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Everyday Discrimination and Metabolic Syndrome Incidence in a Racially/Ethnically Diverse Sample: Study of Women's Health Across the Nation (SWAN)

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Abstract

Objective—Everyday discrimination may contribute to incident metabolic syndrome (MetS) in the U.S. and related racial/ethnic differences in MetS. This study investigated whether ED predicted MetS in a diverse sample.

Methods—Longitudinal, cohort study of 2,132 women (mean [*SD*] 45.8 [2.7] years) who self-reported as Black ($n = 523$), White ($n = 1065$), Chinese ($n = 194$), Japanese ($n = 227$), or Hispanic ($n = 123$) at baseline, drawn from seven cities across the U.S. MetS was defined in accordance with the National Cholesterol Education Program Adult Treatment Panel III criteria. The Everyday Discrimination scale was used to assess exposure to and level of everyday discrimination.

Results—Everyday discrimination exposure at baseline predicted a 33% greater incidence of MetS over the 13.89 year (*SD* = 3.83; HR, 1.33; 95% CI [1.11–1.64], $p = .001$) follow-up in the full sample, and was most pronounced in Black, Hispanic, and Japanese women. Each 1-point increase in the continuous everyday discrimination score (HR, 1.03; 95% CI [1.01–1.05], $p = .001$) predicted a 3% greater incidence of MetS and specifically, blood pressure (HR, 1.01; 95% CI [1.00–1.03], $p = .04$), waist circumference (HR, 1.05; 95% CI [1.03–1.06], $p < .001$), and triglyceride level (HR, 1.02; 95% CI [1.00–1.04], $p = .01$). These associations were independent of risk factors including physical activity, socioeconomic status, smoking and alcohol consumption.

Conclusions—Everyday discrimination contributes to poorer metabolic health in midlife women in the U.S. These findings have clinical implications for the development of MetS, and

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Conflicts of Interest

There were no conflicts of interest for authors involved in the development of this manuscript.

ultimately cardiovascular disease and diabetes, and intervention strategies to reduce these outcomes.

Keywords

everyday discrimination; longitudinal; race/ethnicity; metabolic syndrome incidence

INTRODUCTION

The metabolic syndrome (MetS) represents a cluster of interrelated risk factors for atherosclerosis (1), myocardial infarction, cardiovascular disease (CVD), type 2 diabetes, and all-cause mortality. The five specific risk factors comprising MetS include, elevated blood pressure, abdominal obesity, hypertriglyceridemia, hyperglycemia, and low high-density lipoprotein (HDL) cholesterol. Approximately 34% of the U.S. adult population has MetS. Women are especially vulnerable. A report from the National Health and Nutrition Examination Survey (NHANES) indicated that while MetS is not an independent risk factor for all-cause mortality and CVD-related mortality in men or premenopausal women, it is in postmenopausal women (2). Additionally, with increasing age (≥55 years old) in women MetS becomes a stronger predictor of CVD compared with earlier years of adulthood (3). Racial disparities have also been observed in MetS using NHANES data. Women of Hispanic origin (44.1%) and Black women (38.2%) have higher rates of these risk factors compared to White women (31.3%; 4).

Despite its pervasiveness, significant influence on chronic disease development, and observed racial disparities, little is known about how MetS incidence is affected by psychosocial factors. A limited number of prior cross-sectional (5) and longitudinal (6) studies have demonstrated that sources of chronic stress such as job, marital, and caregiver strain, and stressful life events (7–9) predict increased risk for MetS. In the Whitehall II study a single-item measure of unfair treatment was associated with the MetS in 5,843 participants over a 5.8 year follow-up period independent of age and sex (10). Unfair treatment typically measured through the assessment of everyday discrimination is a specific type of chronic psychosocial stressor conceptualized as those subtle, day-to-day forms of bias or unfair treatment that unfold in interpersonal interactions. In the U.S., everyday discrimination is considered a pervasive chronic stressor (11), particularly among racial/ethnic minorities (12). The Whitehall II study has limited generalizability to the U.S., which is racially/ethnically diverse. Another recent study (13) based in the Netherlands on 12,436 adult (aged 18–70 years) immigrants found that everyday discrimination was associated with MetS in those of South-Asian Surinamese, African Surinamese, and Moroccan ethnicities but not in those of Ghanaian and Turkish ethnicities. This study was cross-sectional. To our knowledge, there have been no studies of the prospective association between everyday discrimination and MetS in the U.S., in any racial/ethnic group.

The current study is the first to prospectively examine the association between everyday discrimination and MetS in a racially/ethnically diverse sample across the U.S. MetS is an important target for clinical intervention to reduce risk of premature CVD and Type 2 diabetes, particularly in the context of racial/ethnic disparities in both of these endpoints.

Thus, as we seek to reduce these outcomes, it is reasonable to understand factors that may contribute to MetS, and in turn, more serious physical health outcomes. Data from the Study of Women's Health Across the Nation (SWAN) are used to examine the association of everyday discrimination and MetS in 2,132 women. We specifically examine whether greater everyday discrimination predicts greater incidence of developing MetS over an average of 13.89 years ($SD = 3.83$), and whether the relation of everyday discrimination to MetS differs as a function of race/ethnicity. With regard to everyday discrimination, we examine whether exposure (yes/no) or level of frequency via a continuous score are associated with MetS. We also consider attributions to race/ethnicity for experiences of everyday discrimination specifically among the Black, Chinese, and Japanese women, and whether socioeconomic status moderates the association of everyday discrimination to MetS in the full sample.

METHODS

The study design, sampling, recruitment, and enrollment for the Study of Women's Health Across the Nation (SWAN) have been previously described (13). In brief, SWAN is a multiracial/ethnic community-based, longitudinal cohort study of the menopausal transition among 3,302 women enrolled at 7 U.S. sites (Boston, Massachusetts; Chicago, Illinois; Detroit, Michigan; Los Angeles, California; Oakland, California; Newark, New Jersey; and Pittsburgh, Pennsylvania). The baseline sample included midlife women who were premenopausal or early perimenopausal of White, Black, Japanese, Chinese, and Hispanic origins, aged 42–52 (mean age = 45.8). From February 1996 through April 2013, women completed a median of 12 visits.

