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Affect, Inflammation, and Health in Urban At-Risk Civilians

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Abstract

Positive and negative affect are both associated with health outcomes. Using validated measures, we examined associations between affect, self-reported measures of health, and objective measures of systemic inflammation in a cross-sectional sample of outpatient subjects recruited from an urban county hospital. Participants (n=1055) recruited from the Grady Trauma Project in Atlanta, GA underwent standardized interviews including self-report measures of psychiatric symptoms and physical health. A subset (n=246) consented to an assay of serum C-reactive protein (CRP). Regression models including positive affect as the predictor variable with covariates of age, gender, income, trauma load, depression and PTSD symptoms, were significantly associated with physical health domain scales of the Short Form-36 Health Survey (SF-36) of general health (R^2=0.212; p<0.001) and physical functioning (R^2=0.154; p=0.013). No association was observed using negative affect as the predictor variable. While greater serum CRP concentrations were associated with less positive affect (r=−0.137; p=0.038), this relationship did not remain significant (p=0.250) when controlling for demographic variables, body mass index, trauma load, and psychiatric symptoms. Future studies using larger samples or samples with more variance for CRP and positive and negative affect may be helpful in investigating the relationship between CRP and positive and negative affect. Our results support the hypothesis that positive affect contributes beneficially to physical health. Development of strategies to enhance positive affect in at-risk populations may be a meaningful way to improve their health.

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Keywords

PTSD; c-reactive protein; immune response; positive affect; negative affect; health

Introduction

The literature examining negative affective states and their resulting outcomes has historically greatly outweighed comparable studies of positive affective states (Diener et al., 1999). Through large community samples, much evidence has accrued in the medical literature describing the association of psychiatric disorders such as depression, that are characterized by negative affective state, with large global disability burdens including coronary heart disease (Hemingway and Marmot, 1999) and diabetes (Golden et al., 2004). Conversely, a growing body of data examining the impact of positive affect on human biology has demonstrated a modest, but beneficial, influence of positive affect on biomarkers of autonomic, neuroendocrine, and immune physiology (Dockray and Steptoe, 2010), measures of general physical health (Pressman and Cohen, 2005; Rasmussen et al., 2009) and health or disease progression in clinical populations of patients with diabetes (Robertson et al., 2012) or cardiovascular disease (Huffman et al., 2017).

The relationships between affect and health have been consistently observed in a variety of international studies across socioeconomic and racial/ethnic cohorts. An overall higher life satisfaction score in a cohort of healthy Finnish adults from the Finnish Twin Study was negatively related to mortality (Koivumaa-Honkanen et al., 2000). Lack of positive affect was associated with increased mortality in a British community sample recruited as part of the Health and Lifestyle Study (Huppert and Whittington, 1995) as well as a North Carolina cohort of urban and rural-dwelling, African-American and white elders (Blazer and Hybels, 2004). In the same North Carolina cohort, it was also found that while increasing scores on a depressive scale were associated with increased risk of stroke, increasing scores on a positive affect scale were even more strongly associated with decreased risk of stroke (Ostir et al., 2001). In a Mexican-American elder cohort, lack of positive affect, rather than increased negative affect, was predictive for development of physical disability (Ostir et al., 2000).

A recent meta-analysis of prospective observational cohort studies examining the association between positive well-being and mortality found positive affect and positive-trait-like disposition to be associated with reduced mortality in both healthy and ill populations (Chida and Steptoe, 2008). More significantly, this association was found to be independent of the effect of negative affect, consistent with previous studies identifying an independent effect of positive affect on health (Diener et al., 1985).

In the present study, we examined the relationship between positive and negative affect and self-reported subjective health using the Short Form Health Survey (SF-36) in a predominantly African-American, heavily trauma-exposed and impoverished population recruited from the primary care waiting rooms of a large county hospital. We hypothesized that increasing positive affect would be associated with better health outcomes, and conversely, that increasing negative affect would be associated with worsened health

outcomes. To test this hypothesis, we developed a statistical model accounting for the effects of demographic factors, depressive symptoms, and post-traumatic stress symptoms, as our study cohort has high rates of current and lifetime prevalence of major depressive disorder and post-traumatic stress disorder (PTSD) (Gillespie et al., 2009). In addition to our subjective measurement of health and its association with positive and negative affect, we also examined the association of positive and negative affect with an objective measure of health, serum C-reactive protein (CRP) level, a biomarker of systemic inflammation linked to increased medical and psychiatric risk (Miller et al., 2009; Penninx et al., 2003) in a sub-sample of study participants.

Methods

Study Design and Participants

Participants in the current study were recruited as a part of the Grady Trauma Project, a 5-year National Institutes of Health-funded study of risk factors and resilience in PTSD (Bradley et al., 2011; Gillespie et al., 2009). Data were collected between 2009 and 2014. Participants were recruited from general primary care and obstetric/gynecologic clinic waiting rooms during normal business hours at Grady Memorial Hospital, a large, publically-funded county hospital serving a low-income, primarily African-American population in Atlanta, Georgia.

