Are there sociodemographic-specific associations of coping with heart disease and diabetes incidence?

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ABSTRACT

Objective: Psychological factors, including psychological distress and well-being, have been associated with cardiometabolic disease risk. Here, we examined whether a psychological process, namely how individuals cope with stressors, relate to such risk, which has been understudied. **Methods:** In 2004-2006, 2,142 participants without heart disease and diabetes from the Midlife in the U.S. study completed a validated coping inventory assessing six strategies (Positive Reinterpretation & Growth, Active Coping, Planning, Focus on & Venting of Emotion, Denial, Behavioral Disengagement) and relevant covariates. As a proxy for coping flexibility, participants were also classified as having lower, moderate, or greater variability in their use of these strategies. Heart disease and diabetes were documented in 2013-2015. Logistic regressions modeled adjusted odd ratios (AOR) and 95% confidence intervals (CI) of developing heart disease and diabetes, separately, with coping exposures. **Results:** In sociodemographics-adjusted models, greater use of adaptive strategies predicted lower diabetes risk (e.g., Positive Reinterpretation & Growth: AOR=0.83; 95%CI=0.72-0.96); estimates were weaker for maladaptive strategies, and all strategies were unrelated to heart disease. All associations for coping variability were null. In secondary analyses, greater use of adaptive strategies predicted lower heart disease risk in more educated participants only (e.g., Active Coping: AOR=0.71; 95%CI=0.55-0.92) and lower diabetes risk in females only (e.g., Planning: AOR=0.75; 95%CI=0.61-0.91). Results were maintained additionally adjusting for health, behavioral, and social factors. **Conclusions:** Findings suggest sex and education differences in coping's association with heart disease and diabetes. Future studies should recognize adaptive strategies may be more potent for health among certain populations.

Public significance: Despite convincing evidence linking stressors and psychological distress to cardiometabolic disease risk, this is the first study examining the role of stress-related coping strategies and variability in their use in the onset of heart disease and diabetes. Results suggest

the associations of coping with these conditions vary by sex and education levels, which underscores the importance of evaluating psychosocial interventions that are sociodemographic-specific to possibly prevent heart disease and diabetes.

Keywords: coping, coping variability, cardiometabolic risk, diabetes, heart disease

INTRODUCTION

Cardiometabolic diseases (CMD), including heart disease and type II diabetes, are among the leading causes of death in the U.S. Many risk factors for CMD are non-modifiable characteristics including age and family history, and risk-related behaviors like physical inactivity and smoking can be difficult to alter (Centers for Disease Control and Prevention, 2022a, 2022b). Hence, the identification of additional modifiable risk factors would provide further strategies for improving population health. Accordingly, a 2021 scientific statement by the American Heart Association highlights documented relationships between specific psychosocial factors and cardiometabolic health (Levine et al., 2021). For instance, many studies have shown positive associations of chronic stressors (e.g., discrimination) and psychological distress (e.g., anxiety) with higher CMD risk, while greater levels of psychological well-being have been associated with lower CMD risk (Cohen et al., 2015; Hackett & Steptoe, 2016; Trudel-Fitzgerald et al., 2017). However, limited work has investigated the relationship of CMD outcomes with psychological *processes*, such as *how* individuals handle stressful situations and modulate related distress and well-being levels (Trudel-Fitzgerald et al., 2024). Such research is critical because psychological regulatory processes like stress-related coping may be a transdiagnostic, more cost-effective intervention target to prevent CMD than separately addressing stressors, distress, and well-being (Trudel-Fitzgerald et al., 2024).

Broadly, coping is conceptualized as a regulation process that occurs in response to stressors and aims to modulate related psychological responses (e.g., anxiety). Coping strategies are typically conceptualized as being adaptive (e.g., Active Coping) or maladaptive (e.g., Denial) based on the direction of their associations with physical and mental health outcomes in prior work (Carver et al., 1989; Kato, 2015). For example, a meta-analytic review indicated that greater use of planning to cope with stressors, a strategy often deemed adaptive, was indeed related to better physical functioning, whereas greater self-blame, usually deemed maladaptive, was strongly related to poorer psychological functioning (Penley et al., 2002).

Several studies have also theorized that the impact of any coping strategy may depend on the context in which it is employed, rather than an inherent categorization as adaptive or maladaptive (Cheng et al., 2014); thus, the same coping strategy may be adaptive or maladaptive in different contexts. Optimal psychological adjustment may be characterized by coping flexibility, or the ability to select coping strategies that best fit a given situation rather than solely using one type of strategies regardless of the situation. Coping flexibility has been operationalized in prior work by measuring the level of *variability* between distinct strategies used across multiple situations, which may range from lower (less *variability*) to greater (more *variability)* (Blanke et al., 2020; Cheng et al., 2014). Previous work suggests that more coping variability is related to better psychological adjustment (Cheng et al., 2014), but less work has considered associations with physical health outcomes. Additionally, as most of these studies have been lab-based or involved repeated daily assessments over relatively short periods of time (Cheng, 2001; Cheng et al., 2014), it remains unclear if coping variability levels predict long-term health outcomes. A recent longitudinal study examined dispositional coping variability captured at one time point, hence reflecting the extent to which strategies chosen within one's repertory are (un)equally used across multiple and varied situations (Trudel-Fitzgerald et al., 2022). Results showed that greater versus moderate variability levels were related to 15% shorter lifespan in 4398 aging adults over 12-14 years of follow-up, suggesting the value of further research on long-term health consequences of distinct coping variability levels.

Despite the longstanding literature linking stressors, distress, and more recently, well-being to CMD risk, few studies have examined relations of the use of adaptive and maladaptive coping strategies with CMD risk. In a prospective cohort in Iran, 6323 adults aged 35-60 years reported how often they used 10 adaptive (e.g., Positive Self-instruction) and 20 maladaptive (e.g., Passive Avoidance) coping strategies (Roohafza et al., 2022). Participants were classified as having higher versus lower use of adaptive or maladaptive strategies, separately, based on an algorithm reflecting the proportion of strategies mainly used. Over 15 years of follow-up, individuals with higher versus lower use of adaptive strategies had 3% lower heart disease risk (hazard ratio, HR=0.97, 95% CI, CI=0.95-0.99), while individuals with higher versus lower use of maladaptive strategies had 2% higher heart disease risk (HR=1.02, 95%CI=1.01-1.04) after adjusting for numerous covariates including sociodemographics, behavioral factors, and initial health status. Another prospective study considered three adaptive and three maladaptive coping strategies individually (i.e., Planning, Consulting Someone, Positive Reappraisal; Fantasizing, Avoidance, Self-Blame) with heart disease incidence and mortality, among 57,017 Japanese adults aged 50-79 years over 8 years of follow-up (Svensson et al., 2016). After adjusting for multiple covariates, using fantasizing (versus not) was related to a 24% increased risk of developing heart disease (HR=1.24, 95%CI=1.03-1.50), whereas using positive reappraisal (versus not) was related to 37% decreased risk of ischemic heart disease mortality (HR=0.63, 95%CI=0.40-0.99). Other coping strategies assessed were not clearly related to these endpoints. While informative, these results may not be generalized to other populations, including U.S. adults, and leave unclear the role of distinct coping strategies and variability in their use in the onset of CMD, including type II diabetes (thereafter labeled “diabetes”).

The present study examined associations of individual coping strategies and coping variability in their use, characterized at one time-point and reflecting a general tendency or disposition, with the risk of developing heart disease and diabetes, separately, using longitudinal data from the Midlife in the United States (MIDUS) study. We hypothesized coping strategies characterized as adaptive would be associated with lower likelihood, and strategies characterized as maladaptive would be associated with higher likelihood of developing these diseases, separately. Given limited prior work regarding the relationship between coping variability and physical health outcomes (Cheng et al., 2014; Svensson et al., 2016; Trudel-Fitzgerald et al., 2022), we examined this association in an exploratory way, without *a priori* hypotheses. Following past research suggesting women tend to engage in a greater number of coping strategies and individuals with lower financial resources discontinue the use of certain strategies, like active coping, over time (Brennan et al., 2012; Carver et al., 1989), we also investigated sex and education level as potential moderators. We used educational level as a proxy for financial resources because education can provide a more valid measure than other, more directly measured, financial variables like household income, which may change substantially from year to year and often have a high level of non-response on surveys (Moore et al., 1999). All analyses adjusted for traditional sociodemographic covariates and initial health status (e.g., hypertension, obesity) to mitigate concerns about confounding and reverse causality. Because behavioral factors were captured as general lifestyle habits (e.g., smoking status) rather than stress-related coping strategies in MIDUS (e.g., frequency of smoking cigarettes to reduce anxiety), we included them as covariates in exploratory models.