Eligibility criteria for admission to the SWAN longitudinal cohort study included self-identifying as White or the given site's other designated racial/ethnic groups, having an intact uterus, and having had at least one menstrual period and no use of reproductive hormones in the previous 3 months. To determine eligibility for entry to the SWAN study, health history, reproductive, demographic, and lifestyle data were collected during screening interviews conducted between 1995 and 1997. Research assistants, interview-administration, and interview-assistance were available to assist with literacy needs.

In the current study, women were excluded if they did not have any everyday discrimination data at baseline ($n = 29$), or also at baseline, reported meeting criteria for ≥ 3 components of MetS or did not have baseline MetS data ($n = 845$) or reported myocardial infarction or stroke ($n = 92$), or at follow-up visits, did not have any MetS or everyday discrimination data (i.e., $n = 59$ & $n = 145$, respectively). Thus, the current analyses included 2,132 women (1,065 non-Hispanic Whites, 523 Blacks, 123 Hispanics, 194 Chinese, and 227 Japanese Americans). The Institutional Review Boards at each site approved the study and all women provided written consent.

Demographic and Clinical Measures

Age (in years), self-identified race/ethnicity, and socioeconomic status were assessed at baseline. Socioeconomic status was measured by asking participants about financial strain via a single question in the SWAN screening interview, "How hard is it for you to pay for the

very basics like food, housing, medical care, and heating?" This item was coded; 1 = no difficulty paying for basics and 0 = somewhat or very hard paying for basics. Physical activity was also assessed at baseline. Time-varying characteristics assessed at baseline and at each of the annual follow-up visits were; alcohol consumption and smoking status, menopausal status (early peri, late peri, surgical post, unknown), hormone therapy (including: estrogen injection/patch, estrogen pills, progestin pills, and combination of estrogen/progestin), or use of medications including anticoagulants, heart medications, or birth control pills. We also assessed whether participants had a heart attack or stroke, became insulin-dependent, or began using antihypertensives at each of the follow-up visits.

Everyday Discrimination

Everyday discrimination was assessed with 10 items from the Everyday Discrimination scale (14). Respondents were asked to indicate the frequency with which they experienced 10 specific instances of discrimination (i.e., never, rarely, sometimes, or often). Previous assessments (e.g., 15–16) of everyday discrimination in SWAN participants have indicated that these reports are 'consistent across several years and the Cronbach's alpha was .88 in the current subsample. Further, the within-person stability estimates across time were high, with intraclass correlation coefficients of .90 for White women, .91 for Chinese women, .85 for Black women, and .90 (95% CI [.88 – .91]; $p < .001$) for the full sample. In the current analyses, we utilize the baseline everyday discrimination data. Two assessment approaches were applied to everyday discrimination data in this study, continuous scoring and a dichotomous indicator. To create the continuous measure, a sum of the 10 items was calculated to obtain the everyday discrimination score where a higher score indicates greater everyday discrimination. The dichotomous or exposure indicator (yes) was defined as a response by participants as either "sometimes" or "often" to any of the 10 items, whereas if they responded "never" or "rarely" to each of the 10 items, this indicated *no* exposure. Prior reports have applied these approaches and demonstrated that the severity and even exposure are linked to adverse health outcomes (e.g., 17–22).

Metabolic Syndrome

Based on the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III) guidelines for women (1), the metabolic syndrome (MetS) was defined as the presence of ≥ 3 of the following criteria: (1) waist circumference ≥ 88 cm for White, Black, and Hispanic participants and ≥ 80 cm for Chinese and Japanese participants; (2) blood pressure ≥ 130 mmHg systolic, ≥ 85 mmHg diastolic, or use of antihypertensive medication; (3) fasting serum glucose ≥ 100 mg/dL (or taking diabetic medication at the visit); (4) serum triglycerides ≥ 150 mg/dL or medication for hypertriglyceridemia; and (5) HDL cholesterol ≤ 50 mg/dL or use of medication for low HDL cholesterol. Participants were evaluated for the presence of the metabolic syndrome at visits 1, 3–10, 12, and 13. However, data for visits 8–10 was based on only 3 components (i.e., waist circumference, blood pressure, and being classified as being diabetic) as lipid data were not available at these visits.

Waist circumference was measured in centimeters at the natural waist, or the narrowest part of the torso. Blood pressure was assessed with readings taken on the right arm, with the respondent seated for at least five minutes prior to measurement. Two sequential blood

pressure values were obtained within a five-minute interval, and the average blood pressure was used in analyses. Standardized laboratory protocols were used for both. A fasting blood draw was used to assess glucose and lipid levels. Glucose levels were measured using a hexokinase-coupled reaction (Boehringer Mannheim Diagnostics, Indianapolis, IN). All lipids were analyzed on EDTA-treated plasma. Triglycerides were analyzed by enzymatic methods using a Hitachi 747 analyzer (Boehringer Mannheim Diagnostics, Indianapolis, IN). HDL cholesterol was isolated using heparin-2Mmanganese chloride.

The inter-assay coefficients of variability were as follows: for glucose, 2.1% (94 mg/dL) and 2.5% (305 mg/dL); triglycerides, 1.9% (73 mg/dL), 1.8% (142 mg/dL), and 2.0% (203 mg/dL); and HDL, 3.2% (36 mg/dL), 4.5% (53 mg/dL) and 3.9% (69 mg/dL). The intra-assay coefficients of variability were as follows: for glucose, 1.3% (94 mg/dL) and 1.2% (305 mg/dL); triglycerides, 1.3% (94 mg/dL) and 1.2% (305 mg/dL); and, HDL 2.6% (37 mg/dL), 2.3% (53 mg/dL) and 1.9% (69 mg/dL).