Inclusion criteria included English-language fluency and ability to give informed consent. Verbal and written consent was obtained for all participants. Trained interviewers approached participants while they were waiting for medical appointments. Approximately 60% of participants approached at this phase agreed to participate. Study participants completed a series of self-report questions verbally, in cooperation with study interviewers, over a period of 45 to 75 minutes (dependent on participants' trauma history and current symptom reports). All procedures in this study were approved by the institutional review boards of Emory University School of Medicine and Grady Memorial Hospital, Atlanta, Georgia.

Our sample (N=1055) includes individuals who completed self-report affect and health outcome measures. However, as participants were allowed to decline questions they did not wish to answer, or did not complete all measures due to the time constraints inherent to interviewing in a clinical waiting room, the number of participants for each individual analyses varies. A subgroup of participants (n=246) who completed this initial interview was invited to participate in a secondary phase of the study that included structured interviews, history & physical examination, laboratory measurements, and physiologic studies that comprised additional study areas of the Grady Trauma Project. This included venipuncture to assess serum CRP levels during the secondary phase of the study that occurred on average 1–2 weeks post-initial assessment. Body Mass Index (BMI) was calculated based on measurements obtained at the time of physician history and physical exam (mean = 32.05, SD = 7.87, range 18.38 – 70.41).

Psychological Measures

A full description of the battery of self-report measures obtained during the interview has previously been described (Gillespie et al., 2009). See Table 1 for detailed descriptive statistics on psychological measures. Demographic information was assessed using a locally-developed demographics form (Gillespie et al., 2009). Trauma exposure was measured using the Traumatic Events Inventory (TEI; Gillespie et al., 2009), a 14-item screening measure of the total number of different types of trauma an individual has been exposed to in their lifetime (e.g., domestic violence, serious car accident, child abuse). Symptoms of depression were assessed with the Beck Depression Inventory (BDI), a 21-item self-report inventory measuring frequency and severity of depression symptoms (Beck et al., 1988). Depression symptom scores range from 0–63, with 0–13 considered minimal, 14–19 mild, 20–28 moderate, and 29–63 severe. Current post-traumatic stress symptoms were assessed using the modified PTSD Symptom Scale (PSS). The PSS is a 17-item self-report measure which assesses the presence/absence of the 17 symptoms contained in the DSM-IV diagnostic criteria for PTSD during the two weeks preceding assessment, with scores ranging from 0–51. A total score higher than 13 is indicative of probable PTSD (Foa et al., 1993).

Positive and negative affect was measured using the Positive and Negative Affect Schedule (PANAS), a 20-item self-report measure of positive and negative affect (Watson, D. et al., 1988). The PANAS, developed as a 20-item scale in 1988 (Watson, D. et al., 1988), measures two dominant dimensions of emotional experience as positive and negative affect that account for most of the variance in self-rated affect. Across multiple studies, the PANAS has shown good reliability and validity (Crawford and Henry, 2004). Cronbach's alpha coefficients for the present study were 0.90 for positive affect subscale and 0.88 for negative affect subscale, demonstrating good internal validity. The two PANAS subscales were used to assess positive affect and negative affect in our sample.

Self-report of physical health status was measured using the Short Form Health Survey (SF-36), a 36-item self-report of health status (Ware Jr and Sherbourne, 1992). This survey consists of 8 scales of eight health domains, four of which are part of the summary measure of physical health, and the other four of mental health. The four physical health scales are categorized as physical functioning (10 items), role limitations due to physical health (role-physical; 4 items), bodily pain (2 items), and general health (5 items). Each item can be standardized to a 0 to 100 range, and then all items of each scale can be summed and averaged to obtain a scaled score, which is norm-based to a mean of 50, and standard deviation of 10. Construct validity, internal consistency, and reliability of the SF-36 and each of its individual domain scales has been demonstrated in numerous large general populations with divergent socio-demographic features and rates of disease states along with efficacy in the detection of differences in health between groups (Sullivan et al., 1995; Ware Jr, 2000).

Measurement of Serum C-reactive Protein (CRP)

Blood samples were obtained during the morning between the hours of 9:00 AM and 10:00 AM by venipuncture and stored at -80° C until time of assay. Serum CRP levels were measured using an immunoturbidometric assay from Sekisui Diagnostics

(www.sekisuidiagnostics.com) on the Beckman AU480 chemistry analyzer, with an inter-assay coefficient of variation (CV) of 5.2% and an intra-assay CV of 3.1%. CRP levels averaged 5.14 ± 4.77 mg/L and ranged from 0.03 to 18.84 mg/L. CRP was collected on average within two weeks of psychological assessment.

Statistical Analysis

First, bivariate correlations were used to assess the association between positive and negative affect and measures of health including subjective ratings of general health, bodily pain, physical functioning, and physical limitations, as well as BMI and serum CRP. A series of linear regression models were then used to examine the associations of positive and negative affect with physical health outcomes. Potential confounders that have been previously associated with positive and negative affect, including age, sex, income, trauma exposure, and current depressive and post-traumatic symptoms, were controlled for in linear regression analyses.