METHOD

Transparency and Openness

In this article, we met the following TOP standards: Citations Standards, Level 2: Data. Relevant calculations developed by other teams are appropriately cited in the manuscript. Data Transparency, Level 1: MIDUS data is publicly available at www.icpsr.umich.edu/web/ICPSR/series/203. Analytic Methods (Code) Transparency, Level 2: The computer code needed to reproduce the major analyses is available in Suppl. Text 1. Research Materials Transparency, Level 2: MIDUS questionnaires can be accessed at www.icpsr.umich.edu/web/ICPSR/series/203. Reporting Standards; Design and Analysis Transparency, Level 2: the STROBE checklist for observational studies is available in Suppl. Text 2. Preregistration of Studies, Level 2: This study was not preregistered. Preregistration of Analysis Plans, Level 2: These analyses were not preregistered. Replication, Level 1: This study is not a replication study.

Study Sample

The MIDUS study is a national cohort of non-institutionalized English-speaking adults between the ages of 25-74 at the study onset, recruited through random-digit-dialing. Once selected, participants were interviewed at three separate time points: MIDUS I (N=7,108; 1995-

1996), MIDUS II (N=4,963; 2004-2005; 70% response rate from MIDUS I), and MIDUS III (N=3,294; 2013-2015; 66% response rate from MIDUS II). The study was approved by the Institutional Review Board at all participating centers, and written informed consent was obtained from all participants.

For each assessment, data were collected via phone interview and a mailed self-administered questionnaire. Because coping was first queried at MIDUSII, this served as the study's analytic baseline. As depicted in Suppl. Figure 1, participants were excluded if they were missing data on coping (n=538), heart disease (n=1,574), diabetes (n=237), or the clustering variable (which accounts for whether participants belonged to the same family; n=0). We further excluded participants who reported having heart disease or diabetes at the analytic MIDUSII baseline (n=445), resulting in an analytic sample of 2,142 participants. Multiple imputation using 15 imputed datasets was used to account for missing data for all covariates (with most covariates missingness ranging from 0.001% to 5.7%) (Bodner, 2008). Compared to participants included in our main analytic sample, those who were excluded (n=2,821) were slightly older, generally less educated, as well as more likely to be men, non-White, have hypertension or high cholesterol, and be former smokers (Suppl. Table 2).

Measures

Coping. At MIDUSII in 2004-2006, participants completed a modified version of the 60-item Coping Orientation to Problems Experienced (COPE) inventory (Carver et al., 1989), which describes how someone typically manages stressful events, or dispositional coping. This version includes 24 items categorized into 6 subscales that represent distinct strategies: Active Coping, Planning, Positive Reinterpretation & Growth, Focus on & Venting of Emotions, Denial, and Behavioral Disengagement (Carver et al., 1989). The first three strategies are generally characterized as more adaptive, while the other three strategies are generally characterized as maladaptive. Each subscale had acceptable internal consistency in our analytic sample (α=0.73-0.84; Suppl. Table 3). Across subscales, item scores were coded and summed to create a total score ranging from 4 to 16, with higher scores indicating greater use of the strategy. To facilitate comparison with prior studies, each total subscale score was then standardized using *z* scores. For conceptual reasons explained elsewhere (Trudel-Fitzgerald et al., 2022) and following the latest recommendations from the COPE lead author (Carver, 2019), all subscales were considered individually in analyses.

To operationalize coping variability, we used an algorithm adapted from prior research (Blanke et al., 2020) and recently validated in MIDUSII (Trudel-Fitzgerald et al., 2022) to obtain the dispositional Between-Strategy Index (calculations in Suppl. Text 2). Because the coping scale administered in MIDUSII captures how individuals cope in general, or habitually, rather than in specific situations, this measure of between-strategy variability indicates the extent to which strategies chosen within one's repertory are (un)equally used across multiple and varied situations, in a dispositional manner (Blanke et al., 2020; Trudel-Fitzgerald et al., 2022). Thus, individuals reporting lower variability are more likely to use all strategies in their repertory to a similar extent across situations (displaying high evenness in their use of different coping strategies), whereas those reporting greater variability are more likely to use some strategies and rarely use others (displaying high unevenness across strategies used). By contrast, those categorized with moderate variability are likely to engage in several or many strategies with varied frequency across situations, which may reflect efforts to find the best strategy for each given context (displaying moderate unevenness across strategies used) (Blanke et al., 2020).

Following recent research (Trudel-Fitzgerald et al., 2022), we created tertiles of the dispositional Between Strategy Index (lower, moderate, greater) based on the distribution of scores in the sample to facilitate examination of potential threshold effects (Aldao et al., 2015; Cheng et al., 2014). Of note, characterizing coping variability according to a standard deviation (*SD*) score can be confounded by the average score of all strategies favored (Blanke et al., 2020); said differently, individuals with consistently low or high mean scores across all strategies cannot display high levels of variability due to floor or ceiling effects. Therefore, following prior research (Blanke et al., 2020; Trudel-Fitzgerald et al., 2022), we further controlled for mean strategy use score in all models to assess whether coping variability, beyond the average use score across strategies, would relate to CMD risk.

Cardiometabolic Diseases. Heart disease and diabetes were self-reported at the 2013-2015 follow-up. Such self-reported health measures have been found reliable and valid when compared with physical measures and medical records (Kim et al., 2014; Okura et al., 2004). Participants were classified as having heart disease if they indicated they (i) ever had a heart attack, coronary heart disease, ischemia, heart failure, or stroke, or (ii) took prescription medicine for a heart condition in the past 30 days, as well as if myocardial infarction or stroke was listed as cause of death via the National Death Index until 2018. Participants were classified as having diabetes if they indicated they (i) experienced or were treated for diabetes in the past twelve months or ii) took prescription medication for diabetes in the past 30 days.

Covariates. Covariate measures, selected following previous research (Roohafza et al., 2022; Svensson et al., 2016; Trudel-Fitzgerald et al., 2022), are described in more detail in Suppl. Text 3. Briefly, sociodemographic characteristics (i.e., age, biological sex, race, marital status, education levels), health status (i.e., hypertension, cholesterol, obesity), behavioral factors (i.e., physical activity, smoking, alcohol consumption, sleep duration), and social factors (positive relations with others) (Ryff, 2014) were self-reported at the 2004-2006 analytic baseline. Because behavioral and social factors may be coping strategies themselves, we considered their role by further adjusting for them in exploratory analyses.

Statistical Analysis

Descriptive Statistics. All statistical analyses were conducted using SAS 9.4, with a two-tailed $p < 0.05$ threshold, to ease comparison with prior studies using a similar methodology (Roohafza et al., 2022; Svensson et al., 2016; Trudel-Fitzgerald et al., 2022). We calculated the mean and standard deviation for all continuous variables, and frequencies for all categorical variables in the analytic sample (n=2,142), overall and stratified by coping variability level. We also computed Pearson and Spearman correlations across the COPE subscales to determine the strength of associations between constructs. Pearson correlations were also computed to examine the strength of the association between individual COPE strategy scores obtained at MIDUS II and MIDUS III. Lastly, we performed a factorial analysis to ensure that the six strategies would load on two distinct factors in our analytic sample, hence reflecting more versus less adaptive strategies (Active Coping, Planning, and Positive Reinterpretation & Growth versus Focus on & Venting of Emotions, Denial, and Behavioral Disengagement).

Primary models. We first conducted a series of sequentially adjusted logistic regression models estimating odds (Adjusted Odd Ratios; AOR) of developing heart disease and diabetes, separately, during the 8-14 years of follow-up by 1 standard deviation (SD) increase in each individual coping strategy used. The first model was age-adjusted, and the second, core model further controlled for sociodemographics. A third model added initial health status. Behavioral factors were then included in an exploratory fourth model. An exploratory Model 5 included all sociodemographic factors, initial health status, and positive relations with others. These five models were repeated with coping variability as a categorical exposure (looking at all contrasts).