Statistical Analyses

Survival analyses with hazard ratios (HR), 95% confidence intervals (CI), and *p*-values were computed to investigate the relation of everyday discrimination to MetS incidence. Sensitivity analyses were conducted to determine the consistency of findings as the New Jersey site (Hispanic women) only included data through follow-up visit five. These analyses determined there was no difference, thus all data from that site were included. All analyses were adjusted for sample characteristics from baseline and those that were time-varying. We conducted analyses to determine whether greater everyday discrimination (continuous variable) and exposure ("yes" = respondent indicated "sometimes" or "often" to ≥ 1 of the 10 items; otherwise "no") were related to MetS onset in the full sample and whether these associations differed as a function of race/ethnicity. To examine associations between everyday discrimination and the five specific components of MetS, interval censored survival analyses were conducted. The semi-adjusted models included age and race/ethnicity. All fully-adjusted models included age and race/ethnicity (unless used as a component of the interaction term) as well as, study site, education, current smoking status, medication use including anticoagulants and heart medication, financial strain, and physical activity. Power estimations were conducted to determine whether there was sufficient power to detect associations within each racial/ethnic subgroup. The power estimates for Cox models were < 60% for White, Chinese, and Hispanic subgroups, and 80% and 82% for Black and Japanese subgroups, respectively. To assess attributions to race and ethnicity for everyday discrimination, participants affirming experiences with everyday discrimination, were asked to report on the reason for these experiences. That is, if one or more everyday discrimination items were endorsed as occurring "often" or "sometimes", participants were asked to indicate the main reason for these experiences. Respondents could select: race, ethnicity, sex, age, income level, language, physical appearance, sexual orientation, or other. We examined race and ethnicity only which were combined for the purposes of analyses in the current study. Due to limited *n* (i.e., < 10%) making attributions to race/ethnicity within each racial/ethnic group, 2-way interactions testing race/ethnicity × attributions to race/ethnicity for everyday discrimination, were not conducted in the full sample. However, given that a sufficient number of Black (i.e., 36.3%), Chinese (i.e., 22%), and Japanese (i.e., 11%)

women made these attributions, analyses assessing the relation of these attributions to MetS incidence were conducted in these three subgroups in fully-adjusted models. All analyses were conducted using Statistical Analysis System, version 9.3, software (SAS Institute, Inc., Cary, North Carolina).

RESULTS

Table 1 presents baseline characteristics by race/ethnicity. There were significant differences in all adjustment variables with the exception of anticoagulant and heart medication use. The greatest BMI and the highest number of smokers were observed in Black women. Regarding everyday discrimination, Black and Chinese women experienced the highest levels (mean = 19, *SD* = 5.1 and mean = 18, *SD* = 4.8, respectively), whereas Japanese women had the lowest levels, behind White women. A similar pattern emerged for exposure to everyday discrimination (see Table 1). In unadjusted correlations between baseline everyday discrimination (continuously modeled) and the baseline MetS components in the full sample (Table S1, Supplemental Digital Content 1), we observed positive, but weaker associations between everyday discrimination and waist circumference and glucose levels in the full sample.

Over the course of the study, 624 (29.3%) women developed MetS; of these women, 107 only had 1 visit with MetS diagnosis. The highest cumulative incidence was among Black and Hispanic women whereas the lowest cumulative incidence was among Chinese and Japanese women. For the remaining 517 participants who had > 2 visits with MetS data, 151 (28.2%) had consistent MetS diagnosis after the initial MetS diagnosis and 142 (27.5%) had only 1 positive MetS diagnosis as after the initial diagnosis they did not have another positive MetS diagnosis.

Tables 2 characterizes metabolic syndrome at baseline and over the follow-up period in this sample. Table 2 illustrates three main points; (1) at baseline Black women have the highest levels of most MetS components, followed by Hispanic women (for whom data are only available through Visit 5), (2) across follow-up, this pattern becomes more nuanced with Hispanic women having overall the highest triglyceride levels and similar levels of blood pressure as those observed in Black women, whereas Black women have the greatest waist circumference and glucose levels, and (3) across follow-up Black (39.2%) and Hispanic (37.4%) women had similar levels of MetS incidence, whereas Japanese (24%) women had the lowest incidence levels.

Baseline Everyday Discrimination Predicts MetS Incidence Over Time

The primary analyses were conducted with women who did not have MetS at baseline. Among women without MetS at baseline, after a semi-adjustment for baseline age and race/ethnicity, each 1 point increase in the continuous score for everyday discrimination (HR, 1.03; 95% CI [1.01–1.05], $p = .001$) was related to a 3% greater incidence of MetS in the full sample across the follow-up. This association remained in the fully-adjusted model (HR, 1.03; 95% CI [1.01–1.05], $p = .001$). The everyday discrimination (continuously modeled) × race/ethnicity interaction term ($p = .02$) predicted MetS incidence as well. The stratified analyses indicated that these effects were observed in Black (HR, 1.04; 95% CI [1.01–1.08],

$p = .01$), Hispanic (HR, 1.09; 95% CI [1.00–1.24], $p = .05$), and Japanese (HR, 1.09; 95% CI [1.02–1.20], $p = .004$) participants, but not in the White (HR, 1.02; 95% CI [1.00–1.06], $p = .10$) or Chinese (HR, .96; 95% CI [.92–1.04], $p = .24$) participants.

With everyday discrimination modeled as a dichotomous exposure variable, the relation of everyday discrimination to MetS incidence was consistent across the semi- (i.e., age and race/ethnicity; HR, 1.34; 95% CI [1.12–1.63], $p = .001$) and fully-adjusted (HR, 1.33; 95% CI [1.11–1.64], $p = .001$) models. Specifically, exposure to everyday discrimination was related to a 33% greater incidence of MetS over the follow-up (mean [*SD*] 13.89 [3.83] years) in the full sample, this finding is illustrated in Figure 1. The exposure to everyday discrimination × race/ethnicity interaction term did not significantly predict MetS incidence ($p = .49$).

Relation of Everyday Discrimination to MetS Components Incidence

We also examined whether baseline everyday discrimination was associated with the incidence of the individual components over time. Sub-analyses of the components in the full sample indicated that continuous everyday discrimination predicted the blood pressure component, (HR, 1.01; 95% CI [1.00–1.03], $p = .04$), waist circumference (HR, 1.05; 95% CI [1.03–1.06], $p < .001$), and triglyceride level (HR, 1.02; 95% CI [1.00–1.04], $p = .01$). Everyday discrimination modeled as a dichotomous exposure variable predicted the waist circumference component of MetS, (HR, 1.42; 95% CI [1.25–1.65], $p < .001$). All other *p*-values were > .10.

