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Combining psychosocial data to improve prediction of cardiovascular disease risk factors and events:: The NHLBI-Sponsored Women's Ischemia Syndrome Evaluation (WISE) Study

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Abstract

Background—There is overlap among psychosocial variables associated with cardiovascular disease (CVD), and utility of combining psychosocial variables as risk markers for understanding CVD is largely unknown.

Methods—Women (n=493) in the NHLBI Women's Ischemia Syndrome Evaluation (WISE) Study were evaluated. The predictive value for CVD events was determined for multivariate combination of Beck Depression Inventory (BDI), State-Trait Anxiety Inventory (STAI), Social Network Index (SNI), and Cook-Medley hostility (Ho) scales. Principal components analysis of psychosocial scales revealed composite psychosocial risk markers, and their relationships to CVD events and risk factors were assessed.

Results—In a multivariate model, the block of SNI, Hostile Affect, STAI and BDI predicted CVD events (χ^2[6]=27.8, p<0.001). Scale-wise factor analysis revealed two factors: Negative Affectivity (NA) and Hostility(explained variance 45.6% and 17.1%, respectively). SNI didn't load on either factor. NA was associated with BMI (β [SE] = 0.18[0.09], *p*=0.04), Hostility with metabolic syndrome (Exp(β)= 0.60[0.28], *p*=0.04), both factors with blood pressure (BP). NA with SBP β=2.53[1.04], *p*=0.02, DBP β=1.66[0.60], *p*=0.02; Hostility with SBP β=2.72[1.13], *p*=0.02, DBP β =1.83[0.65], *p*=0.005). Neither factor predicted CVD events. In multivariable analyses, original scales were associated with CVD events (lower SNI HR=0.74, CI=0.57–0.96), low Hostile Affect (HR=0.80, CI=0.56–1.03), and higher BDI(HR=1.33, CI=1.08–1.74).

Conclusion—In women with suspected ischemia, there is shared variance among psychosocial variables. Multivariate combination of psychosocial risk markers predicts CVD events; derived psychosocial factors were associated with CVD risk factors but not events. Measuring common and unique variance among psychosocial variables may be useful for understanding and predicting CVD.

Keywords

Women; Cardiovascular Disease; Psychosocial Variables; Factor Analysis; Cardiovascular Events

Introduction

The relationship of multiple psychosocial variables with the development and progression of cardiovascular disease (CVD) has been widely demonstrated. Depression and anxiety have been associated with incident hypertension (1), increased body mass index (BMI) (2) and metabolic syndrome (3, 4) which are major known clinical risk factors for CVD. Prior studies show that depression, anxiety, hostility, and limited social networks predict an increased risk of myocardial infarction (MI) (5–7) and adverse CVD outcomes (8, 9). This research indicates that the adverse relationship between depression, anxiety, and poor social networks with overall health and CVD outcomes in patients with existing CVD is consistent and independent of biomedical risk factors (10, 11).

Trait anger and hostility are also predictive of myocardial infarction (MI) and life-threatening arrhythmias (12, 13). Similarly, low social support has been associated with poor outcomes in patients with coronary artery disease, and several recent reviews have confirmed that lack of social support is a predictor of CVD morbidity and mortality (14–17).

Most studies have investigated single psychosocial variables rather than multivariate combinations of these variables. Aggregate approaches to these variables, however, may yield superior prediction of cardiovascular risk. Some researchers have addressed this issue by creating psychosocial scores using a small number of questions aimed at evaluating different types of stress. Using this type of methodology, the INTERHEART study demonstrated an association between psychosocial stress and increased risk of acute MI (9). Since psychosocial traits often cluster together and co-occur in the same individuals (18), the issue of commonalities or shared variance among these variables themselves needs to be addressed. Depression, anxiety and anger/hostility measures are moderately to strongly correlated with one another (18). Social support also correlates with other psychosocial variables. Lett and colleagues explored the relationship between several measures of social support on all-cause mortality or nonfatal MI in post-MI patients enrolled in ENRICHD, and showed that greater perceived social support (and not social networks or tangible support) was associated with improved outcomes in patients with low levels of depression (19). The WISE research group has also looked at interactions between psychosocial variables and shown that depression scores predict CVD events in women with suspected ischemia that have low, but not high anxiety scores (20). Their results suggest that assessing more than one psychosocial variable and/or assessing multiple dimensions of a particular psychological construct, like social support, would be beneficial in identifying individuals at psychosocial risk for adverse cardiovascular outcomes. Thus, prior research indicates that investigating the shared variance among psychosocial variables may reveal the existence of underlying factors that can improve upon previous CVD prediction models that use only separate psychosocial variables.