Secondary models. To account for the comorbidity of heart disease and diabetes in 39 participants who had developed both conditions between MIDUSII and MIDUSIII, we first conducted a sensitivity analysis removing these participants, using core Model 3. Then, based on previous work (Brennan et al., 2012; Carver et al., 1989), we conducted stratified analyses to evaluate the association between individual coping strategies and CMD risk in each biological sex (males versus females) and education (some college or below versus Bachelor's degree or higher) subgroups, separately, while adjusting for all sociodemographic variables (core Model 2). We also included interaction terms of each coping strategy with sex and education subgroups, separately, in Model 2. Coping variability was not examined in stratified analyses due to the limited statistical power in some strata.

RESULTS

Baseline characteristics

Descriptive statistics in the total analytic sample (N=2,142) and stratified by coping variability levels are displayed in Table 1. Overall, participants were on average 53.9 years at our study baseline (SD=10.9), and most were White (93.5%), married (72.5%) and had attended at least some college (75.7%). Participants were moderately active (summary score detailed in Suppl. Text 3; M=29.6, range=9-54), and the majority were never or former smokers (81.4%) and moderate drinkers (43.8%), which is the alcohol intake level advised by disease prevention guidelines (US Department of Health and Human Services & US Department of Agriculture, 2020) and noted in prior empirical evidence (Chiuve et al., 2008; Roth et al., 2020). Characteristics were similar across coping variability levels, except for marital status, sleep duration, physical activity, and positive relations with others; participants with greater variability levels were less likely to be married, to be good sleepers (7-8 hours/night), to have a somewhat lower level of physical activity and positive relations with others ($p \leq 0.05$), although the two former differences are unlikely to be clinically significant.

Nearly all coping strategies were significantly correlated with one another; the magnitude of these associations varied widely ($|r|$=.07 to .81; Suppl. Table 3). Coping strategies generally deemed adaptive were inversely and modestly correlated with maladaptive ones. Except for Denial, scores from all individual coping strategies were moderately to strongly correlated between MIDUS II and MIDUS III (r=.49 to .62; Suppl. Table 4), suggesting stability between waves and, thus, reinforcing their dispositional nature. Lastly, and as expected, in this analytic sample Active Coping, Planning, and Positive Reinterpretation & Growth strategies load onto the same factor (values from 0.70 to 0.86) while Focus on & Venting of Emotions, Denial, and Behavioral Disengagement load onto a distinct factor (values from 0.48 to 0.64; Suppl. Table 5).

Coping Strategies and Variability with Heart Disease and Diabetes Onset

Over the 8- to 14-year follow-up period, 10.3% of participants reported developing heart disease (n=221) and 8.5% of participants reported developing diabetes (n=181). Only 39 participants had developed both conditions at the end of follow-up. Age-adjusted analyses showed no association of adaptive and maladaptive strategies, separately, with likelihood of developing heart disease (Table 2). Estimates remained null when further adding sociodemographic (core Model 2), health status (Model 3), behavioral covariates (Exploratory Model 4), and social support (Exploratory Model 5). Across models, coping variability levels were also unrelated with heart disease incidence.

Results from models evaluating the odds of developing of diabetes are presented in Table 3. In age-adjusted models, all three adaptive strategies –namely Positive Reinterpretation & Growth, Active Coping, and Planning– were associated with a lower likelihood of developing diabetes. For instance, each 1-SD increase in Active Coping was related to a 19% (AOR=0.81, 95%CI=0.71-0.94) lower odds of diabetes incidence. Estimates were generally maintained after further adjusting for sociodemographic, health, behavioral, and social covariates. Regarding maladaptive strategies, in age-adjusted models, a 1-SD increase in Denial was related to 17% (AOR=1.17, 95%CI=1.01-1.36) increased odds of developing diabetes. After further adjustment for sociodemographic, and then health status and behavioral and social covariates, this association was slightly attenuated. Similar to findings with heart disease, coping variability levels were not associated with likelihood of developing diabetes. In sensitivity analyses, results for both incident heart disease and diabetes, separately, remained overall robust after excluding participants who had developed both conditions over the follow-up period (Suppl. Table 6).

Differences by Biological Sex and Education

Several, although not all, interaction terms between coping strategies and sex, and coping strategies and education, reached statistical significance when included in Model 2 for each outcome (Suppl. Table 7). More specifically, for heart disease, tests of interaction were significant between education levels and all three adaptive coping strategies (i.e., Positive Reinterpretation & Growth, p=.01; Active Coping, p<.01; Planning, p=.01). For diabetes, only the test of interaction between sex and Planning reached statistical significance (*p*=.03). None of the interaction terms with maladaptive coping strategies were statistically significant.

In stratified models adjusting for all sociodemographics, adaptive strategies were all associated with reduced odds of developing heart disease among more educated individuals only (Figure 1, Suppl. Table 7). For example, each 1-SD increase in Active Coping was related to a 29% (AOR=0.71, 95%CI=0.55-0.92) lower odds of developing heart disease in this group but was unrelated to the outcome in less educated participants. Males versus females only differed in the association of Positive Reinterpretation & Growth with heart disease (AOR_{males}=1.27, 95%CI=1.01-1.61; $AOR_{females}$=0.87, 95%CI=0.72-1.07). No difference in estimates for maladaptive strategies were noted across either the two education groups, or males and females in relation to heart disease. Considering diabetes (Figure 2, Suppl. Table 7), both sex and education levels appeared to modify the association between adaptive but not maladaptive coping strategies and odds of incident disease. For instance, compared to males or more educated individuals, females and less educated individuals had a 25% ($AOR_{females}$=0.75, 95%CI=0.61-0.91) and 19% ($AOR_{lower\ education}$=0.81, 95%CI=0.68-0.97) lower odds of developing diabetes, with each 1-SD increase in Planning.

DISCUSSION

This study examined associations of individual coping strategies and variability in their use with risk of developing heart disease and diabetes, separately. Findings showed a 14-17% lower likelihood of developing diabetes with greater use of adaptive strategies (i.e., Positive Reinterpretation & Growth, Active Coping, and Planning) after adjusting for sociodemographic covariates; associations were only slightly attenuated after further inclusion of health status as well as behavioral and social covariates in the models. Similar odds ratios for the active coping and planning adaptive strategies may suggest that these strategies are often used together, as part of an overall problem-solving approach, whereby planning is first implemented and then active coping is executed. Accordingly, results from correlation matrix showed that these two strategies were highly correlated (*r* = .81) and those from the factor analysis indicated that they load similarly onto the same factor, as found in another recent MIDUS study (Nikolaev et al., in press). Yet, from a theoretical perspective, these two strategies remain distinct, as planning represents a cognitive strategy that would happen at the secondary appraisal phase of the stress process, when evoking a possible response to a stressor, whereas active coping reflects an executive strategy that would be implemented subsequently, at the coping phase, when implementing that response (Carver et al., 1989; Lazarus & Folkman, 1984).

Conversely, strategies deemed maladaptive were not as strongly related to disease risk, although associations were sometimes suggestive. However, all estimates from the main models were null for heart disease incidence, and we did not observe associations for coping variability with either outcome. Yet, secondary analyses suggested a protective effect of adaptive coping strategies among certain sociodemographic subgroups. Specifically, employing adaptive strategies was associated with up to 29% lower odds of developing heart disease among more but not less educated individuals. Also, adopting these strategies was related to up to 19-25% lower likelihood of developing diabetes in females and less educated individuals. Although not all interaction terms were statistically significant, the fact that estimates of all three adaptive coping strategies were consistently protective and at least marginally significant in some subgroups but not others is indicative of a possible true effect. No evidence of effect modification between maladaptive coping strategies and either sex or education was observed.

To our knowledge, no study has examined the role of coping strategies in risk of developing diabetes. Consistent with our hypotheses, adaptive strategies were associated with a lower likelihood of disease onset. Although maladaptive strategies were not as clearly related, estimates for disease onset were in the expected direction albeit generally weaker. Moreover, our results are consistent with prior research showing altered diabetes risk with psychological well-being, including life satisfaction and optimism (Boehm et al., 2015; Okely & Gale, 2016), and psychological distress (Hackett & Steptoe, 2016), respectively, in the expected directions.

Conversely, our findings with heart disease appeared at first unexpected. In fact, previous studies have shown associations of certain adaptive and maladaptive coping strategies (but not all) with the risk of heart disease-related events (Roohafza et al., 2022; Svensson et al., 2016).