Supplementary Analyses

We conducted a series of supplementary analyses to more fully characterize the relation of everyday discrimination to MetS incidence in this sample.

Inclusion of Women with Established MetS at Baseline—We sought to determine whether the associations between everyday discrimination and MetS were observed when women with MetS at baseline were included. That is, in these analyses, we included women who had a positive MetS diagnosis at baseline and also adjusted for MetS diagnosis at baseline. Across these models, compared to the primary study models (in which we did not include women who had MetS at baseline and did not adjust for MetS at baseline), the effects were slightly weakened, but remained significant. Specifically, baseline everyday discrimination treated continuously (semi-adjusted; HR, 1.02; 95% CI [1.00–1.03], $p < .01$ and fully-adjusted; HR, 1.02; 95% CI [1.00–1.03], $p = .01$) or as an exposure variable (semi-adjusted; HR, 1.19; 95% CI [1.05–1.36], $p < .005$ and fully-adjusted; HR, 1.03; 95% CI [1.00–1.34], $p < .01$) predicted MetS incidence over follow-up.

Relation of Everyday Discrimination to Persistent MetS Across the Follow-up Period—In analyses restricted to women who maintained a positive MetS diagnosis after the visit at which MetS was initially detected, everyday discrimination predicted their positive MetS diagnosis. In these analyses, we removed those women with only 1 positive MetS diagnosis who then had all negative MetS diagnoses afterward. Specifically, in fully-adjusted models, each 1 point increase in the continuous score for everyday discrimination

(HR, 1.04; 95% CI [1.01, 1.06], $p < .001$) was related to a 4% greater incidence of MetS in the full sample. Similarly, exposure to everyday discrimination at baseline predicted a 38% greater incidence of MetS in women who persistently presented with a positive MetS diagnosis after initial onset (HR, 1.38; 95% CI [1.13–1.75], $p = .001$).

Attributions to Race/Ethnicity for Everyday Discrimination—Race/ethnicity was the most reported attribution for experiences of everyday discrimination in this sample (i.e., 31.3%). In fully-adjusted models, an attribution to race/ethnicity for everyday discrimination at baseline predicted MetS over time (HR, 1.28; 95% CI [1.0–1.69], $p = .04$) in the full sample. Given the limited numbers of women making attributions within each racial/ethnic group, we were able to conduct race/ethnicity-stratified analyses among Black, Japanese, and Chinese women only. Among the Black and Japanese women, those making an attribution to race/ethnicity for the everyday discrimination they reported had a 44–50% increased risk of MetS over the follow-up period compared to all other Black and Japanese women who did or did not endorse experiencing any everyday discrimination (i.e., HR, 1.44; 95% CI [1.04–2.17], $p = .02$ and HR, 2.50; 95% CI [1.14, 8.42], $p = .02$), respectively in the two racial/ethnic groups. Among the Chinese women, there was no association between race/ethnicity attributions and MetS (HR, .50; 95% CI [.29–1.32], $p > .13$).

Socioeconomic Status as a Moderator—Using education, income, and financial strain as indices of SES, we assessed in three separate analyses whether SES modified the relation of everyday discrimination (as a continuous and exposure variable) and race/ethnicity to MetS. All 3-way models were non-significant, $p > .25$. In 2-way models examining everyday discrimination (i.e., as a continuous and exposure variable, respectively) × SES (i.e., education, income, and financial strain, respectively), we observed no significant models predicting MetS, all p-values > .7 (data not shown).

DISCUSSION

The key findings in the current study are that women who report exposure to everyday discrimination are at a 33% greater risk for incident MetS over an average of 13.89 years, and Black, Hispanic, and Japanese women who report greater levels of everyday discrimination are at particular risk compared to other racial/ethnic groups. These associations were not attenuated after adjusting for known traditional (e.g., age and medication use) and non-traditional MetS risk factors including physical activity, smoking, and financial strain. The current findings demonstrate that everyday discrimination may act as a chronic stressor, similar to other chronic stressors which have been linked to MetS. However, these findings are unique in that they prospectively link the experience of interpersonal-level discrimination to the incidence of MetS in the U.S. for the first time and also in a racially/ethnically diverse sample.

Our findings extend previous studies by showing that chronic stress arising specifically from everyday discrimination is a factor in the development of MetS in the U.S. The Whitehall study assessed whether study participants felt that they were treated unfairly (9) and was limited to civil servants. Prior work has also linked discrimination to other risk factors for CVD in the U.S. (24–27), but none have linked discrimination to MetS. Chronic stress has a

demonstrated linkage to neuroendrocrine pathways such as the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system. Additionally, changes in the autonomic nervous system and increased inflammation may serve as pathways linking discrimination to the development of MetS. Further, lifestyle factors such as physical activity, smoking, and alcohol consumption may also be risk factors but these were considered in the current study and the effects were unchanged. However, discrimination has been linked to depression and sleep quality (19) – which may be explanatory factors for the associations we observed. Importantly, stress-related eating practices may also be a factor in the development of MetS associated with discrimination. Hyperpalatable foods (sweet, salty, fatty, etc.) are typically chosen in stress-related eating (28, 29) and research has shown a link between discrimination and weight gain (30–32). The findings for an association between everyday discrimination and waist circumference also build upon prior cross-sectional findings in this sample (12).

In supplementary analyses, we observed that everyday discrimination – modeled as continuous and exposure variables – continued to predict an increase in MetS even when including women who had been excluded in primary analsyes at baseline for current MetS . Additionally, we also observed that everyday discrimination predicted MetS in women who consistently maintained MetS diagnosis after the initial onset during the 13.89 year follow-up period. Specifically, greater levels of everyday discrimination were associated with a 4% greater risk for MetS whereas exposure was associated with a 38% greater risk for incidence. Approximately 30% of study participants maintained a consistent MetS diagnosis after onset across the follow-up period. Altogether, these findings suggest at least three important points to consider in future research; (1) everyday discrimination predicts the actual increase in occurrence or maintenance of MetS over time and these findings do not reflect a cross-sectional association between everyday discrimination and MetS, (2) assessing the extent of and exposure to everyday discrimination both provide different, but relevant insight about the relation of this chronic stressor for CVD risk, and (3) the association between interpersonal-level discrimination and MetS incidence is robust. The inclusion of women with MetS at baseline reduced, but did not attenuate the observed linkages, indicating a robust effect of everyday discrimination. Additionally, restriction of analyses to women who maintained a positive MetS diagnosis across the follow-up period after initial onset appreciably strengthened the associations we observed.