Other studies have used a data reduction technique known as principal components analysis (PCA) that makes it possible to reduce multiple variables into a few “factors” based on the

amount of variance shared among the individual variables. In this regard several studies (21–23) suggest that analyzing the shared variance of psychosocial variables can provide additional insight into the relationship between these variables and CVD events.

In a study of post MI patients (21) using multiple psychosocial measures including the State-Trait Anxiety Inventory, Beck Depression Inventory and the General Health Questionnaire, only depression remained significantly associated with CVD mortality after adjusting for disease covariates. A PCA using a larger set of psychological indices revealed three underlying factors: Negative Affectivity (including the BDI and STAI), Overt Anger (including Anger Expression), and Social Support (Perceived Social Support and the number of close friends and relatives). The Negative Affectivity factor predicted cardiovascular mortality and was marginally significant after adjusting for depression and cardiovascular risk factors.

Another prospective cohort study (22) created a “Psychological Risk Factor” score by factor analyzing the Cook-Medley Hostility Scale and the Minnesota Multiphasic Personality Inventory (MMPI) subscales of depression, anxiety, and anger. This composite factor was a significantly better predictor of incident cardiovascular disease than any of the individual psychosocial subscales alone. Another study (23) found 4 psychosocial factors (Depressed Affect, Anxious Apprehension, Positive Affect, and Emotional Exhaustion) in post-MI patients. These factors were then used to create symptom profiles which were significantly predictive of current health status as assessed by the Seattle Angina Questionnaire.

The aforementioned studies set the stage for investigations utilizing factor analytic techniques to study the relationship between multiple psychosocial variables and the onset and progression of cardiovascular disease. Looking at the clustering of psychosocial factors in individuals with and without angiographic coronary artery disease and examining how these factors might be related to standard risk factors and the progression of disease and cardiovascular events could be important to advance research in this area.

The NHLBI-sponsored Women's Ischemia Syndrome Evaluation (WISE) study provides a unique opportunity to explore the shared variance across multiple psychosocial scales and to identify underlying psychosocial risk factors for CVD. Unlike prior studies in this area, the WISE study looks at a population of women undergoing coronary angiography to evaluate their symptoms of ischemia. A number of psychosocial scales were administered thereby allowing for prospective analysis of cardiovascular events over a median 5.9-year follow-up period. Moreover, multiple psychosocial constructs such as anger, hostility, depression and social networks are predictive of CVD outcomes in the WISE study (24–29), which may suggest common variance among these psychosocial variables. Prior studies reveal a clustering of risk factors in the same individual (30), and individual psychosocial variables were also associated with standard clinical risk factors in the WISE (24). Thus, we also assessed whether multivariate combinations of psychosocial variables increase associations with standard clinical risk factors.

Using data from the WISE study, the present study aimed: (1) to determine whether multivariate combinations of psychosocial scales could improve the predictive value of psychosocial variables for CVD compared to standard bivariate prediction models; and (2) to evaluate the clustering, association, and predictive value of psychosocial scales with CVD risk factors and CVD events in women.

Methods

The present analyses used data collected from the National Heart, Lung, and Blood Institute (NHLBI) – sponsored WISE study (May, 2001-April 2007). WISE was a multicenter study

designed to evaluate the pathophysiology and clinical course of ischemic heart disease (IHD) in women. A secondary goal of the WISE study was to investigate the relationship of psychosocial variables with CVD risk factors in women with suspected IHD.

A total of 936 women participated in the core WISE protocol. Because psychosocial scales were added several months after WISE began, a subset of participants took part in the psychosocial protocol. Women were excluded from the current analysis if they were missing total scores for any of the following psychosocial questionnaires: Beck Depression Inventory (BDI)(31), State-Trait Anxiety Inventory (STAI) (32), Cook-Medley Hostility Inventory (Ho)(33) subscales Cynicism, Hostile Affect, and Aggression(34), Social Network Index (SNI)(35), a panic attack scale (derived from the Body Sensations Questionnaire (BSQ) (36), and an autonomic perception scale using questions previously designed to assess to what extent an individual is aware of various autonomic processes (i.e., temperature, heart rate, etc.) and was included because of its overlap with anxiety symptoms (37). Exclusion of participants without complete psychosocial data was necessary to perform an accurate scale-wise principal components analysis of the psychosocial data. A subset of 493 women completed all the psychosocial measures of interest in the present analyses.