However, stratified analyses provided important insight, with findings suggesting that adaptive coping strategies could have a protective effect on heart disease onset, but only among more educated individuals. Also worth noting is that we found greater use of adaptive strategies was related to a slightly *increased* odds of developing heart disease incidence in less educated individuals. It is possible that with more education, individuals also acquire additional cognitive resources that facilitate more effectively implementing strategies like positive reinterpretation or problem-solving; greater effectiveness in implementation may increase the probability that these adaptive strategies positively influence heart health. Conversely, these same strategies may not be implemented as effectively by less educated individuals or they may require an additional cognitive load that, over time, taxes their bodily systems and results in an increased disease risk (Felix et al., 2019). Beyond these individual factors, structural forces may be at play too. For instance, less educated individuals can live in under-resourced neighborhoods (e.g., limited or lack of access to psychosocial services) or experience discrimination that may be upstream barriers to implementing these adaptive strategies effectively (Felix et al., 2019). It is also possible that less educated individuals face financial barriers that constrain their access to health care, which may shape both how they cope with stressors and their heart disease risk in the longer term. A last alternative explanation may be that these are spurious findings; yet, the consistency of direction and magnitude of estimates across all three adaptive strategies makes this idea seem somewhat less likely.

While education level also seemed to matter with regard to associations of coping strategies with odds of developing diabetes, findings were not in the same direction as those with heart disease. Stratified analyses indicated that less rather than more educated participants benefited from adaptive coping strategies. Because diabetes is a risk factor for heart disease and typically develops earlier in life (Martin-Timon et al., 2014), it is possible that psychological factors that are beneficial in the shorter term for diabetes onset become detrimental over a longer period of time for heart disease onset. For instance, less educated individuals might be as effective as their more educated counterparts at actively coping with a stressor, which yields cardiometabolic benefits in the shorter term, but because the implementation of such strategy may require greater effort for less educated individuals, later on it might bear a hidden cost. Similarly, divergent effects by education or socioeconomic status over time have been noted in prior studies investigating the health impacts of individuals exhibiting favorable psychological functioning despite exposure to social stressors (Chen & Miller, 2012; DeFrance et al., 2022; Trudel-Fitzgerald & Ouellet-Morin, 2022). In models stratified by sex, adaptive coping strategies appeared protective against diabetes and heart disease onset in females but not males, although the magnitude of the diabetes estimates for some coping strategies were not drastically different between the two groups. Moreover, the sample size and incident cases were comparable across males and females, reducing concerns about insufficient statistical power. This trend is aligned with some (Demmer et al., 2015; Farvid et al., 2014), although not all (Boehm et al., 2015; Okely & Gale, 2016), previous findings from studies that have found suggestive sex differences in the role of psychological factors as determinants of diabetes onset. Additionally, since heart disease symptomatology in females may look different compared to men (e.g., back pain besides chest pain) (Centers for Disease Control and Prevention, 2022c), predictors of disease may differ too.

Biological, behavioral, and social pathways may explain the observed relationships of individual adaptive coping strategies and CMD incidence. Evidence suggests that inflammation and hypertension may be pathways linking psychological factors to long-term heart outcomes (Hackett & Steptoe, 2016; Trudel-Fitzgerald et al., 2017), and greater psychological well-being and stress resilience may be related to healthier levels of blood pressure and cholesterol over time (Boylan & Ryff, 2015; Crump et al., 2016; Radler et al., 2018; Trudel-Fitzgerald et al., 2014). When further controlling for hypertension, high cholesterol, and obesity in our third model, the estimates were sometimes attenuated, suggesting that such biological processes may confound or lie on the pathway of the coping-CMD association in our sample. However, as health status (and behaviors) were not available between the 2004-2006 analytic baseline and the 2013-2015 follow-up assessment, we could not rigorously evaluate them as mechanistic pathways of the coping-CMD relationship.

Maladaptive coping strategies may also lead to stress-relieving behaviors like smoking, physical inactivity, alcohol use, and longer sleep, which may in turn affect an individual's risk for CMD (Park & Iacocca, 2014; Trudel-Fitzgerald et al., 2017); in parallel, adaptive strategies like active coping may necessitate social support, which consequently alter CMD risk. Yet, determining the contribution of behaviors and social support in coping studies specifically is difficult, because such factors can be coping strategies themselves (Mezuk et al., 2013; Park & Iacocca, 2014). Our exploratory analyses found that additional adjustment for behavioral and social factors did not attenuate the coping-CMD associations. It is also worth noting that, in MIDUS, behavioral and social factors are queried as habitual rather than coping-motivated habits (e.g., *"Do you smoke cigarettes regularly now?"* versus "*Do you smoke to relieve tension?*"; "*I know that I can trust my friends, and they know they can trust me.*" versus "*Do you rely on your social relationships to handle stressors?"*). Given some participants may not even realize their motivation (Sheeran et al., 2013) for adopting certain behaviors, future research should pinpoint the reasons behind specific behaviors, including seeking social support, and whether this distinction may alter disease onset.

Several limitations of this study should be noted. First, given the dispositional nature of the COPE inventory, we did not have information about the characteristics of stressful events (e.g., frequency, severity, chronicity) that serve as the context for coping, which can vary across participants. Second, by using observational data, we cannot infer causality. Third, due to sample size, we were unable to examine coping variability within stratified analyses, or test associations within racial subgroups. Moreover, because non-Hispanic White individuals and those of higher socioeconomic status are over-represented MIDUS compared to the U.S. population, our results may not be generalizable to other, more diverse samples. Fourth, this modified COPE version captured only six coping strategies at one time point, which prevented the investigation of whether other ways individuals cope with stressors (e.g., use of religion/spirituality, self-blame) influence CMD incidence and the examination of dynamic changes in strategies used at a more granular level (e.g., within-strategy variability across days/stressors) (Blanke et al., 2020). Yet, even a single dispositional coping assessment can be informative when investigating long-term health outcomes (Lazarus, 1990) as they capture relatively stable phenomenon over time. Given that CMD were self-reported, either as a diagnosis received or medication taken, our study may be vulnerable to outcome misclassification. However, given previous work showing high concordance between self-reported CMD and medical records (Kim et al., 2014; Okura et al., 2004), such effects are unlikely to fully explain our findings. Lastly, we acknowledge that some of our subgroup analyses have a limited number of cases, and thus may be underpowered to detect small but existing effects for maladaptive strategies and coping variability.

Nonetheless, several strengths are worth noting. First, we considered multiple individual coping strategies using a validated measure, which helps identify specific promising avenues for psychosocial intervention research. Second, we further explored coping variability as a proxy for how flexibly individuals use these strategies across contexts, which allowed us to provide a more holistic image of these complex regulatory processes rather than solely considering coping strategies as either adaptive or maladaptive. Lastly, we used a richly characterized cohort and could therefore account for multiple established factors that may either confound or explain the coping-CMD association.

To our knowledge, this is the first study to examine associations of individual coping strategies and variability in their use with heart disease and diabetes incidence. Our main findings found linkages of certain adaptive coping strategies with reduced odds of diabetes and of some maladaptive strategies with suggestive but weaker increased odds of diabetes. Somewhat surprisingly, we found no evidence of relationships between any coping exposures and heart disease incidence. Yet, secondary analyses further highlighted the importance of investigating these associations across various sociodemographic subgroups, with evidence suggesting for instance that adaptive coping strategies may be protective against heart disease among more educated individuals particularly.

Future research should focus on replicating within more diverse populations to evaluate, for instance, the presence of racial/ethnic differences in the coping-CMD relationship. Larger samples will also permit the examination of coping variability levels across distinct subgroups. In fact, while variability levels were unrelated to CMD outcomes in our overall sample, they might be predictive of CMD for certain subpopulations, as observed with our heart disease findings. A last promising avenue is triangulation, whereby researchers should seek to obtain concordant findings about the coping-CMD relationship with complementary methods. For example, future studies may focus on established and novel CMD-relevant biomarkers (e.g., inflammation, metabolomics) to capture biological precursors of CMD (Trudel-Fitzgerald et al., 2017). Others might leverage repeated assessments of coping strategies used to deal with daily hassles, which have been shown to capture complementary information (i.e., low-to-moderate correlations) relative to dispositional coping scales (Stone et al., 1998). Building such empirical evidence appears promising: given that many CMD risk factors are non-modifiable, how individuals typically cope with stressors –a modifiable process and a universal human experience–, and in turn modulate their psychological distress and well-being levels, may be a meaningful and more cost-effective intervention target to bolster CMD prevention efforts, rather than targeting stressors, distress, and well-being separately.