Separate models examining the association between positive and negative affect independent of sociodemographic variables (i.e., age, gender, and income) with each physical health outcome were first run. Then, four models including both positive and negative affect were run covarying for sociodemographic variables to determine the unique effects of positive and negative affect on outcome variables. Finally, stepwise models were run to examine associations of variables of interest and covariates with the four physical health domain scales of the SF-36 and serum CRP; step 1) age, sex, income, and trauma load, step 2) current PTSD and depression symptoms, and step 3) positive or negative affect (run separately). Positive and negative affect were entered as the third and final step to examine the incremental validity in our predictive linear regression model. BMI was included as a covariate in step 1 for our stepwise regression models predicting CRP concentrations. The data were analyzed using SPSS (v.21).

Results

Sample characteristics

Study participants predominantly self-identified as African-American in both the primary sample (92.1%) and in the serum CRP subsample (91.9%; Table 1). Rates of participation by other racial groups were similar between the primary sample and subsample. Female participants (66.3%) outnumbered male participants in the primary sample and male participants (57.3%) outnumbered female participants in the subsample. With respect to the primary sample, most participants were unemployed (77.5%) with household income less than $2000 per month and education level of high school diploma or less (69.7%). Socioeconomic characteristics for the CRP subsample were similar. Study participants experienced high levels of trauma with 95.1% of the sample reporting exposure to at least one type of traumatic event (see Table 1 for descriptive details). Psychiatric symptom counts were also high (mean BDI score = 15.7 ± 12.4 and mean PSS score = 13.7 ± 12.4 in the primary sample; similar rates were found in the subsample.

Bivariate Correlations of Positive and Negative Affect with Physical Health Outcomes

Bivariate correlations were used to calculate Pearson correlation coefficients between positive and negative affect subscales of the PANAS and the SF-36 physical health domain scales. The correlation between positive and negative affect in the overall sample was 0.340 ($p<0.001$). All four SF-36 physical health domain scales: general health (n=1031, r=0.288), physical functioning (n=821, r=0.231), bodily pain (n=1041, r=0.229), role-physical (n=832, n=0.234) were positively correlated with positive affect ($p<0.001$, Table 2). Conversely, the same four scales: general health (n=1033, r=−0.240), physical functioning (n=823, r=−0.146), bodily pain (n=1043, r=−0.235), and role-physical (n=834, r=−0.194) were inversely correlated with negative affect ($p<0.001$, Table 2).

Bivariate Correlations of Positive and Negative Affect with Trauma load, PTSD, and Depressive Symptoms

Trauma load, (n=942, r=−0.150, $p<0.001$), PTSD (n=1022, r=−0.288, $p<0.001$), and depression (n=1037, r=−0.512, $p<0.001$) symptoms were negatively correlated with positive affect (Table 2). Trauma load, (n=942, r=0.256, $p<0.001$), PTSD (n=1024, r=0.527, $p<0.001$), and depression (n=1038, r=0.636, $p<0.001$) symptoms were positively correlated with negative affect (Table 2).

Bivariate Correlations of Positive and Negative Affect with serum CRP

Serum CRP was inversely correlated with positive affect (n=245, r=−0.137, p=0.038). However, serum CRP was not correlated with negative affect (n=246, r=0.038, p=0.551).

Linear Regression Models of Affect and Physical Health Outcomes

Initial linear regression models controlling for sociodemographic variables only showed that positive affect was significantly associated with all four physical health outcome variables (all p's<.001; see Table 3). Similarly, negative affect was significantly associated with all four physical health outcome variables independent of sociodemographic variables (all p's<.001; see Table 3). To examine the unique effects of positive and negative affect, additional models were run including both positive and negative affect while controlling for sociodemographic variables; as shown in Table 3, results were similar with both positive and negative affect showing significant associations across all four physical health outcomes (all *p's<.05).*

Stepwise Models with Positive Affect and Physical Health Outcomes

Results for the full stepwise models including positive affect with all covariates are shown in Table 4. An overall model accounting for age, gender, income, trauma load, PTSD and depression symptoms, and positive affect was statistically significant and accounted for 21.2% of the variance in general health outcomes ($p<0.001$). In Step 3, positive affect had a significant positive association with general health outcomes above and beyond demographic and trauma variables and psychiatric symptoms (p=0.001; Table 4).

For bodily pain, the overall model including age, gender, income, trauma load, PTSD and depression symptoms, and positive affect was not statistically significant (p=0.478; Table 4).

Adding positive affect in the final step further did not significantly explain additional variance in bodily pain above and beyond other variables included in the model (Table 4).

An overall model accounting for age, gender, income, trauma load, PTSD and depression symptoms, and positive affect was statistically significant and accounted for 15.4% of the variance in physical functioning ($p<0.05$; Table 4). In the final step, positive affect had a significant positive association with physical functioning above and beyond demographic and trauma variables and psychiatric symptoms ($p=0.013$; Table 4).

For physical role limitations, the overall model including age, gender, income, trauma load, PTSD and depression symptoms, and positive affect was not statistically significant ($p=0.057$; Table 4). Adding positive affect in the final step further did not significantly explain additional variance in physical role limitations above and beyond other variables included in the model, although the association approached significance ($p=0.057$; Table 4).