Outcome variables

We evaluated two types of outcomes. The first consisted of CVD events over a median 5.9 years of follow-up. Participants were contacted by telephone and/or mail at six weeks and annually thereafter by an experienced site study nurse or physician to assess any clinical events since last contact. A CVD event was defined as a composite of non-fatal stroke, non-fatal myocardial infarction (MI), congestive heart failure, or death related to CVD. In the event of death, a death certificate was obtained. CVD death was assigned based upon a review of the death certificates by study physicians blinded to other clinical data.

A second set of dependent variables consisted of CVD risk factors measured and collected at baseline: blood pressure, body mass index, and presence of metabolic syndrome. Metabolic syndrome was defined according to the ATP – III Criteria revised by the American Heart Association and the NHLBI (38) and based on a combination of elevated fasting triglycerides, fasting glucose, waist circumference, systolic or diastolic blood pressure, low HDL cholesterol, or taking medication for any of these conditions (27).

Statistical analyses

Data were analyzed using SPSS for Windows, version 16.0 (SPPS Inc., Chicago, IL). Cox proportional hazards modeling was used to assess the predictive value of the multivariate combination of individual psychosocial scales on CVD-related outcomes during the median 5.9-year follow-up period. After entering disease and risk factor covariates into the Cox Regression Model, a multivariate block consisting of Depression, Anxiety, Cynicism, Hostile Affect, Aggression, and Social Networks was entered into the model to determine the predictive value of the multivariate combination of these variables.

Scale-wise principal components factor analysis with varimax rotation was conducted. The Kaiser-Meyer-Olkin measure of sampling adequacy and the Bartlett test of sphericity were used to evaluate the appropriateness of the data for factor analysis. The number of factors was determined using a combination of the Kaiser criterion (Eigenvalues greater than 1.0) and the use of parallel analysis (39). Factor scores were derived from the PCA with Varimax rotation with listwise deletion of missing variables; regression variables for each factor were computed. A varimax rotation was chosen because it optimized the factor loadings of the eight psychosocial scales (i.e., BDI, STAI, Hostile Affect, Cynicism, Aggression, SNI, Autonomic Perception, and the Panic Attack Scale) and, being a type of orthogonal rotation,

ensured that the axes were not correlated. This made it easier to identify each of the original variables with a single factor (40). A non-orthogonal (oblique) rotation was evaluated for comparison and did not further improve the factor solution.

Based on the Kaiser Criterion alone, the PCA with a varimax rotation yielded three underlying factors. A parallel analysis was performed to confirm the number of factors (39). Results of the parallel analysis supported the existence of only two factors.

Cox proportional hazards regression analysis was used to assess whether the derived psychosocial factors predicted CVD events over the median 5.9-year follow-up period. Logistic and linear regressions were used to determine cross-sectional association between the derived psychosocial factors and CVD clinical risk factors. To further address the question of whether accounting for multiple psychosocial constructs provides greater understanding of the relationship between clinical CVD risk factors and CVD events, Z scores were computed for each of the psychosocial scales (i.e., BDI, STAI, Hostile Affect, Cynicism, Aggression, SNI, Autonomic Perception, and the Panic Attack Scale), and a composite psychosocial score was calculated as the sum of these Z-scores. Each analysis was rerun using the new Z score composite scale. Furthermore, BDI scores were dichotomized into no depression (scores less than 10) and depression (scores greater than 10) for all regression analyses as a score of 10 or above on the BDI has been shown to predict clinical outcomes (6, 26). Disease covariates included age, history of smoking, history of diabetes, history of obstructive coronary artery disease, BMI, and use of blood pressure medication. For all regression analyses, disease covariates were decided a priori using prior research, and the final models included only the covariates with significant bivariate associations with each of the outcome variables in this sample, which lead to slightly different covariates for the separate regression analyses.

Results

Sample Characteristics

Of the 493 women who participated in this study, the mean age was 57.6 and 16.4% were non-white, primarily African American. At the end of the median 5.9 year follow-up period, 75 participants reported 95 CVD events (congestive heart failure (n=26), stroke (n=20), MI (n=20), and/or CVD-related death (n=29)). There were no significant differences in the demographic data between the total WISE cohort (n= 936) and the subsample used in these analyses. Baseline characteristics are shown in Table 1.

Correlations Among Psychosocial Variables

The Pearson correlations among psychosocial scales ranged from 0.04 to 0.69 (See Table 2). The BDI was highly correlated with both the STAI (0.69) and the panic attack scale (0.52). The CM subscales Hostile Affect and Cynicism were also strongly correlated with one another (0.51). The remaining correlation coefficients were <0.50 but many remained statistically significant. As expected, most of the psychosocial scales were significantly correlated with one another, and most of the correlations were of moderate magnitude.