Drawing on growing calls for more comprehensive assessment interpersonal-level discrimination (33, 34), we considered whether the level of or any exposure to everyday discrimination would differentially contribute to MetS incidence. The current findings suggest that overall, both approaches to capturing the experience of everyday discrimination demonstrate this ubiquitous stressor is a risk factor for MetS. Indeed, in the women with persistent MetS after initial onset across follow-up, any exposure to discrimination at baseline contributes to 38% greater incidence. Similarly, we see for the continuous measure that every 1-point increase contributes a 4% increase in MetS incidence in this subgroup.

Largely, the findings across the two measurement approaches were consistent in the current paper with the exception of one finding. The one instance where the findings were not consistent was for the exposure to everyday discrimination × race/ethnicity. It is possible

that this was due to the *n* in particular racial/ethnic groups versus a relevancy or measurement. It is important to note that the exposure assessment is a cruder measurement approach in that it may underestimate the contribution of discrimination across a greater number of situations, that occur at a lower level of frequency a factor which may be more relevant when trying to ascertain variations between racial/ethnic groups with more limited *n*. These findings illustrate the clinical significance of both assessment approaches, yet provide somewhat different information which is important to consider. First, the exposure findings elucidate very simply that acknowledging that just one event has happened at least sometimes is predictive of MetS incidence. At the same time, considering the level of discrimination across multiple forms unfolding in interpersonal interactions (e.g., being treated with disrespect, less courtesy, or as if you are lazy or not smart) is also predictive of MetS incidence. A key factor to consider in future research is whether exposure alone will always fully reflect the complexities of these experiences and in turn provide a comprehensive gauge of the linkage of discrimination to endpoints of interest. Perhaps employing multiple approaches (e.g., count, severity, and exposure) concurrently as complementary may be optimal, but our findings demonstrate that even any exposure is a risk factor.

We also observed that attributions to race/ethnicity for experiences of everyday discrimination predicted MetS incidence in the full sample, specifically 28% incidence. In race/ethnicity-stratified analyses, we observed the associations in Black and Japanese women, that is, a 44% and 2.5% incidence of MetS, respectively. These findings suggest that when women in the U.S. believe that their poor interpersonal interactions with others are due to their race/ethnicity, these events hold particular risk for their health. In this case, the rates of MetS are alarming for Black and especially, Japanese women when they make these attributions. A growing research area demonstrates that individuals of Asian ancestry report moderate to high rates of interpersonal-level discrimination (35), with some reporting that 75% of Japanese Americans endorse having been treated poorly due to their race/ethnicity in their lifetime. The findings for Blacks making such attributions are well established (11, 36). While we were unable to test these associations in the White and Hispanic women due to low (i.e., < 10%) positive response rates for this particular item, these findings provide meaningful insight on the linkage of race/ethnicity attributions for discrimination to MetS.

The current study had several strengths compared to the prior single prospective study on unfairness and MetS. The strengths of the current study are drawn from its study design, sample, and assessment of everyday discrimination and MetS. First, the participants represented a racially/ethnically diverse sample in the U.S. As noted above, the Whitehall study is known to be mainly White, although race was not reported. As noted above, this sample was followed for a longer period of time providing greater understanding of the patterns of the association. The current study also used a reliable and valid measure of interpersonal-level discrimination (15) and also used in a prior study of MetS (13). The validity and reliability of the single-item measure used in the prior study is unclear, as it cannot be measured. These strengths contribute significantly to the current literature highlighting the linkages of this chronic stressor to MetS in the U.S.

The current study also had some limitations. Approximately 35.4% (1,170) of the SWAN sample was excluded due to missing data or pre-existing MetS or CVD. However, in supplementary analyses inclusion of women with MetS at baseline did not fully attenuate the findings. We also observed that we had more limited power to observe effects in particular racial/ethnic subgroups, specifically, the White, Chinese, and Hispanic women. Relatedly, we did observe null findings in the White and Chinese women, but not the Hispanic women. It is plausible that the *n* indeed limited the ability to observe significant associations in these groups, especially if the associations were smaller in size. Chinese women may have also had low power because fewer women had a positive MetS diagnosis and their risk may have also been offset by cultural factors, such as diet. However, given the growing research highlighting the health implications of unfair treatment at the interpersonal-level among Whites (e.g., 37) and Chinese (e.g., 38), future research should continue to consider this linkage in these groups. Another limitation was that lipid data were not available at 3 visits, thus the evaluation of metabolic syndrome was based on waist circumference, blood pressure, and having been classified as diabetic at these particular visits. This limitation may have contributed to an underestimation of those with MetS at those time points. Finally, SWAN exclusively investigates women's health and thus, men are not included. While this may be considered a limitation as it limits generalizability, it is also a consideration that the experience of interpersonal-level discrimination and the subsequent linkages to health among women is of critical importance to elucidate in the U.S., which is a unique contribution of the SWAN study. Women are at a significantly higher risk for MetS (39) compared with men, and this in turn contributes to greater risk for subsequent CVD (40). However, it is plausible that similar patterns would emerge in men, particularly those who are racial/ethnic minorities. Future studies should indeed pursue these questions in men as well.