References

Aldao, A., Sheppes, G., & Gross, J. J. (2015). Emotion regulation flexibility. *Cognitive Therapy and Research*, *39*, 263–278. https://doi.org/10.1007/s10608-014-9662-4

Blanke, E. S., Brose, A., Kalokerinos, E. K., Erbas, Y., Riediger, M., & Kuppens, P. (2020). Mix it to fix it: Emotion regulation variability in daily life. *Emotion*, *20*(3), 473-485. https://doi.org/10.1037/emo0000566

Bodner, R. E. (2008). What improves with increased missing data imputations? *Structural Equation Modeling: A Multidisciplinary Journal*, *15*(4), 651-675. https://www.tandfonline.com/doi/abs/10.1080/10705510802339072

Boehm, J. K., Trudel-Fitzgerald, C., Kivimaki, M., & Kubzansky, L. D. (2015). The prospective association between positive psychological well-being and diabetes. *Health Psychol*, *34*(10), 1013-1021. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=25603420

Boylan, J. M., & Ryff, C. D. (2015). Psychological well-being and metabolic syndrome: Findings from the midlife in the United States national sample. *Psychosom Med*, *77*(5), 548-558. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=25984827

Brennan, P. L., Holland, J. M., Schutte, K. K., & Moos, R. H. (2012). Coping trajectories in later life: A 20-year predictive study. *Aging Ment Health*, *16*(3), 305-316. https://doi.org/10.1080/13607863.2011.628975

Carver, C. S. (2019). *Self-reported measures available: COPE*. Retrieved August, 2020 from https://local.psy.miami.edu/people/faculty/ccarver/availbale-self-report-instruments/cope/

Carver, C. S., Scheier, M. F., & Weintraub, J. K. (1989). Assessing coping strategies: A theoretically based approach. *J Pers Soc Psychol*, *56*(2), 267-283. https://doi.org/10.1037//0022-3514.56.2.267

Centers for Disease Control and Prevention. (2022a). *Diabetes and prediabetes*. https://www.cdc.gov/chronicdisease/resources/publications/factsheets/diabetes-prediabetes.htm

Centers for Disease Control and Prevention. (2022b). *Heart disease facts*. https://www.cdc.gov/heartdisease/facts.htm

Centers for Disease Control and Prevention. (2022c). *Women and heart disease*. https://www.cdc.gov/heartdisease/women.htm

Chen, E., & Miller, G. E. (2012). "Shift-and-Persist" strategies: Why low socioeconomic status isn't always bad for health. *Perspectives on Psychological Sciences*, *7*(2), 135-158. https://doi.org/10.1177/1745691612436694

Cheng, C. (2001). Assessing coping flexibility in real-life and laboratory settings: A multimethod approach. *J Pers Soc Psychol*, *80*(5), 814-833. https://doi.org/10.1037//0022-3514.80.5.814

Cheng, C., Lau, H. P., & Chan, M. P. (2014). Coping flexibility and psychological adjustment to stressful life changes: A meta-analytic review. *Psychol Bull*, *140*(6), 1582-1607. https://doi.org/10.1037/a0037913

Chiuve, S. E., Rexrode, K. M., Spiegelman, D., Logroscino, G., Manson, J. E., & Rimm, E. B. (2008). Primary prevention of stroke by healthy lifestyle. *Circulation*, *118*(9), 947-954. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=18697819

Cohen, B. E., Edmondson, D., & Kronish, I. M. (2015). State of the art review: Depression, stress, anxiety, and cardiovascular disease. *American Journal of Hypertension*, *28*(11), 1295-1302. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=25911639

Crump, C., Sundquist, J., Winkleby, M. A., & Sundquist, K. (2016). Low stress resilience in late adolescence and risk of hypertension in adulthood. *Heart*, *102*(7), 541-547. https://doi.org/10.1136/heartjnl-2015-308597

DeFrance, K., Evans, G. W., Brody, G. H., & Doan, S. N. (2022). Cost of resilience: Childhood poverty, mental health, and chronic physiological stress. *Psychoneuroendocrinology*, 105872. https://doi.org/10.1016/j.psyneuen.2022.105872

Demmer, R. T., Gelb, S., Suglia, S. F., Keyes, K. M., Aiello, A. E., Colombo, P. C., Galea, S., Uddin, M., Koenen, K. C., & Kubzansky, L. D. (2015). Sex differences in the association between depression, anxiety, and type 2 diabetes mellitus. *Psychosom Med*, *77*(4), 467-477. https://doi.org/10.1097/PSY.0000000000000169

Farvid, M. S., Qi, L., Hu, F. B., Kawachi, I., Okereke, O. I., Kubzansky, L. D., & Willett, W. C. (2014). Phobic anxiety symptom scores and incidence of type 2 diabetes in US men and women. *Brain Behav Immun*, *36*, 176-182. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=24184473

Felix, A. S., Shisler, R., Nolan, T. S., Warren, B. J., Rhoades, J., Barnett, K. S., & Williams, K. P. (2019). High-effort coping and cardiovascular disease among women: A systematic review of the John Henryism hypothesis. *J Urban Health*, *96*(Suppl 1), 12-22. https://doi.org/10.1007/s11524-018-00333-1

Hackett, R. A., & Steptoe, A. (2016). Psychosocial factors in diabetes and cardiovascular risk. *Curr Cardiol Rep*, *18*(10), 95. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=27566328

Kato, T. (2015). Frequently used coping scales: A meta-analysis. *Stress & Health*, *31*(4), 315-323. https://doi.org/10.1002/smi.2557

Kim, E. S., Smith, J., & Kubzansky, L. D. (2014). Prospective study of the association between dispositional optimism and incident heart failure. *Circ Heart Fail*, *7*(3), 394-400. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=24647117

Lazarus, R. S. (1990). Theory-based stress measurement. *Psychological Inquiry*, *1*, 3-13.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal and coping*. Springer.

Levine, G. N., Cohen, B. E., Commodore-Mensah, Y., Fleury, J., Huffman, J. C., Khalid, U., Labarthe, D. R., Lavretsky, H., Michos, E. D., Spatz, E. S., & Kubzansky, L. D. (2021). Psychological health, well-being, and the mind-heart-body connection: A scientific statement from the American Heart Association. *Circulation*, *143*(10), e763-e783. https://doi.org/10.1161/CIR.0000000000000947

Martin-Timon, I., Sevillano-Collantes, C., Segura-Galindo, A., & Del Canizo-Gomez, F. J. (2014). Type 2 diabetes and cardiovascular disease: Have all risk factors the same strength? *World J Diabetes*, *5*(4), 444-470. https://doi.org/10.4239/wjd.v5.i4.444

Mezuk, B., Abdou, C. M., Hudson, D., Kershaw, K. N., Rafferty, J. A., Lee, H., & Jackson, J. S. (2013). "White Box" epidemiology and the social neuroscience of health behaviors: The Environmental Affordances Model. *Society and Mental Health*, *3*(2). https://doi.org/10.1177/2156869313480892

Moore, J. C., Stinson, L. L., & Welniak, E. J. (1999). Income reporting in surveys: Cognitive issues and measurement error. In M. G. Sirken, D. J. Herrmann, S. Schechter, N. Schwarz, J. M. Tanur, & R. Tourangeau (Eds.), *Cognition and Survey Research* (pp. 155-174). John Wiley and Sons.