Principal Components Analysis

When the eight available psychosocial scales (i.e., BDI, STAI, Hostile Affect, Cynicism, Aggression, SNI, Autonomic Perception, and the Panic Attack Scale) were entered into a principal components analysis; the measure of sampling adequacy (Bartlett test of sphericity) for the total matrix was 0.81 (p<0.001). Based on the Kaiser Criterion alone the PCA yielded three factors corresponding to the constructs of “negative affectivity,” “hostility” and “social networks” and accounting for 68% of the variance. The parallel

analysis (39) supported the existence of only two factors which accounted for 62.7% of the variance: the Negative Affectivity Factor accounted for 45.6% of the variance and the Hostility Factor accounted for 17.1% of the variance. In light of these findings, the decision was made to rerun the principal components analysis excluding the SNI (See Table 3). Since the SNI has been shown to be related to CVD outcomes in the WISE study but did not load on the derived psychosocial factors, it was treated as a separate variable in the present analyses (See Table 4).

Derived Psychosocial Factors and CVD Risk Factors

After controlling for age and use of blood pressure medications, greater Negative Affectivity and Hostility Factor Scores were both associated with higher systolic and diastolic blood pressure at study baseline (Negative Affectivity: systolic blood pressure β [SE] = 2.53 [1.04], p=0.02, diastolic blood pressure β [SE] = 1.66 [0.60], p=0.02; Hostility: systolic blood pressure β (SE) = 2.72 [1.13], p=0.02, diastolic blood pressure β [SE] = 1.83 [0.65], p=0.005). Controlling for age, Negative Affectivity Factor Scores were also associated with higher BMI (β [SE] = 0.18[0.09], p=0.04). Higher Hostility Factor Scores were associated with existing metabolic syndrome (Exp(β) [SE] = 0.60 [0.28], p=0.04) after controlling for age and history of obstructive CAD.

Derived Psychosocial Factors and CVD Events

Cox proportional hazards regression modeling was used to determine whether the Negative Affectivity Factor or the Hostility Factor were associated with CVD events. No significant relationship was found between either the Negative Affectivity or Hostility factor and CVD events in disease covariate adjusted or unadjusted models (See Table 4). Figure 1 summarizes the relationships among CVD risk factors, CVD events, and psychosocial variables for both the multivariate analysis and analyses using derived psychosocial factors.

Associations Between Psychosocial Variables and CVD Events

In order to build a case for the utility of predicting CVD outcomes with multiple psychosocial variables or derived psychosocial factors, over that of single variables, Cox proportional hazards regression modeling was first used to assess whether the individual psychosocial variables (i.e., each psychosocial variable in a separate model alone and after controlling for disease covariates in the regression analyses) were predictive of cardiovascular events. Separate models were run for Depression, Anxiety, Cynicism, Hostile Affect, Aggression, and Social Networks. In unadjusted models Depression[1] (HR [95% CI]: 1.94 [1.23.–3.06]), Cynicism (1.07 [1.01–1.14]), and Social Networks (0.79 [0.69–0.91]) were significantly predictive of CVD events. No significant relationships were seen with CVD events and Anxiety, Hostile Affect, or Aggression. Controlling for disease covariates (age, smoking, history of diabetes, history of obstructive coronary artery disease) in each of these models attenuated the relationship with CVD events and Depression (1.31 [1.04–1.65]), and Social Networks (0.74 [0.58–0.95]) and the relationship between CVD events and Cynicism was no longer significant

Associations Between Multiple Psychosocial Variables and CVD Events

Cox proportional hazards regression modeling was then used to assess whether the combination of individual psychosocial variables (i.e., entered as a single block in the regression analysis) was predictive of cardiovascular events. The unadjusted model (with no

[1]As stated earlier, BDI scores were dichotomized into presence (≥10) or absence (<10) of depressive symptoms as this is a well-established, and frequently used threshold for predicting clinical outcomes in medical patients (6, 26). When looked at as a continuous variable, BDI was not predictive of CVD events (HR [95% CI]: 1.03 [0.998.–.105]).

clinical covariates) that included Depression, Anxiety, Cynicism, Hostile Affect, Aggression, and Social Networks, was significant (χ^2 [6]=25.81, p<0.001). Smaller Social Networks (HR [95% CI]: 0.69 [0.56–0.87]), lower Hostile Affect (0.71 [0.53–0.94]), and higher Depression (1. 42 [1.08–1.87]) were independent predictors of increased CVD events. Controlling for disease covariates attenuated the effects of Depression (HR [95% CI] 1.33 [1.08–1.74]), Hostile Affect (0.80 [0.56–1.03]) and Social Networks (0.74 [0. 57–0.96]).