In conclusion, the current study demonstrated that exposure to everyday discrimination was related to a 33% greater incidence of MetS and was associated with increased incidence of MetS over time. This observed linkage may be an important target for intervention given the deletrioius clinical implications of MetS. Further, we observed that these findings were more pronounced among Black, Japanese, and Hispanic women, and that attributions to race/ethnicity as a primary reasons for these experiences was particularly salient among Black and Japanese women. To that end, in light of the racial/ethnic disparities in obesity, diabetes, overall MetS, and CVD in the U.S., this study provides important insight on everyday discrimination as a psychosocial factor, which may contribute to this outcome, especially in racial/ethnic groups which have been historically underrepresented or marginalized in the U.S.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Glossary

MetS	metabolic syndrome
CVD	cardiovascular disease
HDL	high-density lipoprotein
NHANES	National Health and Nutrition Examination Survey
SWAN	Study of Women's Health Across the Nation

References

1. Grundy SM, Cleeman JI, Daniels SR, Donato KA, Eckel RH, Franklin BA, Gordon DJ, Krauss RM, Savage PJ, Smith SC Jr, Spertus JA, Costa F. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute scientific statement. Circulation. 2005; 112:2735–52. [PubMed: 16157765]
2. Lin JW, Caffrey JL, Chang MH, Lin YS. Sex, menopause, metabolic syndrome, and all-cause and cause-specific mortality—cohort analysis from the Third National Health and Nutrition Examination Survey. J Clin Endocrinol Metab. 2010; 95:4258–4267. [PubMed: 20534759]
3. Lorenzo C, Williams K, Hunt KJ, Haffner SM. The National Cholesterol Education Program–Adult Treatment Panel III, International Diabetes Federation, and World Health Organization definitions of the metabolic syndrome as predictors of incident cardiovascular disease and diabetes. Diabetes Care. 2007; 30:8–13. [PubMed: 17192325]
4. Ford ES, Li C, Zhao G. Prevalence and correlates of metabolic syndrome based on a harmonious definition among adults in the US. J Diabetes. 2010; 2:180–93. [PubMed: 20923483]
5. Ortiz MS, Myers HF, Schetter CD, Rodriguez CJ, Seeman TA. Psychosocial predictors of metabolic syndrome among Latino groups in the Multi-Ethnic Study of Atherosclerosis (MESA). PloS One. 2015; 10:e0124517. [PubMed: 25906072]
6. Edwards EM, Stuver SO, Heeren TC, Fredman L. Job strain and incident metabolic syndrome over 5 years of follow-up: the coronary artery risk development in young adults study. J Occup Environ Med. 2012; 54:1447–52. [PubMed: 23171915]
7. Chandola T, Brunner E, Marmot M. Chronic stress at work and the metabolic synrome: prospective study. BMJ. 2006; 332:521–525. [PubMed: 16428252]
8. Henry NJ, Smith TW, Butner J, Berg CA, Sewell KK, Uchino BN. Marital quality, depressive symptoms, and the metabolic syndrome: a couples structural model. J Behav Med. 2015; 38:497–506. [PubMed: 25677374]
9. Pyykkönen AJ, Räikkönen K, Tuomi T, Eriksson JG, Groop L, Isomaa B. Stressful life events and the metabolic syndrome. Diabetes Care. 2010; 33:378–384. [PubMed: 19880581]
10. De Vogli R, Brunner E, Marmot MG. Unfairness and the social gradient of metabolic syndrome in the Whitehall II Study. J Psychosom Res. 2007; 63:413–419. [PubMed: 17905050]

11. Kessler RC, Mickelson KD, Williams DR. The prevalence, distribution, and mental health correlates of perceived discrimination in the United States. J Health Soc Behav. 1999; 40:208–230. [PubMed: 10513145]
12. Brown C, Matthews KA, Bromberger JT, Chang Y. The relation between perceived unfair treatment and blood pressure in a racially/ethnically diverse sample of women. Am J Epidemiol. 2006; 164:257–262. [PubMed: 16777930]
13. Ikram UZ, Snijder MB, Agyemang C, Schene AH, Peters RJ, Stronks K, Kunst AE. Perceived ethnic discrimination and the metabolic syndrome in ethnic minority groups: The Healthy Life in an Urban Setting Study. Psychosom Med. 2017; 79:101–111. [PubMed: 27359175]
14. Sowers, MF., Crawford, S., Sternfeld, B., Morganstein, D., Gold, EB., Greendale, GA., Evans, D., Neer, R., Matthews, R., Sherman, S., Lo, A., Weiss, G., Kelsey, J. Design, survey sampling and recruitment methods of SWAN: a multi-center, multi-ethnic, community-based cohort study of women and the menopausal transition. In: Lobos, R.Marcus, R., Kelsey, JL., editors. Menopause. New York, NY: Academic Press; 2000. p. 175-188.
15. Williams DR, Yu Y, Jackson JS, Anderson NB. Racial differences in physical and mental health socio-economic status, stress and discrimination. J Health Psychol. 1997; 2:335–351. [PubMed: 22013026]
16. Lewis TT, Everson-Rose SA, Powell LH, Matthews KA, Brown C, Karavolos K, Sutton-Tyrell K, Jacobs E, Wesley D. Chronic exposure to everyday discrimination and coronary artery calcification in African-American women: the SWAN Heart Study. Psychosom Med. 2006; 68:362–368. [PubMed: 16738065]
17. Beatty Moody DL, Brown C, Matthews KA, Bromberger JT. Everyday discrimination prospectively predicts inflammation across 7-years in racially diverse midlife women: Study of Women's Health Across the Nation. J Soc Issues. 2014; 70:298–314. [PubMed: 25342861]
18. Ong AD, Williams DR, Nwizu U, Gruenewald TL. Everyday unfair treatment and multisystem biological dysregulation in African American adults. Cultur Divers Ethnic Minor Psychol. 2017; 23:27–35. [PubMed: 28045308]
19. Paradies Y, Ben J, Denson N, Elias A, Priest N, Pieterse A, Gupta A, Kelaher M, Gee G. Racism as a determinant of health: A systematic review and meta-analysis. PloS One. 2015; 10:e0138511. [PubMed: 26398658]
20. Cunningham TJ, Berkman LF, Kawachi I, Jacobs DR Jr, Seeman TE, Kiefe CI, Gortmaker SL. Changes in waist circumference and body mass index in the US CARDIA cohort: fixed-effect associations with self-reported experiences of racial/ethnic discrimination. J Biosoc Sci. 2013; 45:267–278. [PubMed: 22856616]
21. Schulz AJ, Gravlee CC, Williams DR, Israel BA, Mentz G, Rowe Z. Discrimination, symptoms of depression, and self-rated health among African American women in Detroit: results from a longitudinal analysis. Am J Public Health. 2006; 96:1265–1270. [PubMed: 16735638]
22. Gong F, Xu J, Takeuchi DT. Racial and ethnic differences in perceptions of everyday discrimination. Sociology of Race and Ethn. 2016 2332649216681587.
23. Lewis TT, Aiello AE, Leurgans S, Kelly J, Barnes LL. Self-reported experiences of everyday discrimination are associated with elevated C-reactive protein levels in older African-American adults. Brain Behav Immun. 2010; 24:438–443. [PubMed: 19944144]
24. Brondolo E, Love EE, Pencille M, Schoenthaler A, Ogedegbe G. Racism and hypertension: a review of the empirical evidence and implications for clinical practice. Am J Hypertens. 2011; 24:518–529. [PubMed: 21331054]
25. Lucas T, Wegner R, Pierce J, Lumley MA, Laurent HK, Granger DA. Perceived discrimination, racial identity, and multisystem stress response to social evaluative threat among African American men and women. Psychosom Med. 2017; 79:293–305. [PubMed: 27806018]
26. Rodriguez CJ, Gwathmey TM, Jin Z, Schwartz J, Beech BM, Sacco RL, Di Tullio MR, Homma S. Perceived discrimination and nocturnal blood pressure dipping among Hispanics: the influence of social support and race. Psychosom Med. 2016; 78:841–50. [PubMed: 27136505]
27. Owens SL, Hunte HER, Sterkel A, Johnson DA, Johnson-Lawrence V. Association between discrimination and objective and subjective sleep measures in the Midlife in the United States Study Adult Sample. Psychosom Med. 2017; 79:469–478. [PubMed: 28114149]