Stepwise Models with Negative Affect and Physical Health Outcomes

Results for the full stepwise models including negative affect with all covariates are shown in Table 5. An overall model predicting general health outcomes and accounting for age, gender, income, trauma load, PTSD and depression symptoms, and negative affect was not statistically significant ($p=0.084$). Adding negative affect in the final step further did not significantly explain additional variance in overall health above and beyond other variables included in the model (Table 5). For bodily pain, the overall model including age, gender, income, trauma load, PTSD and depression symptoms, and negative affect was not statistically significant ($p=0.524$). Adding negative affect in the final step further did not significantly explain additional variance in bodily pain above and beyond other variables included in the model (Table 5). Similarly for physical functioning, the overall model including age, gender, income, trauma load, PTSD and depression symptoms, and negative affect was not statistically significant ($p=0.698$). Adding negative affect in the final step further did not significantly explain additional variance in physical functioning above and beyond other variables included in the model (Table 5). Lastly, for physical role limitations, the overall model including age, gender, income, trauma load, PTSD and depression symptoms, and negative affect was also not statistically significant ($p=0.848$). Adding negative affect in the final step did not significantly explain additional variance in physical role limitations above and beyond other variables included in the model (Table 5).

Positive Affect and Serum CRP

A separate stepwise linear regression with serum CRP as the dependent variable, accounting for age, sex, BMI, income, trauma load, current PTSD and depression symptoms, and positive affect as the predictor was run. The final step of this model including positive affect ($F=1.333$, $df=172$, $p=0.250$) was not significant (Table 6). Only BMI was a significant predictor of CRP concentrations ($t=4.736$, $p<0.001$; Table 6).

Discussion

We observed significant relationships between positive and negative affect and all four domains of physical health functioning, and CRP concentrations as a measure of general

inflammatory state, with effect sizes ranging from 0.14–0.29. Our results show that even after conservatively controlling for the effects of demographic variables, trauma exposure, and current PTSD and depression symptoms, a significant association remains between positive, but not negative, affect and self-reported general health ratings and physical functioning as measured by self-report via the SF-36. To the best of our knowledge, our study is the first reported examination of the relationship between positive and negative affect and health outcomes in a predominantly African-American, heavily trauma exposed, and low socio-economic status population. Our findings are consistent with previous studies in which increased trait positive affect was associated with fewer symptoms of illness and better self-reported health across a variety of clinical populations in ambulatory as well as inpatient settings (Pressman and Cohen, 2005). Other reports have also identified an association between trait positive affect and improved health outcomes in healthy populations along with evidence suggesting that the effects of positive emotion are independent of, and possibly stronger, than the effects of negative emotion on health outcomes (Andreasson et al., 2013; Pressman and Cohen, 2005).

Negative affect was also associated with worse reported health, increased bodily pain, worse physical functioning, and greater physical role limitations. However, these associations did not remain significant when we controlled for the effects of demographic factors, trauma load, and depression and PTSD symptoms. The loss of association between negative affect and these sub-scales of the SF-36 when controlling for psychiatric symptoms may be a consequence of overlap between negative affect and symptoms of anxiety, post-traumatic stress and especially depression (Watson, David et al., 1988). These results also suggest that the effects of negative affect on these health outcomes seem to be fully accounted for by the presence of psychiatric symptoms. As such, this is an important limitation of our statistical model and by extension, our study findings. Previous reports have suggested that chronic pain negatively influences affect/mood rather than negative affect predisposing one to pain (Gaskin et al., 1992). However, causation cannot be determined from our main effects model results given the cross-sectional nature of our analysis.

In a subset of participants from our primary sample, we observed a significant inverse correlation between serum CRP levels and positive affect, but did not observe significant correlation between serum CRP and negative affect. However, the association between positive affect and serum CRP did not remain significant when examined in our stepwise regression model controlling for demographic variables, trauma load, and depressive and post-traumatic stress symptoms. Our failure to find a correlation between negative affect and CRP is particularly surprising considering the extent of previous reports describing an association between depression and PTSD with CRP (Fernandes et al., 2016; Michopoulos et al., 2015; Valkanova et al., 2013), and could be due to inadequate statistical power, considering the smaller size of our subsample.

The significance of the association between increased age and both decreased positive and negative affect in our model may reflect findings of natural changes in measured affect in longitudinal population samples over time (Mroczek and Kolarz, 1998). The significant association between increased depressive symptoms and decreased positive affect, and between increased depressive symptoms and increased negative affect may reflect prior

findings that depressive symptoms may result from combination of both low positive affect and high negative affect (Watson, David et al., 1988). Even considering the high trauma burden observed in our sample, the effect of current depressive symptoms appeared to be more contributory in our model to both positive and negative affect as compared to current PTSD symptoms. The high trauma burden in our cohort itself can be theorized to lead to adverse health outcomes through negative physiological effects such as observed increase in inflammatory markers. However, as described before, affect was found to have a separate effect from trauma exposure and PTSD symptoms in our statistical models.

The central strengths of our study are the relatively large sample size and the demographic focus on lower socioeconomic status, heavily trauma-exposed African-American primary care patients. Studying this particular sample may limit generalizability to other populations, yet the homogeneity of the sample may increase validity of our results to similar populations of lower socioeconomic status, highly traumatized African-Americans, that tend to be understudied populations in biomedical research. As recruitment occurred in primary care settings, this population may reflect a more general population than a specific disease or mental health population.