Comparison of Individual Psychosocial Variables and Aggregated Psychosocial Scales in Relations to CVD Risk Markers and Events

To further address the question of whether accounting for multiple psychosocial constructs provides greater understanding of the relationship between clinical CVD risk factors and CVD events, we used another approach to combining the psychosocial scales. After computing Z scores for each of the psychosocial scales (i.e., BDI, STAI, Hostile Affect, Cynicism, Aggression, SNI, Autonomic Perception, and the Panic Attack Scale), summed total scores corresponding to each of the derived psychosocial factors were computed (e.g., Negative Affect Z Score was the sum of the BDI, STAI, Autonomic Perception, and the Panic Attack Scales total scores; Hostility Z score was the sum of the Hostile Affect, Cynicism, Aggression scales). Results for the combined Z scores were similar to those of the derived psychosocial factors (see Table 4). Neither of the Negative Affect Z score or the Hostility Z score were significantly predictive of CVD events, nor was a total Z score (i.e., the sum of all psychosocial scales: BDI, STAI, Hostile Affect, Cynicism, Aggression, SNI, Autonomic Perception, and the Panic Attack Scale). However, the Negative Affect Z score and the Hostility Z scores were significantly associated with the same CVD risk factors as the derived psychosocial factors. Systolic and diastolic blood pressure, and BMI were significantly related to the summed total of all the psychosocial scales (SBP β=0.15, p=0.001; DBP β=0.12, p<0.0001; BMI β=0.15, p=0.03).

Discussion

The present study utilized several approaches to assessing the predictive value of combinations of psychosocial risk markers for CVD events and CVD risk factors in women with signs and symptoms of CVD. First, we observed that when the multivariate block of Depression, Anxiety, Social Network Index, and the Affect subscale of the Cook-Medley Hostility Inventory, was entered into a Cox regression analysis, this block was predictive of CVD events, though only the BDI, SNI and Hostile Affect were significant independent variables. Combining the psychosocial scales using either a factor analytic approach or a summed Z score approach did not yield a significant relationship to CVD outcomes. While the factor score and Z scores did demonstrate significant relationships to clinical CVD risk factors, these approaches did not yield anything novel over independent psychosocial scale predictions.

CVD is a multifaceted disease process and understanding the role of psychosocial variables is important. Our findings indicate (as summarized in Table 4) that combining psychosocial variables results in only slightly better prediction of CVD risk factors (when looking at the amount of variance accounted for in the model) than using the individual psychosocial scales. Clinically, it seems that psychosocial risk markers often occur together or at least significantly overlap in their presentation. It is often times hard for a clinician to determine what the main cause of psychosocial distress is when a patient presents with signs of depression, anxiety, and low social support since any one of these things might exacerbate the symptoms of the other. It was this notion that, in part, lead to the present investigation. While aggregating the psychosocial variables measured in this study did not seem to provide better prediction of cardiovascular events, they do show correlations with clinical

cardiovascular disease risk factor. Previous work from our group and others has shown that investigating the interaction between psychosocial variables to be more predictive of CV events than looking at the simple effects of the variables (14, 20). Taken together, these findings bring to light the possibility of creating an aggregated Psychosocial Risk Score for CVD, much like the Framingham Risk Score. It might be possible to create an algorithm based on various psychosocial factors that can be used to predict CVD risk markers, which may ultimately help clinicians better identify patients at risk for a variety of CVD outcomes. Determining such an algorithm would require assessment and validation of the predictive relationship of multivariate combinations of psychosocial variables to CVD, comparing these relationships in healthy controls, and examining the additive and multiplicative relationship of these variables to the prediction of CVD outcomes.

A second aim of the present analysis was to evaluate whether the various psychosocial variables in the WISE dataset could be effectively summarized by factor analysis. The results revealed a two-factor solution. The SNI did not load on either of the two derived factors, Negative Affectivity and Hostility. The absence of a relationship of the SNI to other scales in WISE could have been attributable to the lack of other psychosocial scales in this dataset related to the social support construct. Similarly, this result may also reflect the fact that the SNI is distinct from Negative Affectivity and Hostility. The clustering of the negative affect, anger, and social networks observed in our study is the same pattern observed by Frasure-Smith and Lesperance (21).

In this sample of women with signs and symptoms of IHD, the results of the subsequent regression analyses utilizing the two derived factors indicated that factor analytic combinations of psychosocial variable scores were predictive of CVD risk factors, but not of subsequent CVD events. There was also evidence that some of these factor scores were related to CVD risk factors where many of the individual scales were not. Specifically, higher Negative Affectivity was associated with higher BMI, greater Hostility associated with metabolic syndrome, and both factors were associated with elevated systolic and diastolic blood pressure.