28. Groesz LM, McCoy S, Carl J, Saslow L, Stewart J, Adler N, Laraia B, Epel E. What is eating you? Stress and the drive to eat Appetite. 2012; 58:717–721. [PubMed: 22166677]
29. Torres SJ, Nowson CA. Relationship between stress, eating behavior, and obesity. Nutrition. 2007; 23:887–894. [PubMed: 17869482]
30. Gee GC, Ro A, Gavin A, Takeuchi DT. Disentangling the effects of racial and weight discrimination on body mass index and obesity among Asian Americans. Am J Public Health. 2008; 98:493–500. [PubMed: 18235065]
31. Hunte HE. Association between perceived interpersonal everyday discrimination and waist circumference over a 9-year period in the Midlife Development in the United States cohort study. Am J Epidemiol. 2011; 173:1232–1239. [PubMed: 21354988]
32. Hunte HE, Williams DR. The association between perceived discrimination and obesity in a population-based multiracial and multiethnic adult sample. Am J Public Health. 2009; 99:1285–1292. [PubMed: 18923119]
33. Krieger N. Discrimination and health inequities. Int J Health Serv. 2014; 44:643–710. [PubMed: 25626224]
34. Lewis TT, Cogburn CD, Williams DR. Self-reported experiences of discrimination and health: scientific advances, ongoing controversies, and emerging issues. Annu Rev Clin Psychol. 2015; 11:407–440. [PubMed: 25581238]
35. Gee GC, Ro A, Shariff-Marco S, Chae D. Racial discrimination and health among Asian Americans: evidence, assessment, and directions for future research. Epidemiol Rev. 2009; 31:130–151. [PubMed: 19805401]
36. Ayalon L, Gum AM. The relationships between major lifetime discrimination, everyday discrimination, and mental health in three racial and ethnic groups of older adults. Aging Ment Health. 2011; 15:587–594. [PubMed: 21815851]
37. Hunte HER, Williams DR. The association between perceived discrimination and obesity in a population-based multiracial and multiethnic adult sample. Am J Public Health. 2009; 99:1285–1292. [PubMed: 18923119]
38. Li LW, Dong X. Self-reported discrimination and depressive symptoms among older Chinese adults in Chicago. J Gerontol A Biol Sci Med Sci. 2017; 72:S119–S124. [PubMed: 28575255]
39. Hari P, Nerusu K, Veeranna V, Sudhakar R, Zalawadiya S, Ramesh K, Afonso L. A gender-stratified comparative analysis of various definitions of metabolic syndrome and cardiovascular risk in a multiethnic U.S. population. Metab Syndr Relat Disord. 2012; 10:47–55. [PubMed: 21999397]
40. McNeill AM, Rosamond WD, Girman CJ, Golden SH, Schmidt MI, East HE, Ballantyne CM, Heiss G. The metabolic syndrome and 11-year risk of incident cardiovascular disease in the atherosclerosis risk in communities study. Diabetes Care. 2005; 28:385–90. [PubMed: 15677797]

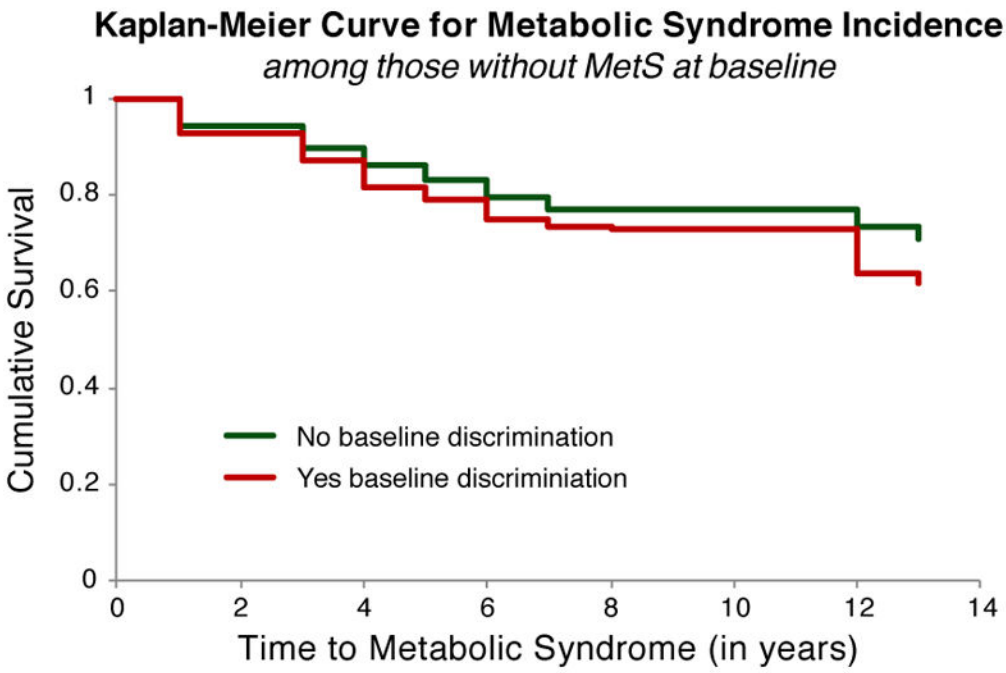

Figure 1.