Nikolaev, B. N., Lerman, M. P., Boudreaux, C. J., & Muller, B. A. (in press). Self-employment and eudamonic well-being: The mediating role of problem- and emotion-focused coping. *Entrepreneurship Theory and Practice*. https://doi.org/https://doi.org/10.1177/10422587221126486

Okely, J. A., & Gale, C. R. (2016). Well-being and chronic disease incidence: The English Longitudinal Study of Ageing. *Psychosom Med*, *78*(3), 335-344. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=26569542

Okura, Y., Urban, L. H., Mahoney, D. W., Jacobsen, S. J., & Rodeheffer, R. J. (2004). Agreement between self-report questionnaires and medical record data was substantial for diabetes, hypertension, myocardial infarction and stroke but not for heart failure. *J Clin Epidemiol*, *57*(10), 1096-1103. https://doi.org/10.1016/j.jclinepi.2004.04.005

Park, C. L., & Iacocca, M. O. (2014). A stress and coping perspective on health behaviors: Theoretical and methodological considerations. *Anxiety Stress Coping*, *27*(2), 123-137. https://doi.org/10.1080/10615806.2013.860969

Penley, J. A., Tomaka, J., & Wiebe, J. S. (2002). The association of coping to physical and psychological health outcomes: A meta-analytic review. *J Behav Med*, *25*(6), 551-603. https://doi.org/10.1023/a:1020641400589

Radler, B. T., Rigotti, A., & Ryff, C. D. (2018). Persistently high psychological well-being predicts better HDL cholesterol and triglyceride levels: Findings from the midlife in the U.S. (MIDUS) longitudinal study. *Lipids Health Dis*, *17*(1), 1. https://doi.org/10.1186/s12944-017-0646-8

Roohafza, H., Askari, M., Nouri, F., Talaei, M., Sarrafzadegan, N., & Sadeghi, M. (2022). Do coping strategies really affect cardiovascular events? The Isfahan cohort study of adults in Eastern Mediterranean Regional Office. *European Journal of Cardiovascular Nursing*, *21*(5), 483-490. https://doi.org/10.1093/eurjcn/zvab110

Roth, G. A., Mensah, G. A., Johnson, C. O., Addolorato, G., Ammirati, E., Baddour, L. M., Barengo, N. C., Beaton, A. Z., Benjamin, E. J., Benziger, C. P., Bonny, A., Brauer, M., Brodmann, M., Cahill, T. J., Carapetis, J., Catapano, A. L., Chugh, S. S., Cooper, L. T., Coresh, J., Criqui, M., DeCleene, N., Eagle, K. A., Emmons-Bell, S., Feigin, V. L., Fernandez-Sola, J., Fowkes, G., Gakidou, E., Grundy, S. M., He, F. J., Howard, G., Hu, F., Inker, L., Karthikeyan, G., Kassebaum, N., Koroshetz, W., Lavie, C., Lloyd-Jones, D., Lu, H. S., Mirijello, A., Temesgen, A. M., Mokdad, A., Moran, A. E., Muntner, P., Narula, J., Neal, B., Ntsekhe, M., Moraes de Oliveira, G., Otto, C., Owolabi, M., Pratt, M., Rajagopalan, S., Reitsma, M., Ribeiro, A. L. P., Rigotti, N., Rodgers, A., Sable, C., Shakil, S., Sliwa-Hahnle, K., Stark, B., Sundstrom, J., Timpel, P., Tleyjeh, I. M., Valgimigli, M., Vos, T., Whelton, P. K., Yacoub, M., Zuhlke, L., Murray, C., Fuster, V., & Group, G.-N.-J. G. B. o. C. D. W. (2020). Global burden of cardiovascular diseases and risk factors, 1990-2019: Update from the GBD 2019 Study. *J Am Coll Cardiol*, *76*(25), 2982-3021. https://doi.org/10.1016/j.jacc.2020.11.010

Ryff, C. D. (2014). Psychological well-being revisited: advances in the science and practice of eudaimonia. *Psychotherapy and Psychosomatics*, *83*(1), 10-28. https://doi.org/10.1159/000353263

Sheeran, P., Gollwitzer, P. M., & Bargh, J. A. (2013). Nonconscious processes and health. *Health Psychol*, *32*(5), 460-473. https://doi.org/10.1037/a0029203

Stone, A. A., Schwartz, J. E., Neale, J. M., Shiffman, S., Marco, C. A., Hickcox, M., Paty, J., Porter, L. S., & Cruise, L. J. (1998). A comparison of coping assessed by ecological momentary assessment and retrospective recall. *J Pers Soc Psychol*, *74*(6), 1670-1680. https://doi.org/10.1037//0022-3514.74.6.1670

Svensson, T., Inoue, M., Sawada, N., Yamagishi, K., Charvat, H., Saito, I., Kokubo, Y., Iso, H., Kawamura, N., Shibuya, K., Mimura, M., Tsugane, S., & Group., J. S. (2016). Coping strategies and risk of cardiovascular disease incidence and mortality: the Japan Public Health Center-based prospective Study. *Eur Heart J*, *37*(11), 890-899. https://doi.org/10.1093/eurheartj/ehv724

Trudel-Fitzgerald, C., Boehm, J. K., Kivimaki, M., & Kubzansky, L. D. (2014). Taking the tension out of hypertension: a prospective study of psychological well being and hypertension. *J*

Hypertens, *32*(6), 1222-1228. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=24786293

Trudel-Fitzgerald, C., Chen, R., Lee, L. O., & Kubzansky, L. D. (2022). Are coping strategies and variability in their use associated with lifespan? *J Psychosom Res*, *162*, 111035. https://doi.org/10.1016/j.jpsychores.2022.111035

Trudel-Fitzgerald, C., Guimond, A. J., & Kubzansky, L. D. (2024). Emotion regulation and cardiovascular health. In B. Q. Ford & J. J. Gross (Eds.), *Handbook of Emotion Regulation* (3rd ed.). Guilford Press.

Trudel-Fitzgerald, C., & Ouellet-Morin, I. (2022). The cost of resilience: How allostatic load may jeopardize health through repeated demands for (successful) adaptation. *Psychoneuroendocrinology*, *144*, 105874. https://doi.org/10.1016/j.psyneuen.2022.105874

Trudel-Fitzgerald, C., Qureshi, F., Appleton, A. A., & Kubzansky, L. D. (2017). A healthy mix of emotions: Underlying biological pathways linking emotions to physical health. *Current Opinion in Behavioral Sciences*, *15*, 16-21. https://doi.org/https://doi.org/10.1016/j.cobeha.2017.05.003

US Department of Health and Human Services & US Department of Agriculture. (2020). *Dietary guidelines for Americans, 2020-2025*. https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf

Table 1. Participants' characteristics at baseline among the total sample and by levels of coping variability

Variable	Total Sample (N=2,142) M (SD)	Total Sample (N=2,142) N (%)	Lower Coping Variability (N=714) M (SD)	Lower Coping Variability (N=714) N (%)	Moderate Coping Variability (N=714) M (SD)	Moderate Coping Variability (N=714) N (%)	Greater Coping Variability (N=714) M (SD)	Greater Coping Variability (N=714) N (%)	p-value
Age, M (SD)	53.9 (10.9)		53.5 (10.9)		54.5 (10.8)		53.9 (11.0)		0.23
Female, N (%)		1249 (58.3)		413 (57.8)		401 (56.2)		435 (60.9)	0.18
White, N (%)		1998 (93.5)		670 (94.4)		669 (93.7)		659 (92.3)	0.27
Highest Level of Education, N (%)									0.46
Less than High School/High School Diploma/GED		585 (27.3)		184 (25.8)		199 (27.9)		202 (28.3)	
Some College		595 (27.8)		209 (29.3)		183 (25.7)		203 (28.5)	
Bachelor's Degree or Higher		960 (44.9)		321 (45.0)		331 (46.4)		308 (43.2)	
Marital Status, N (%)									**0.005**
Married		1551 (72.5)		535 (75.0)		535 (75.0)		481 (67.4)	
Separated/Widowed/Divorced		415 (19.4)		122 (17.1)		130 (18.2)		163 (22.8)	
Never Married		174 (8.1)		56 (7.9)		48 (6.7)		70 (9.8)	
Hypertension, N (%)		512 (23.9)		163 (22.8)		168 (23.5)		181 (25.4)	0.51
High Cholesterol, N (%)		341 (18.5)		126 (20.2)		118 (19.1)		97 (16.0)	0.14
Obesity, N (%)		515 (25.0)		173 (25.0)		159 (23.2)		183 (26.7)	0.33
Physical Activity, M (SD)	29.6 (10.7)		29.9 (10.2)		30.3 (10.8)		28.5 (10.9)		**0.003**
Smoking Status, N (%)									0.29
Never Smoker		613 (39.5)		192 (38.1)		229 (43.0)		192 (37.1)	
Past Smoker		652 (41.9)		215 (42.7)		216 (40.5)		221 (42.8)	
Current Smoker		289 (18.6)		97 (19.3)		88 (16.5)		104 (20.1)	
Alcohol Consumption, N (%)									0.82
Moderate Consumption		885 (43.8)		292 (43.2)		301 (44.8)		292 (43.5)	
Abstinence/Heavy Consumption		1135 (56.2)		384 (56.8)		371 (55.2)		380 (56.6)	
Sleep Duration, N (%)									
6h or less/night		409 (27.4)		121 (25.1)		134 (27.0)		154 (30.1)	**0.02**
7-8h/night		980 (65.7)		326 (67.5)		341 (68.6)		313 (61.1)	
9h or more/night		103 (6.9)		36 (7.5)		22 (4.4)		45 (8.8)	
Positive Relations with Others, M (SD)	5.9 (1.0)		5.9 (0.9)		6.0 (0.9)		5.7 (1.1)		**<.0001**

Notes. GED=General Education Development; M=Mean; SD=Standard Deviation. Descriptive analyses were conducted on participants with available data (race/ethnicity, N=2,138; highest education level, N=2,140; marital status, N=2,140; high cholesterol, N=1,847; obesity, N=2,063; physical activity, N=2,131; smoking status, N=1,554; alcohol consumption, N=2,020; sleep duration, N=1,492; positive relations with others, N=2,139.