Non-significant results for the two derived factors as well as the combined Z scores in relation to the prediction of CVD events may be due the relatively small number of CVD events in this sample. According to the methodology proposed by Hsieh & Lavori (41) which allows for the calculation of sample size in Cox regression models that use non-binary covariates (previous methodology only allowed for calculation of sample size in Cox regression using binary covariates), the number of events observed in this study was inadequate. When performing a multivariate Cox regression, adjusting for covariates that explain 30% of the variance in the outcome variable requires a total of 108 events/endpoints (as the number of endpoints should be inflated by 1/(1–.3)). The current analyses had 75 events, leaving them underpowered for hazard ratios under 1.3. It should also be noted that absence of a relationship between the SNI and CVD risk factors previously demonstrated in the larger WISE sample (29) may have resulted from the differences in the covariates and definition of clinical risk factors utilized in the statistical techniques needed for the current analyses.

It may also be argued that these null findings in relationship to CVD event prediction support a simpler, more parsimonious approach to psychosocial risk factors in CVD. Perhaps looking at smaller sets of variables (e.g., depression and anxiety, or depression and social support) would yield better results. Factor scores contain variables that fall out of multivariate modeling, which my wash out the effects of a smaller set of variables within the derived factor that have theoretical evidence to support their combination in the attempt to predict CVD outcomes. Our results also raise the questions of whether some psychosocial

variables may be more or less predictive of CVD events over varying lengths of time. While Cox regression analysis addresses this concern somewhat by using a time-to-event variable, we cannot fully answer this question. Perhaps a multivariate approach to psychosocial risk prediction is more relevant for acute or short term risk predictions than for the longer follow-up period measured in the current study.

The present study supports previous findings that suggest psychosocial variables share variance and that specific factor analytic constructs can be derived from groups of psychosocial variables. While a direct comparison of the present study's findings to those of INTERHEART (9) is difficult due to the different methodologies, both suggest a relationship between psychosocial variables and cardiovascular disease risk. The two factors derived in this population of women with signs and symptoms of IHD partially confirm the factors derived in a population of predominantly men (664 men; 74% of the study sample) with CAD (21). Since several of the constructs shown to be predictive of CV events (e.g., depression, anxiety, etc) are known to reflect a dimension of negative affect (42), it is not surprising that our factor analysis revealed Negative Affectivity as a factor. It is important to note that factor analytic results are a function of the variables entered into the analysis and also a function of the sample studied. The current study and the study conducted by Frasure-Smith and Lesperance did not use all of the same scales to measure the same psychosocial variables, but did show a similar pattern of constructs (21).

Factor analytic techniques can be complicated and there is some debate over the benefits of performing such intricate analyses. In light of our findings that summed Z scores of psychosocial variables are comparable to factor analytically derived psychosocial scores, future investigators may consider combining psychosocial variables in such a manner to obtain a better picture of the contribution of aggregated psychosocial variables on cardiovascular disease. And, in so doing, better capture the shared variance among psychosocial constructs that are brought to light in factor analysis. Our findings might also suggest that an interaction approach to combining psychosocial variables might be more beneficial than aggregating psychosocial variables when trying to predict CVD outcomes.

In summary, most studies of psychosocial variables for CVD have focused on demonstrating the importance of single psychosocial variables. One of the biggest strengths of the present study is the multiple ways in which the relationship between psychosocial variables and clinical CVD risk factors and CVD events is approached. Our findings demonstrate that aggregating psychosocial variables predicts clinical CVD risk markers but not CVD events. Future research is needed to clarify the relationship between psychosocial variables and to assess whether accounting for these relationships provides better prediction of CVD risk markers and CVD events.

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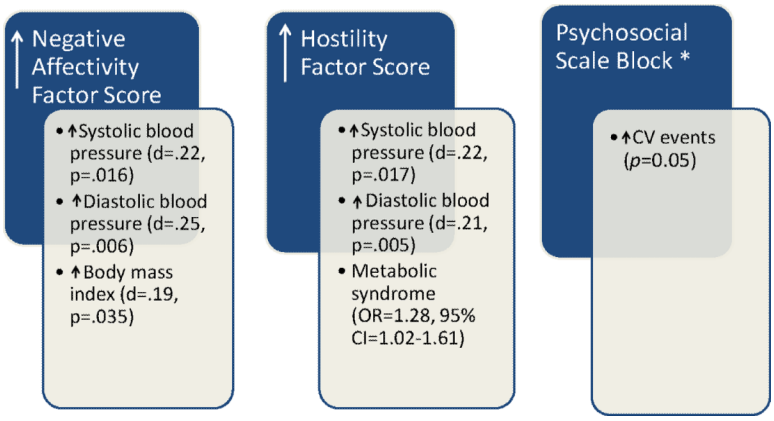

Figure 1.

