely to develop future MetS. We tested the hypothesis that depressive symptoms would contribute to a more pronounced increase in MetS severity among African Americans in the Jackson Heart Study (JHS).

Methods: We used repeated-measures modeling among 1743 JHS participants during Visits 1–3 over 8 years of follow-up to evaluate relations between depressive symptom score (Center for Epidemiologic Survey-Depression (CES-D)) at baseline and a sex- and race/ethnicity-specific MetS severity Z-score at each visit.

Results: 20.3% of participants had a CES-D score ≥ 16 , consistent with clinically-relevant depressive symptoms. Higher depressive-symptom scores were associated with higher MetS severity in women but not men ($p = 0.005$ vs. $p = 0.490$). There was no difference by depressive symptom score with rate of change in MetS severity over time. Both depressive-symptom score and MetS severity Z-score were associated with lower levels of physical activity and higher levels of C-reactive protein; however, addition of these to the regression model did not attenuate the association between depressive symptoms and MetS severity.

Conclusion: African American women but not men in the JHS exhibit relationships between baseline depressive symptoms and MetS severity over an 8-year period. These data may have implications for targeting of MetS-associated lifestyle changes among individuals with depressive symptoms.

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1. Introduction

Depression and the metabolic syndrome (MetS) are both precursors to type 2 diabetes mellitus (T2DM) and cardiovascular disease (CVD) and have been linked bidirectionally to each other (Dunbar et al., 2008; Joynt et al., 2003; Mezuk et al., 2008; R  ikk  nen et al., 2007; Sims et al., 2015; Skilton et al., 2007). In a large meta-analysis comprised almost exclusively of white participants, individuals

classified as having depression at baseline had an odds ratio (OR) of 1.52 for developing later MetS, while those classified as having MetS at baseline had an OR of developing depression of 1.49 (Pan et al., 2012). While still unclear, these connections have been postulated to relate to shared lifestyle practices, systemic inflammation and activation of stress hormone pathways (Berk et al., 2013; Dunbar et al., 2008; Raison et al., 2006; R  ikk  nen et al., 2007). Given risk conveyed for T2DM and CVD, the inter-related nature of depression and MetS raises significant issues for the screening and intervention for both disorders.

Nevertheless, the relationship is unclear between depression and MetS among African Americans for whom both depression

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and MetS are under-recognized. Physicians surveyed regarding patients with depressive symptoms were less likely to recognize or treat these symptoms among African Americans than among white patients (Breslau et al., 2005; Gallo et al., 2005), while other studies have revealed that African Americans exhibit depressive symptoms for a longer period of time (Breslau et al., 2005).

African Americans are also less likely to be classified as having MetS (Park et al., 2003; Walker et al., 2012), despite having more T2DM (Cowie et al., 2010), and more death from CVD (Mensah et al., 2005). This appears to result from a bias in the criteria traditionally used to categorize MetS (DeBoer, 2011; Sumner and Cowie, 2008). Using criteria such as those from the Adult Treatment Panel-III (ATP-III) (Grundey et al., 2005), MetS is categorized by an individual having abnormal values in at least three of the five components of MetS (high values of waist circumference [WC], blood pressure [BP], triglycerides and fasting glucose and low HDL-cholesterol). However, the cut-off values for these components are based on population norms and may not be accurate among all sub-groups. For example, African Americans in general have lower triglyceride levels and are therefore less likely to have elevations above the cut-off, contributing to a falsely lower estimation of MetS prevalence (Sumner and Cowie, 2008). These criteria carry a further limitation by virtue of being binary—limiting the ability to assess whether depression confers worsening over time in the processes underlying MetS—potentially leading to a more severely abnormal metabolic state. Because of the differences in how MetS is manifested among African Americans and because of the limits of binary MetS criteria, we recently formulated a sex- and race/ethnicity-specific MetS severity score, which is a Z-score that can be used to assess how severely MetS is manifested in an individual and to follow changes in MetS severity over time (Gurka et al., 2012, 2014; Vishnu et al., 2015). This score has been linked to risk for future CVD and T2DM over time (DeBoer et al., 2015a, 2015b).

Our goal in the current study was to assess the relationship between depressive symptoms and MetS severity over time among participants of the Jackson Heart Study (JHS), a cohort of African Americans in the Jackson, MS metropolitan area. Specifically, we hypothesized that African Americans with a higher degree of depressive symptoms would have a higher MetS severity at baseline and a more significant worsening of MetS severity over 8 years of follow-up. We further explored whether both depressive symptoms and MetS had links to lifestyle, inflammation and cortisol—all factors that can be noted in both processes.