Limitations of our study include somewhat superficial measurement of pain through the SF-36, rather than with a more comprehensive pain index such as the McGill Pain Questionnaire (MPQ) (Katz and Melzack, 2011). In addition, our measures of health outcomes were based on subjective self-report without objective correlation. Related to this concern, previously reported studies of patient symptom reporting and affect indicate that when objective measures of disease are held constant, individuals with high trait positive affect report fewer severe symptoms from disease (Cohen et al., 2003). As such, the subjective reporting style of the SF-36 and the positive affect scale may confound the current results. Consequently, we may progressively underestimate the true burden of disease in individuals with increased positive affect. An additional study limitation is related to our assessment of affect with the PANAS. The PANAS places a significant demand on the ability of research participants to discriminate closely related emotions and the capacity of their vocabulary to correctly recognize terminology describing distinct, yet closely-related, emotions. Variability in the recognition and discrimination between closely-related emotions and the interpretation of emotion terminology by study participants may be a random effect, systematic effect, or some combination of both. In the case of a random effect, such variability would be expected to limit statistical power to detect, as opposed to confound, our measurement of positive and negative affect on health measures. Systematic effects on response to the PANAS may also be present and related possibly to effects of trauma on educational achievement and vocabulary. Another study limitation is the cross-sectional manner in which study data were acquired, limiting our capacity to consider causal relationships between study variables. Additionally, because we had not collected data on smoking status of participants we could not include that as a covariate in CRP analyses. Finally, serum CRP was not obtained at the same time the self-report psychological measures (depression, PTSD, and affect) and the length of time between assessment sessions varied by participant. As a result, serum CRP levels may be more reflective of the psychological and medical status of subjects at the time of collection as opposed to the time of their initial study assessment and it is impossible to know how much affect in particular

varied between those sessions. However, we would anticipate that these differences represent random, as opposed to systematic, error that may have contributed to the negative findings in our subsample. Our clinical interview could be argued to have induced a temporary change in state affect, in either a positive or negative direction, and would be prohibitively difficult to objectively quantify.

In summary, we found an independent association between positive affect and self-reported physical health in a large, homogeneous, highly trauma-exposed and impoverished population cohort. Studies have examined the interaction and possible moderating effect of positive affect on stress, pain, and negative affect, and this method could serve as a model for future examination of our study data (Zautra et al., 2005). Growing public interest in positive psychology and related formal and informal psychotherapeutic interventions may reflect a greater empiric realization of the contribution of positive emotions and individual traits to general well-being. Including more physiologic markers of disease severity including autonomic, cardiovascular, immunologic, and endocrine parameters in future analysis could provide further insights and possible confirmation of the effect of positive affect on physical health outcomes. Following the stress-buffering hypothesis, the contribution of individual resilience to physical health and physiological markers should be further examined. Positive psychology and its uses in not only ill, but healthy and at-risk populations, holds significant promise as a powerful tool for public health in physical and mental wellness. As our understanding of what is considered pathology – negative health outcomes and PTSD – has grown, we believe that the focus of research has and will shift to concepts such as positive health, resilience, and posttraumatic growth.

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Table 1

Demographic characteristics of total sample and serum CRP subsample in frequency (n) and percentage (%), and mean ± SD for the total sample and serum CRP subsample.

Demographics.	**Total Sample (n=1055)**		**Serum CRP Sample (n=246)**	
Sex	N	%	N	%
Female	699	66.3	105	42.7
Male	355	33.7	141	57.3
Race				
African-American	972	92.1	226	91.9
Hispanic	6	0.6	2	0.8
Asian	2	0.2	1	0.4
Caucasian	45	4.3	11	4.5
Mixed	15	1.4	4	1.6
Other	12	1.1	2	0.8
Employment				
Unemployed	812	77.5	197	80.1
Employed	236	22.5	49	19.9
Education				
<12th grade	257	24.4	62	25.2
12th grade or HS	368	34.9	90	36.6
Graduate				
GED	57	5.4	19	7.7
Some College or Tech	230	21.8	48	19.5
School				
Tech School Grad	44	4.2	11	4.5
College Graduate	77	7.3	13	5.3
Graduate School	15	1.4	2	0.8
Income				
$0 – 249	309	29.3	79	32.1
$250 – 499	96	9.1	32	13.0
$500 – 999	293	27.8	68	27.6
$1000 – 1999	221	20.9	46	18.7
$2000 or more	110	10.4	14	5.7
Mean ± SD	Mean (SD)	Range	Mean (SD)	Range
Age	42.5 (12.3)	18–65	41.1 (12.2)	18–65
PANAS positive	37.2 (9.4)	10–50	39.6 (8.7)	10–50
PANAS negative	21.8 (9.1)	10–50	22.0 (9.7)	10–49
Overall trauma exposure (TEI)	5.1 (3.9)	0–14	5.5 (3.3)	0–14
Depressive Symptom Severity (BDI)	15.7 (12.5)	0–58	15.7 (13.0)	0–57
PTSD Symptom Severity (PSS)	13.7 (12.4)	0–50	15.5 (12.7)	0–50

Demographics.	**Total Sample (n=1055)**		**Serum CRP Sample (n=246)**	
Body Mass Index (BMI)	-	-	32.1 (7.87)	18–70
Serum CRP	-	-	5.1 (4.8)	0.03–18.8

General Sample: Does not sum to 1055; Sex: 1 subject did not report; Race: 3 subjects did not report; Employment: 7 subjects did not report; Education: 7 subjects did not report; Income: 26 subjects did not report; CRP Sample: Does not sum to 246; Sex: 0 subject did not report; Race: 16 subjects did not report; Employment: 0 subjects did not report; Education: 1 subjects did not report; Income: 7 subjects did not report

Table 2

Main effects of SF-36 scales and Serum CRP on positive and negative affect.