Table 2

Associations of Coping Strategies and Variability in Their Use with Incident Heart Disease

	Model 1[a] (Age only)		Core Model 2[b] (Model 1 + sociodemographics)		Model 3[c] (Model 2 + health status)		Exploratory Model 4[d] (Model 3 + behavioral factors		Exploratory Model 5[e] (Model 3 + positive relationships)	
	AOR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI
Individual Coping Strategies										
Positive Reinterpretation & Growth	1.02	(0.87, 1.18)	1.06	(0.91, 1.23)	1.06	(0.91, 1.24)	1.08	(0.93, 1.26)	1.12	(0.95, 1.33)
Active Coping	0.94	(0.82, 1.09)	0.97	(0.84, 1.12)	0.99	(0.85, 1.14)	1.00	(0.86, 1.16)	1.01	(0.87, 1.18)
Planning	0.94	(0.82, 1.08)	0.97	(0.84, 1.12)	0.99	(0.85, 1.14)	1.01	(0.87, 1.17)	1.02	(0.87, 1.18)
Focus on & Venting of Emotion	0.98	(0.84, 1.14)	1.03	(0.88, 1.20)	1.02	(0.87, 1.20)	1.02	(0.87, 1.20)	1.01	(0.86, 1.18)
Denial	1.02	(0.89, 1.17)	1.00	(0.87, 1.17)	1.00	(0.86, 1.16)	0.98	(0.85, 1.15)	0.98	(0.84, 1.14)
Behavior Disengagement	0.98	(0.86, 1.13)	1.00	(0.87, 1.14)	1.00	(0.86, 1.15)	0.97	(0.84, 1.12)	0.96	(0.83, 1.11)
Coping Variability[f]										
Moderate versus lower levels	0.77	(0.54, 1.09)	0.76	(0.53, 1.08)	0.78	(0.55, 1.11)	0.77	(0.54, 1.10)	0.77	(0.54, 1.10)
Greater versus lower levels	0.92	(0.65, 1.29)	0.92	(0.65, 1.30)	0.92	(0.65, 1.30)	0.90	(0.64, 1.28)	0.90	(0.63, 1.26)
Greater versus moderate levels	1.19	(0.83, 1.70)	1.21	(0.84, 1.74)	1.18	(0.83, 1.70)	1.17	(0.82, 1.86)	1.16	(0.81, 1.67)

There were 221 incident heart disease cases over follow-up, including 80 in the lower variability level, 66 in the moderate variability level, and 75 in the greater variability level. The first three strategies are generally characterized as adaptive, while the next three strategies are generally characterized as maladaptive. Because behavioral factors and social support may be coping strategies themselves, we considered their role by further adjusting for them in exploratory analyses. Heart disease is a binary variable (yes, no) self-reported in 2013-15; frequency of strategies typically used to cope with stressors was self-reported with the validated COPE measure in 2004-06.

[a] Adjusted for age.

[b] Additionally adjusted for other sociodemographic covariates.

[c] Additionally adjusted for health status covariates.

[d] Additionally adjusted for behavioral covariates.

[e] Model 3 additionally adjusted for the social covariate (mean score on the Positive Relations with Others subscale).

[f] All coping variability analyses are also adjusted for the mean value of all coping subscales.

Table 3

Associations of Coping Strategies and Variability in Their Use with Incident Diabetes

	Model 1[a] (Age only)		Core Model 2[b] (Model 1 + sociodemographics)		Model 3[c] (Model 2 + health status)		Exploratory Model 4[d] (Model 3 + behavioral factors)		Exploratory Model 5[e] (Model 3 + positive relationships)	
	AOR	**95% CI**	**AOR**	**95% CI**	**AOR**	**95% CI**	**AOR**	**95% CI**	**AOR**	**95% CI**
Individual Coping Strategies										
Positive Reinterpretation & Growth	**0.83**	**(0.71, 0.96)**	**0.83**	**(0.72, 0.96)**	**0.83**	**(0.71, 0.97)**	**0.83**	**(0.71, 0.97)**	**0.83**	**(0.70, 0.99)**
Active Coping	**0.81**	**(0.71, 0.94)**	**0.84**	**(0.73, 0.97)**	0.86	(0.75, 1.00)	**0.86**	**(0.74, 0.99)**	0.86	(0.73, 1.02)
Planning	**0.83**	**(0.72, 0.96)**	**0.86**	**(0.74, 1.00)**	0.89	(0.77, 1.03)	0.89	(0.76, 1.03)	0.90	(0.76, 1.06)
Focus on & Venting of Emotion	1.07	(0.92, 1.26)	1.09	(0.92, 1.28)	1.08	(0.91, 1.29)	1.09	(0.91, 1.29)	1.07	(0.90, 1.28)
Denial	**1.17**	**(1.01, 1.36)**	1.11	(0.96, 1.29)	1.10	(0.94, 1.29)	1.11	(0.95, 1.30)	1.10	(0.94, 1.29)
Behavior Disengagement	1.15	(0.99, 1.35)	1.12	(0.95, 1.31)	1.13	(0.95, 1.33)	1.13	(0.96, 1.34)	1.12	(0.93, 1.35)
Coping Variability[f]										
Moderate versus lower levels	1.05	(0.71, 1.55)	1.04	(0.70, 1.54)	1.13	(0.75, 1.69)	1.11	(0.74, 1.67)	1.11	(0.74, 1.67)
Greater versus lower levels	1.28	(0.88, 1.87)	1.26	(0.86, 1.84)	1.29	(0.87, 1.92)	1.29	(0.87, 1.91)	1.26	(0.85, 1.87)
Greater versus moderate levels	1.22	(0.85, 1.76)	1.21	(0.83, 1.75)	1.15	(0.79, 1.67)	1.16	(0.79, 1.70)	1.13	(0.77, 1.66)

There were 181 incident diabetes cases over follow-up, including 55 in the lower variability level, 58 in the moderate variability level, and 68 in the greater variability level. The first three strategies are generally characterized as adaptive, while the next three strategies are generally characterized as maladaptive. Because behavioral factors and social support may be coping strategies themselves, we considered their role by further adjusting for them in exploratory analyses. Diabetes is a binary variable (yes, no) self-reported in 2013-15; frequency of strategies typically used to cope with stressors was self-reported with the validated COPE measure in 2004-06.

[a] Adjusted for age.

[b] Additionally adjusted for other sociodemographic covariates.