Exposure to everyday discrimination reported at baseline was related to a 33% greater incidence of MetS over the follow-up (mean [SD] = 13.89 [3.83] years) in the full sample in fully adjusted models, this finding is illustrated here in Figure 1. Color version of figure is available only in online version of paper (www.psychosomaticmedicine.org).

Table 1

Baseline Characteristics of Women in the SWAN Study (N = 2,132)

		Black *n=523*		White *n=1,065*		Chinese *n=194*		Hispanic *n=123*		Japanese *n=227*		
		n	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***p-value***
Age, *M* (*SD*), y		45.6 (2.6)		45.8 (2.7)		45.9 (2.6)		45.6 (2.5)		46.3 (2.7)		.032
SES Variables												
Education	*≥college*	190	36.75	610	57.49	100	51.55	11	9.24	110	48.46	<.001
How Hard to Pay for Basics	*some/very hard*	216	41.62	295	27.80	51	26.29	91	76.47	68	30.09	<.001
Health Covariates												
Menopausal Status*	*early peri*	261	50.58	472	45.47	71	36.98	48	41.74	80	35.56	.001
	pre	255	49.42	566	54.53	121	63.02	67	58.26	145	64.44	.001
Heart Medication Use	*yes*	4	0.76	16	1.51	1	0.52	0	0.00	0	0.00	.196
Anticoagulant Medication Use	*yes*	3	0.57	4	0.38	0	0.00	0	0.00	1	0.44	.907
Behavior Variables												
Current Smoker	*yes*	108	21.01	136	12.79	3	1.55	19	15.45	27	12.00	<.001
Current Alcohol use	*yes*	237	45.32	703	66.07	41	21.24	71	57.72	102	45.54	<.001
Body Mass Index, *M (SD)*, kg/m^2		29.3	6.7	25.8	5.3	22.3	2.7	27.3	4.9	22.1	2.8	<.001
Physical Activity, *M (SD)*		7.4 (1.7)		8.3 (1.8)		7.3 (1.7)		6.8 (1.4)		7.9 (1.6)		<.001
Everyday Discrimination Measures **												
.. Continuous, *M* (*SD*)		19 (5.1)		16.6 (4.2)		18.4 (4.8)		12.1 (3.3)		15.7 (4.8)		<.001
.. Exposure	*yes*	335 (64.1)		457 (42.9)		113 (58.3)		32 (26.0)		80 (35.2)		<.001

*early peri = early perimenopausal status.

**Continuous everyday discrimination represents the sum of the score across the 10 items. Exposure to everyday discrimination reflects *greater exposure*, i.e., respondents replied “sometimes” or “often” to any of the 10 items (i.e., “yes”), whereas replying “never” or “rarely” to all of the items (i.e., “no”).

Table 2

Metabolic Components at Baseline and Metabolic Syndrome Incidence and Components Average Across 13 Year Follow-up for Women in the SWAN Study ($N = 2,132$)

		Black *n=523*		White *n=1065*		Chinese *n=194*		Hispanic *n=123*		Japanese *n=227*		
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*p-value*
Baseline												
MetS Components												
Waist Circumference, M (SD), cm		87.3	(13.9)	80.5	(12.4)	74.7	(7.7)	82.8	(10.4)	71.6	(6.6)	<.001
SBP, M (SD), mmHg		121.3	(19.2)	111.1	(12.6)	109.7	(13.3)	120.8	(10.3)	109. 6	(11.1)	<.001
DBP, M (SD), mmHg		75.0	(11.6)	72.1	(8.9)	70.9	(9.5)	80.0	(6.7)	74.6	(8.8)	<.001
Fasting Serum Glucose, M (SD), mg/dl		94.2	(22.7)	89.8	(13.5)	91.6	(8.4)	89.6	(17.6)	91.4	(7.5)	<.001
Serum Triglycerides, M (SD), mg/dl		81.2	(35.1)	89.4	(38.2)	93.7	(42.7)	103.1	(46.2)	98.8	(78.6)	<.001
HDL Cholesterol, M (SD), mg/dl		59.6	(13.5)	59.7	(13.7)	62.9	(11.9)	53.6	(10.5)	63. 7	(13.3)	<.001
Across Follow-up Period												
MetS Incidence	*yes*	205	39.2	273	25.6	45	23.2	46	37.4	55	24.2	<.001
MetS Components Average												
Waist Circumference, M (SD), cm		93.3	(14.5)	86.9	(13.7)	78.2	(9.4)	90.8	(13.7)	75.6	(9.2)	<.001
SBP, M (SD), mmHg		127.0	(17.3)	117.0	(14.6)	115.3	(12.5)	127.0	(15.7)	117.0	(16.9)	<.001
DBP, M (SD), mmHg		77.6	(10.2)	73.1	(9.0)	70.1	(8.2)	77.7	(9.1)	73.7	(9.6)	<.001
Fasting Serum Glucose, M (SD)		95.5	(27.7)	90.1	(16.2)	92.9	(14.3)	93.5	(20.7)	92.2	(10.8)	<.001
Serum Triglycerides, M (SD)		94.3	(41.8)	106.3	(50.2)	114.3	(53.1)	135.2	(109.1)	111.7	(61.1)	<.001
HDL Cholesterol, M (SD), mg/dl		64.0	(16.8)	67.4	(16.7)	69.9	(14.9)	56.5	(13.0)	70.1	(15.8)	<.001

Note: MetS = Metabolic Syndrome