	Positive Affect			Negative Affect		
	n	**r**	**p-value**	**N**	**r**	**p-value**
General Health	1031	0.288	<0.001	1033	−0.240	<0.001
Physical Functioning	821	0.231	<0.001	823	−0.146	<0.001
Bodily Pain[1]	1041	0.229	<0.001	1043	−0.235	<0.001
Role-Physical	832	0.234	<0.001	834	−0.194	<0.001
Serum CRP	245	−0.137	0.038	246	0.038	0.551
TEI Total Score	942	−0.150	<0.001	942	0.256	<0.001
PSS Total Score	1022	−0.288	<0.001	1024	0.527	<0.001
BDI Total Score	1037	−0.512	<0.001	1038	0.636	<0.001

[1]Lower self-reported pain is reported as higher scores on the respective SF-36 measure

Table 3

Linear regression analyses of positive and negative affect with measures of physical health controlling for sociodemographic variables

	b	SE b	β (beta)	*F*	R^2
Positive Affect					
General Health				68.014***	0.158
Age	−0.546	0.059	−0.272		
Sex	1.072	1.516	0.021		
Income	1.386	0.524	0.078**		
PANAS Positive	0.634	0.077	0.243***		
Bodily Pain[1]				28.472***	0.112
Age	−0.622	0.075	−0.252		
Sex	−1.426	1.932	−0.022		
Income	1.072	0.667	0.048		
PANAS Positive	0.606	0.098	0.188***		
Physical Functioning				28.250***	0.142
Age	−0.700	0.080	−0.293***		
Sex	−3.441	2.013	−0.058		
Income	2.067	0.727	0.095**		
PANAS Positive	0.552	0.104	0.178***		
Role – Physical				29.787	0.122
Age	−0.616	0.088	−0.237***		
Sex	0.976	2.204	0.015		
Income	2.413	0.796	0.102**		
PANAS Positive	0.655	0.113	0.195***		
Negative Affect					
General Health				67.803***	0.161

J Psychiatr Res. Author manuscript; available in PMC 2019 September 01.

	b	SE b	β (beta)	F	R^2
Age	−0.605	0.059	−0.301 ***		
Sex	1.110	1.516	0.022		
Income	1.554	0.522	0.087 **		
PANAS Negative	−0.667	0.077	−0.250 ***		
Bodily Pain[1]				65.067 ***	0.131
Age	−0.688	0.074	−0.278 ***		
Sex	−1.200	1.909	−0.019		
Income	1.107	0.655	0.050		
PANAS Negative	−0.787	0.098	−0.239 ***		
Physical Functioning				14.926 ***	0.128
Age	−0.748	0.081	−0.313 ***		
Sex	−3.940	2.025	−0.066		
Income	2.200	0.733	0.101 **		
PANAS Negative	−0.405	0.105	−0.130 ***		
Role – Physical				32.917 ***	0.117
Age	−0.682	0.088	−0.262 ***		
Sex	0.495	2.198	0.008		
Income	2.430	0.796	0.102 **		
PANAS Negative	−0.650	0.113	−0.192 ***		
Both					
General Health				52.791 ***	0.190
Age	−0.569	0.059	−0.283 ***		
Sex	1.513	1.492	0.030		
Income	1.182	0.517	0.666 *		
PANAS Positive	0.477	0.080	0.183 ***		

	b	SE b	β (beta)	F	R^2
PANAS Negative	−0.481	0.081	−0.181***		
Bodily Pain[1]				40.286***	0.146
Age	−0.657	0.073	−0.266***		
Sex	−0.884	1.898	−0.014		
Income	0.813	0.655	0.037		
PANAS Positive	0.389	0.103	0.120***		
PANAS Negative	−0.655	0.103	−0.198***		
Physical Functioning				16.780***	0.148
Age	−0.709	0.080	−0.297***		
Sex	−3.282	2.009	−0.055		
Income	1.923	0.728	0.088**		
PANAS Positive	0.470	0.110	0.152***		
PANAS Negative	−0.250	0.110	−0.080*		
Role – Physical				25.361***	0.140
Age	−0.640	0.087	−0.246***		
Sex	1.227	2.183	0.019		
Income	2.122	0.792	0.089**		
PANAS Positive	0.493	0.119	0.146***		
PANAS Negative	−0.487	0.119	−0.144***		

* P<.05

** P<.01

*** P<.001

[1] Lower self-reported pain is reported as higher scores on the respective SF-36 measure