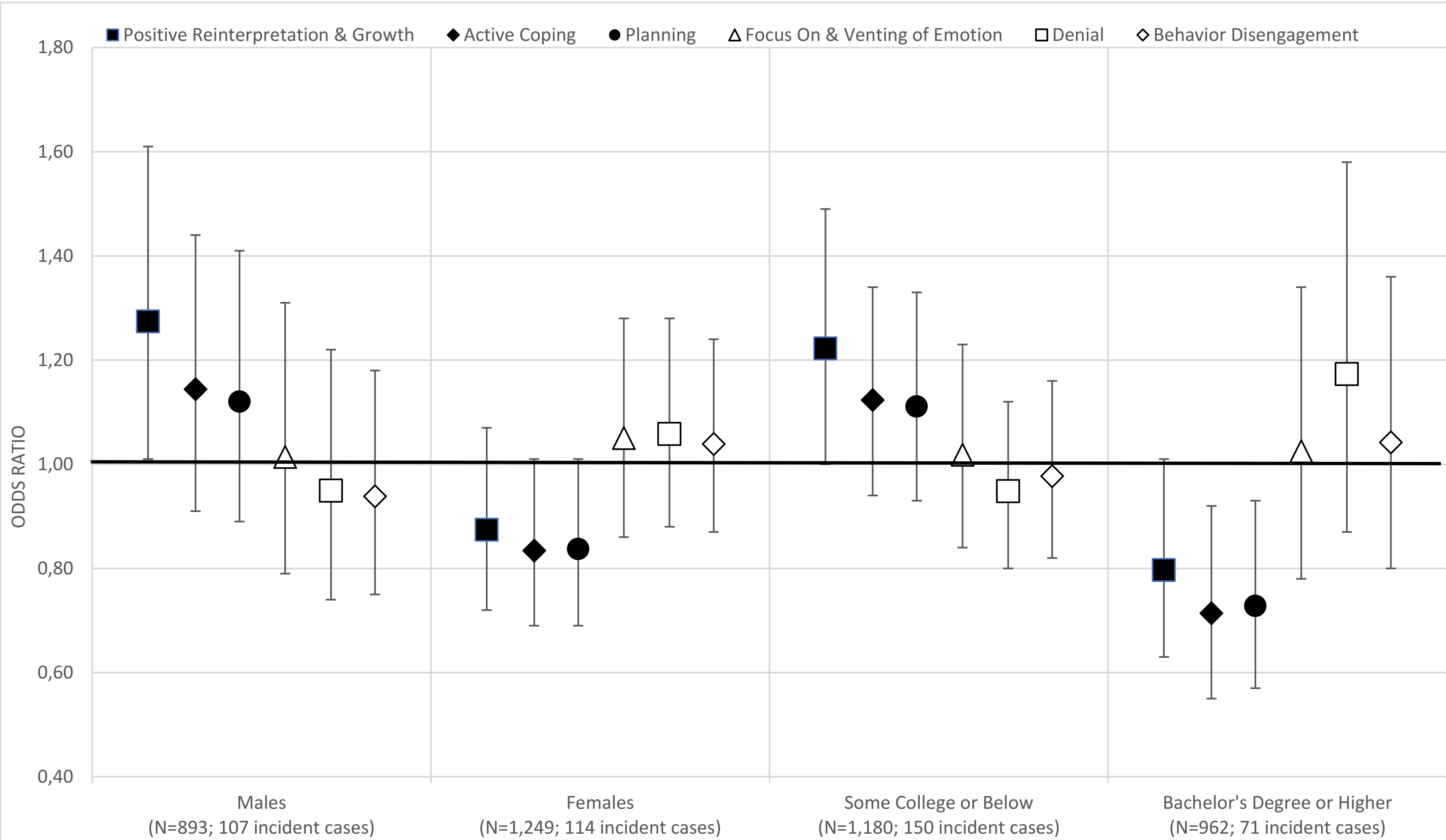
[c] Additionally adjusted for health status covariates.

[d] Additionally adjusted for behavioral covariates.

[e] Model 3 additionally adjusted for the social covariate (mean score on the Positive Relations with Others subscale).

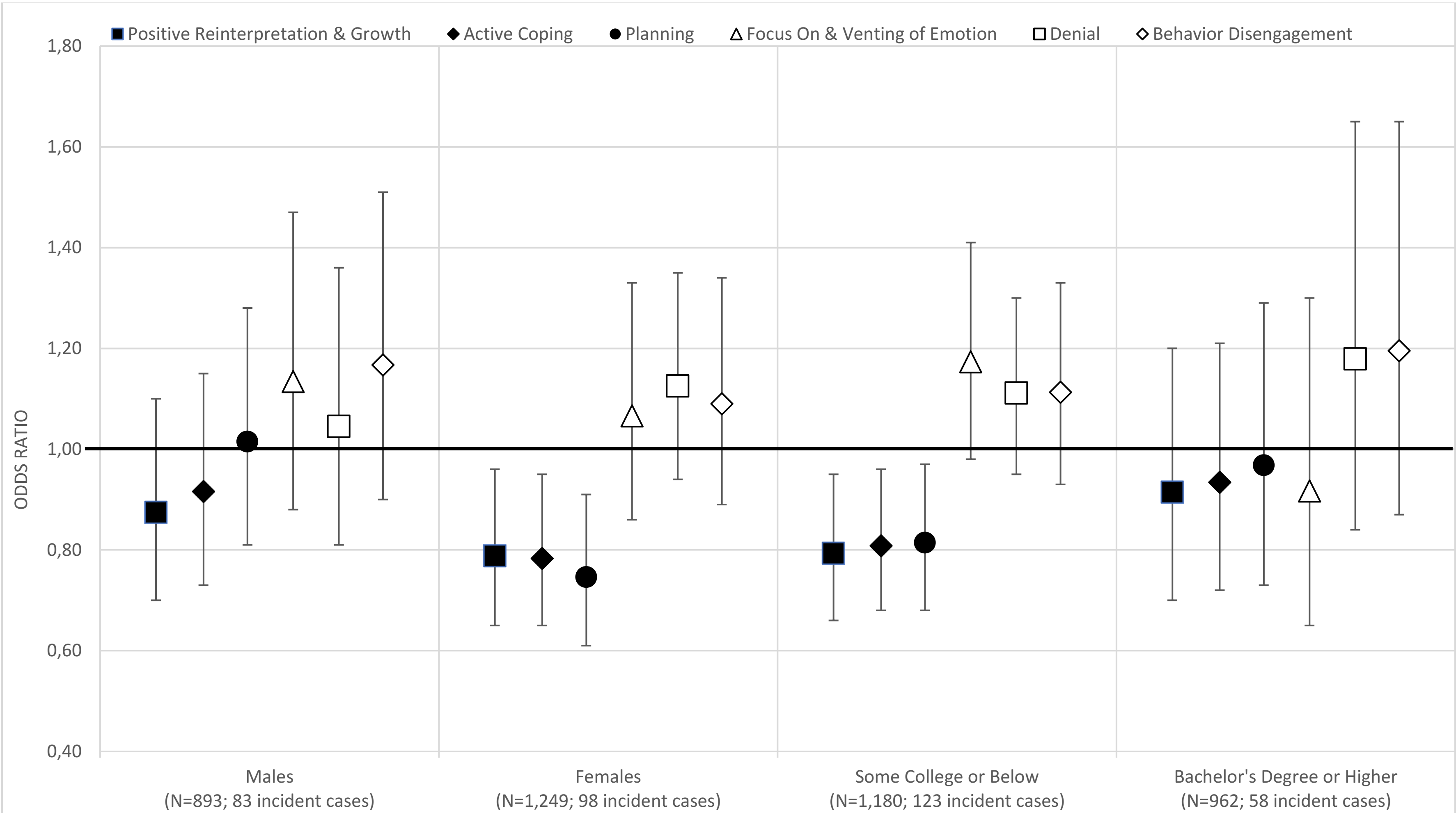
[f] All coping variability analyses are also adjusted for the mean value of all coping subscales.

Figure 1. *Associations of Coping Strategies With Incident Heart Disease Stratified by Sex and Education Levels.*



Notes. N=2,142; 221 cases. All models are adjusted for sociodemographic covariates. The first three strategies are generally characterized as adaptive, while the next three strategies are generally characterized as maladaptive. Interaction terms of each coping strategy with either sex or education subgroups were also included to sociodemographic-adjusted models and were found statistically significant for Positive Reinterpretation & Growth*Sex: $p=0.03$; Positive Reinterpretation & Growth*Education: $p=0.01$; Active Coping*Education: $p<0.001$; Planning*Education: $p=0.01$.

Figure 2. *Associations of Coping Strategies With Incident Diabetes Stratified by Sex and Education Levels*



Notes. N=2,142; 181 cases. All models are adjusted sociodemographic covariates. The first three strategies are generally characterized as adaptive, while the next three strategies are generally characterized as maladaptive. Interaction terms of each coping strategy with either sex or education subgroups were also included to sociodemographic-adjusted models and were statistically significant only for Planning*Sex: p=0.03.