2. Methods

2.1. Cohort

JHS is the largest longitudinal, single-site study of cardiovascular risk in African Americans. The cohort consists of 5301 participants age 21–95 years (Taylor et al., 2005). We utilized data from JHS Visit 1 (2000–2004), Visit 2 (2005–2008) and Visit 3 (2009–2013). During Visit 1, baseline information was gathered by certified interviewers in both home settings and during the clinic visit. These questionnaires focused on data regarding income, education, and lifestyle factors, including tobacco smoking, ethanol consumption, dietary patterns and the amount of physical activity (Taylor et al., 2005).

2.1.1. Depressive symptoms measures

During Visit 1, participants were given a take-home questionnaire with the Center for Epidemiologic Studies Depression (CES-D) scale (Radloff, 1977). This consists of 20 items for which the participant rates the frequency (on a 0–3-point scale) of depressive symptoms, with questions further divided into 4 sub-scales

depressed affect (items 3, 6, 14, 17, and 18), positive affect (items 4, 8, 12, and 16), somatic/retarded activity (items 1, 2, 7, 11, and 20) and interpersonal (items 15 and 19). The scores are summed for a total score. Depression has been typically classified based on a total score ≥ 16 (Radloff, 1977). In recognizing that depression manifests as a range of symptoms, from none to sub-threshold/sub-clinical to clinical, the majority of our analysis utilized this score as a continuous measure as performed previously (Ragland et al., 2005).

2.1.2. Clinical and laboratory measures

At each visit, participants had MetS components measured using standardized protocols (Taylor et al., 2008, 2005). WC assessed by 2 separate measurements at the level of the umbilicus, parallel to the floor using non-dispensable measuring tape. Sitting BP was measured twice at 5-minute intervals and averaged. Fasting blood samples of glucose and lipids were measured at the Central Laboratory of the University of Minnesota. Serum cortisol drawn at random time of day was measured by chemiluminescent immunoassay performed with the Siemens Advia Centaur (Siemens). Serum high sensitivity C-reactive protein (hsCRP) was measured by the latex particle immunoturbidimetric assay (from ITA and from Roche Diagnostics, Indianapolis, IN).

Nutrient information was assessed via four separate 24-hour dietary recalls (2 weekdays and 2 weekend days) scheduled approximately 1 month apart and administered by registered dietitians using University of Minnesota Nutrition Data System for Research software (version 4.04, 2001, Nutrition Coordinating Center, University of Minnesota, Minneapolis) (Carithers et al., 2009).

Physical activity was assessed via the JHS Physical Activity Cohort (JPAC) survey, which was administered by trained interviewers (Dubbert et al., 2005). The JPAC determines activity scores based on the frequency of activities for four domains of PA: 1. Active living (walking and biking for leisure and transportation and watching television), 2. Work (sitting, standing, walking, lifting heavy loads, and sweating from exertion at work; work activity was analyzed only for participants who reported either working or doing volunteer work in the past year), 3. Home life (care giving, preparing and cleaning up from meals, routine and major house cleaning, gardening/yard work, and heavy outdoor and household labor), and 4. Sport (participation in up to 3 recreational activities, and scores take into account the frequency, duration, and intensity of each of the activities reported). For each of these an index score (0–5) was generated, and a total score was computed as the sum of the index scores. Total scores were significantly correlated with 24-hour accelerometer counts ($\rho = 0.24$), and with three days of pedometer counts obtained about four months following the survey ($\rho = 0.32$) (Smitherman et al., 2009).

Lifestyle variables were broken down into categories of “poor health,” “intermediate health,” and “ideal health” according to definitions determined by American Heart Association (AHA) guidelines (Supplementary Table 1) (Lloyd-Jones et al., 2010).

2.1.3. MetS classification and Z-score

Traditional MetS was defined using the ATP-III criteria for adults (Grundey et al., 2005); participants had to meet ≥ 3 of the following 5 criteria: concentration of triglycerides ≥ 1.69 mmol/L (150 mg/dL), HDL-C < 1.04 mmol/L (40 mg/dL) for men and < 1.3 mmol/L (50 mg/dL) for women, WC ≥ 102 cm for males and 88 cm for females, glucose concentration ≥ 5.55 mmol/L (100 mg/dL), and systolic BP ≥ 130 mmHg or diastolic BP ≥ 85 mmHg (Grundey et al., 2005).

MetS severity Z-score was calculated using formulas published elsewhere (Gurka et al., 2012, 2014). Briefly, these scores were formed using confirmatory factor analysis of the 5 traditional components of MetS (as above) to determine the weighted contribution of each of these components to a latent MetS “factor” on a sex-

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