Table 4

Stepwise linear regression analyses of predictor variables for **positive affect** with measures of physical health

	b	SE b	β (beta)	*F-change*	R^2	$R^{2\ change}$
General Health						
Step 1:				29.023^{***}	0.119	0.119
Age	−0.561	0.066	-0.277^{***}			
Sex	0.647	1.683	0.013			
Income	1.913	0.567	0.109^{**}			
Trauma Load	−0.972	0.240	-0.131^{***}			
Step 2:				44.856^{***}	0.202	0.083
Age	−0.575	0.063	-0.283^{***}			
Sex	2.937	1.623	0.058			
Income	1.048	0.548	0.060			
Trauma Load	−0.397	0.258	−0.054			
PSS Score	0.083	0.085	0.042			
BDI Score	−0.658	0.081	-0.330^{***}			
Step 3:				11.305^{**}	0.212	0.010
Age	−0.549	0.063	-0.271^{***}			
Sex	2.991	1.613	0.059			
Income	0.921	0.546	0.052			
Trauma Load	−0.378	0.257	−0.051			
PSS Score	0.067	0.085	0.034			
BDI Score	−0.537	0.088	-0.269^{***}			
PANAS Positive	0.317	0.094	0.118^{**}			
Bodily Pain						
Step 1:				23.635^{***}	0.098	0.098
Age	−0.677	0.082	-0.272^{***}			
Sex	−1.431	2.100	−0.023			

J Psychiatr Res. Author manuscript; available in PMC 2019 September 01.

	b	SE b	β (beta)	*F-change*	R^2	$R^{2\ change}$
Income	1.381	0.704	0.064			
Trauma Load	−1.163	0.298	−0.127***			
Step 2:				43.499***	0.180	0.082
Age	−0.713	0.078	−0.287***			
Sex	1.183	2.025	0.019			
Income	0.435	0.681	0.020			
Trauma Load	0.028	0.322	0.003			
PSS Score	−0.352	0.107	−0.144**			
BDI Score	−0.507	0.101	−0.206***			
Step 3:				0.504	0.181	0.001
Age	−0.706	0.079	−0.284***			
Sex	1.196	2.026	0.019			
Income	0.402	0.682	0.019			
Trauma Load	0.034	0.322	0.004			
PSS Score	−0.356	0.107	−0.146**			
BDI Score	−0.475	0.111	−0.193***			
PANAS Positive	0.084	0.118	0.025			
Physical Functioning						
Step 1:				21.737***	0.116	0.116
Age	−0.757	0.090	−0.312***			
Sex	−3.834	2.230	−0.065			
Income	2.658	0.791	0.123**			
Trauma Load	−0.325	0.319	−0.038			
Step 2:				12.002***	0.147	0.031
Age	−0.764	0.089	−0.315***			
Sex	−2.069	2.223	−0.035			
Income	2.058	0.788	0.095**			
Trauma Load	0.192	0.357	0.022			

	b	SE b	β (beta)	*F-change*	R^2	$R^{2\ change}$
PSS Score	−0.042	0.122	−0.018			
BDI Score	−0.415	0.114	−0.177 ***			
Step 3:				6.161 *	0.154	0.008
Age	−0.735	0.090	−0.303 ***			
Sex	−1.940	2.215	−0.033			
Income	1.956	0.786	0.091 *			
Trauma Load	0.217	0.356	0.025			
PSS Score	−0.052	0.121	−0.022			
BDI Score	−0.297	0.123	−0.126 *			
PANAS Positive	0.324	0.130	0.102 *			
Role – Physical						
Step 1:				17.112 ***	0.092	0.092
Age	−0.690	0.100	−0.259 ***			
Sex	−0.127	2.461	−0.002			
Income	2.616	0.871	0.111 **			
Trauma Load	−0.735	0.352	−0.078 *			
Step 2:				24.409 ***	0.154	0.062
Age	−0.718	0.096	−0.270 ***			
Sex	2.427	2.411	0.037			
Income	1.685	0.853	0.071 *			
Trauma Load	0.310	0.386	0.033			
PSS Score	−0.318	0.131	−0.125 *			
BDI Score	−0.455	0.123	−0.177 ***	3.630	0.158	0.005
Step 3:						
Age	−0.693	0.097	−0.261 ***			
Sex	2.534	2.407	0.039			
Income	1.595	0.853	0.068			

	b	SE b	β (beta)	*F-change*	R^2	$R^{2\ change}$
Trauma Load	0.328	0.385	0.035			
PSS Score	−0.324	0.131	−0.127 *			
BDI Score	−0.357	0.133	−0.139 **			
PANAS Positive	0.270	0.142	0.078			

* P<.05

** P<.01

*** P<.001

[1] Lower self-reported pain is reported as higher scores on the respective SF-36 measure

Table 5

Stepwise linear regression analyses of predictor variables for **negative affect** with measures of physical health

	b	SE b	β (beta)	*F-change*	R^2	$R^{2\ change}$
General Health						
Step 1:				29.023^{***}	0.119	0.119
Age	−0.561	0.066	-0.277^{***}			
Sex	0.647	1.683	0.013			
Income	1.913	0.567	0.109^{**}			
Trauma Load	−0.972	0.240	-0.131^{***}			
Step 2:				44.856^{***}	0.202	0.083
Age	−0.575	0.063	-0.283^{***}			
Sex	2.937	1.623	0.058			
Income	1.048	0.548	0.060			
Trauma Load	−0.397	0.258	−0.054			
PSS Score	0.083	0.085	0.042			
BDI Score	−0.658	0.081	-0.330^{***}			
Step 3:				2.996	0.205	0.003
Age	−0.578	0.063	-0.285^{***}			
Sex	2.948	1.621	0.058			
Income	1.072	0.547	0.061			
Trauma Load	−0.385	0.258	−0.052			
PSS Score	0.108	0.086	0.055			
BDI Score	−0.587	0.090	-0.294^{***}			
PANAS Negative	−0.184	0.106	−0.069			
Bodily Pain						
Step 1:				23.635^{***}	0.098	0.098
Age	−0.677	0.082	-0.272^{***}			
Sex	−1.431	2.100	−0.023			