Illustration of the Obtained Relationships Between Psychosocial Scales and Derived Factors with CV Risk Markers and Events. This figure summarizes the findings of the current study by demonstrating the relationship between the psychosocial scales, derived factors and the CV risk markers and events explored in these analyses.

*Multivariate regression block including: Beck Depression Inventory, Cook-Medley Hostility Inventory, Social Network Index.

OR=odds ratio; CI=95% confidence interval; d=Cohen's *d*.

Table 1

Participant Demographics

Participant Characteristics	Study Sample n=493,	Total Sample n=936,
Age (years)	57.6 ± 11.4(SD)	58.3 ± 11.4(SD)
Race		
African American	77 (15.6%)	164 (17.4%)
Non-Hispanic White	412 (83.6%)	767 (81.1%)
Other	4 (0.8%)	13 (1.4%)
High School Graduate or above	400 (81.1%)	744 (78.6%)
History of Smoking	246 (49.9%)	501 (52.9%)
History of Hypertension	283 (57.4%)	558 (58.9%)
History of Diabetes	114 (23.1%)	236 (24.9%)
History of Dyslipidemia	256 (51.9%)	479 (50.6%)
Average Resting Heart Rate	73.7 ± 12.5(SD)	73.5 ± 12.5(SD)
BMI	29.3 ± 6.2(SD)	29.4 ± 6.3(SD)
History of Obstructive Coronary Artery Disease *	162 (39.2%)	364 (38.4%)
Cardiovascular events **	95 (15.2%)	169 (17.8%)
Mean BDI Score	10.5 ± 8.2 (SD)	
Percent of patients with BDI Score <10	40.1%	
Mean STAI Score	18.9 ± 5.8 (SD)	
Mean CM Hostile Affect Score	1.9 ± 1.3(SD)	
Mean CM Aggression Score	2.8 ± 1.7(SD)	
Mean CM Cynicism Score	5.0 ± 3.4 (SD)	
Mean Autonomic Perception Scale Score	39.6 ± 15.4 (SD)	
Mean Panic Attack Scale Score	0.64 ± .98 (SD)	

BDI: Beck Depression Inventory; STAI: Spielberger Trait Anxiety Inventory; CM: Cook Medley

* ≥ 50% stenosis of any coronary vessel

** incident stroke, myocardial infarction, congestive heart feilure, cardiac death

Table 2

Correlation Table of Psychosocial Variables

	CM Cynicism	CM Aggression	CM Hostile Affect	Panic Attack Scale	Spielberger Trait Anxiety	Autonomic Perception	BDI	SNI
CM Cynicism		.39**	.51**	.32**	.37**	.28**	.33**	−.17**
CM Aggression			.38**	.20**	.15**	.15**	.18**	−.04
CM Hostile Affect				.26**	.39**	.29**	.36**	−.12**
Panic Attack Scale					.50**	.39**	.52**	−.05
Spielberger Trait Anxiety						.45**	.69**	−.17**
Autonomic Perception Scale							.48**	−.05
BDI								−.16**

Abbreviations: CM, Cook Medley; BDI, Beck Depression Inventory (continuous scale not dichotomized) ; SNI, Social Network Index.

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Table 3

Component Matrix from Principal Components Analysis with Varimax Rotation

Psychosocial Variable	Risk Markers	
	Factor 1 Negative Affectivity	Factor 2 Hostility
CM Cynicism Subscale	.28	**.67**
CM Aggression Subscale	.07	**.55**
CM Hostile Affect Subscale	.29	**.64**
Spielberger Trait Anxiety Inventory	**.80**	.21
Beck Depression Inventory*	**.79**	.20
Panic Attack Scale	**.57**	.22
Autonomic Perception Scale	**.54**	**.18**

Extraction Method: Principal Axis Factoring. Rotation Method: Varimax with Kaiser Normalization was chosen to simplify factor loading and provide an uncorrelated factor solution.

Rotation converged in 3 iterations.