J Psychiatr Res. Author manuscript; available in PMC 2019 September 01.

	b	SE b	β (beta)	*F-change*	R^2	$R^{2\ change}$
Income	1.381	0.704	0.064			
Trauma Load	−1.163	0.298	−0.127***			
Step 2:				43.499***	0.180	0.082
Age	−0.713	0.078	−0.287***			
Sex	1.183	2.025	0.019			
Income	0.435	0.681	0.020			
Trauma Load	0.028	0.322	0.003			
PSS Score	−0.352	0.107	−0.144**			
BDI Score	−0.507	0.101	−0.206***			
Step 3:				0.406	0.181	0.001
Age	−0.715	0.078	−0.287***			
Sex	1.184	2.026	0.019			
Income	0.449	0.681	0.021			
Trauma Load	0.033	0.322	0.004			
PSS Score	−0.340	0.108	−0.140**			
BDI Score	−0.475	0.113	−0.193***			
PANAS Negative	−0.085	0.133	−0.026			
Physical Functioning						
Step 1:				21.737***	0.116	0.116
Age	−0.757	0.090	−0.312***			
Sex	−3.834	2.230	−0.065			
Income	2.658	0.791	0.123**			
Trauma Load	−0.325	0.319	−0.038			
Step 2:				12.002***	0.147	0.031
Age	−0.764	0.089	−0.315***			
Sex	−2.069	2.233	−0.035			
Income	2.058	0.788	0.095**			
Trauma Load	0.192	0.357	0.022			

	b	SE b	β (beta)	*F-change*	R^2	$R^{2\ change}$
PSS Score	−0.042	0.122	−0.018			
BDI Score	−0.415	0.114	−0.177***			
Step 3:				0.150	0.147	0.000
Age	−0.764	0.089	−0.315***			
Sex	−2.078	2.225	−0.035			
Income	2.064	0.789	0.096**			
Trauma Load	0.197	0.358	0.023			
PSS Score	−0.035	0.123	−0.015			
BDI Score	−0.393	0.128	−0.167**			
PANAS Negative	−0.057	0.147	−0.018			
Role – Physical						
Step 1:				17.112***	0.092	0.092
Age	−0.690	0.100	−0.259***			
Sex	−0.127	2.461	−0.002			
Income	2.616	0.871	0.111**			
Trauma Load	−0.735	0.352	−0.078*			
Step 2:				24.409***	0.154	0.062
Age	−0.718	0.096	−0.270***			
Sex	2.427	2.411	0.037			
Income	1.685	0.853	0.071*			
Trauma Load	0.310	0.386	0.033			
PSS Score	−0.318	0.131	−0.125*			
BDI Score	−0.455	0.123	−0.177***			
Step 3:				0.037	0.154	0.000
Age	−0.717	0..097	−0.270***			
Sex	2.434	2.413	0.037			
Income	1.682	0.854	0.071			
Trauma Load	0.307	0.386	0.032			

	b	SE b	β (beta)	*F-change*	R^2	$R^{2\ change}$
PSS Score	−0.321	0.132	−0.126 *			
BDI Score	−0.467	0.139	−0.182 **			
PANAS Negative	0.031	0.160	0.009			

* P<.05

** P<.01

*** P<.001

[1] Lower self-reported pain is reported as higher scores on the respective SF-36 measure

Table 6

Stepwise linear regression analyses of predictor variables of positive affect with serum CRP concentrations.

	b	SE b	β (beta)	*F-change*	R^2	$R^{2\ change}$
Serum CRP						
Step 1:				6.958***	0.172	0.172
Age	−0.032	0.044	−0.053			
Sex	1.562	1.060	0.109			
Income	−0.783	0.380	−0.145*			
Trauma Load	0.096	0.161	0.043			
BMI	0.302	0.063	0.352***			
Step 2:				0.078	0.173	0.001
Age	−0.033	0.044	−0.055			
Sex	1.547	1.074	0.108			
Income	−0.784	0.384	−0.146			
Trauma Load	0.105	0.179	0.048			
BMI	0.299	0.064	0.348***			
PSS Score	−0.021	0.061	−0.036			
BDI Score	0.022	0.058	0.038			
Step 3:				1.333	0.180	0.007
Age	−0.037	0.044	−0.061			
Sex	1.436	1.078	0.101			
Income	−0.783	0.384	−0.145			
Trauma Load	0.090	0.180	0.041			
BMI	0.301	0.063	0.349**			
PSS Score	−0.015	0.061	−0.026			
BDI Score	−0.007	0.063	−0.013			
PANAS Positive	−0.088	0.076	−0.095			