* continuous scale, not dichotomized

Table 4

Comparison of Methods of Aggregating Psychosocial Variables and Individual Psychosocial Variables Related to CVD Risk Markers and Outcomes

Outcomes and Risk Factors	Factor Scores		Combined Z-Scores		Multiple Psychological Variables
	Negative Affectivity	Hostility	BDI, STAI, Panic, Autonomic Perception	CM Subscales: Hostile Affect, Aggression, Cynicism	BDI, STAI, SNI, CM Subscales: Hostile Affect, Aggression, Cynicism
CV Events	Overall χ^2 =43.83*** HR=1.12 (CI:0.86–1.45), ns	Overall χ^2 =43.17*** HR=1.08 (CI:0.82–1.42), ns	Overall χ^2 =43.28*** HR=1.02 (CI:0.95–1.10), ns	Overall χ^2 =43.64*** HR=1.03(CI:0.96–1.12), ns	Overall χ^2 =57.47***; BDI HR=1.33* (95%CI:1.02–1.74), SNI HR=0.74* (95%CI:0.57–0.96)
Metabolic Syndrome	OR=1.13 (CI:0.91–1.39), ns	OR=1.27* (CI:1.01–1.60)	OR=1.04 (CI:0.98–1.10), ns	OR=1.07* (CI:1.01–1.14)	Model χ^2=10.41, ns; OR range from OR 0.89 (CI:0.70–1.13) for STAI, to OR 1.25 (CI:0.99–1.57) for BDI, all scales ns
BMI	R^2=0.02; β=0.10*	R^2=0.02; β=0.07, ns	R^2=0.02; β =0.09*	R^2=0.02; β =0.08, ns	R^2=0.03; β range from −0.06 to 0.08, ns
Systolic Blood Pressure	R^2=0.1; β=0.11*	R^2=0.10; β=0.10*	R^2=0.11; β=0.12**	R^2=0.11; β=0.11**	R^2=0.12; CM Cynicism β= 0.13** Other β's range from −0.00 to 0.08, ns
Diastolic Blood Pressure	R^2=0.03; β=0.13**	R^2=0.03; β=0.13**	R^2=0.03; β =0.14**	R^2=0.03; β =0.15***	R^2=0.04; β's range from 0.02 to 0.09ns

Individual Psychological Scale Scores						
	BDI	STAI	CM Hostile Affect	CM Cynicism	CM Aggression	SNI
CV Events	Overall χ^2 =48.33*** HR=1.31* (CI:1.04–1.65)	Overall χ^2 =43.45*** HR=1.09 (CI:0.86–1.37), ns	Overall χ^2 =43.16*** HR=0.96(CI:0.76–1.21), ns	Overall χ^2 =44.13*** HR=1.14(CI:0.92–1.42), ns	Overall χ^2 =44.04*** HR=1.13(CI:0.90–1.41), ns	Overall χ^2 =48.33*** HR=0.74*(CI:0.58–0.95)
Metabolic Syndrome	OR=1.23* (CI:1.05–1.45)	OR=1.12 (CI:0.93–1.34), ns	OR=1.13 (CI:0.94–1.36), ns	OR=1.26** (CI:1.07–1.48)	OR=1.10 (CI:0.92–1.32), ns	OR=0.90 (CI:0.76–1.10), ns
BMI	R^2=0.02; β =0.08*	R^2=0.02; β =0.06, ns	R^2=0.02; β =0.08, ns	R^2=0.01; β =0.04, ns	R^2=0.01; β=−0.01, ns	R^2=0.01; β=−0.01, ns
Systolic Blood Pressure	R^2=0.08; β =0.05, ns	R^2=0.10; β =0.06, ns	R^2=0.10; β =0.03, ns	R^2=0.08; β =0.10**	R^2=0.11; β =−0.09*	R^2=0.08; β =−0.003, ns
Diastolic Blood Pressure	R^2=0.01; β =0.05, ns	R^2=0.02; β =0.10*	R^2=0.03; β =0.09*	R^2=0.02; β =0.11**	R^2=0.02; β =−0.10*	R^2=0.01; β =−0.002, ns

Cox regressions were used for CV events with controlling for age, history of smoking, history of diabetes, and history of obstructive CHD. Logistic and linear regressions were used for the CV risk factors and covariates (age, history of obstructive CHD, BP medication, and BMI) varied based on each outcome measures (as discussed in methods section). For the linear and logistic regressions, the unadjusted R^2 for Step 2 of the regression model (the step that added the psychosocial variables listed at the top of each column) is presented. The variance explained by the model that includes the psychosocial variable is presented along with the beta weight of that variable and its significance. The unadjusted R^2 are statistically significant at or below the p=0.05 level in all models where the standardized βs are significant expect where marked by ns.

* p<0.05,

** p<0.01,

***p<0.001