How mental health relates to everyday stress, rumination, trauma and interoception in women living with HIV: A factor analytic study

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ABSTRACT

Mental health symptoms tend to correlate with one another within individuals. An exploratory factor analysis was performed on responses to five questionnaires related to depression, anxiety, trauma and perceived stress to determine which items related most highly to a common underlying construct in women with HIV (n = 35). Individual responses were further analyzed with respect to ruminations, which are repetitive thoughts about the self and with respect to interoception, which involves cognitive awareness of bodily states. Scores for ruminative thoughts were highly correlated with those for trauma-related thoughts (r = 0.77), perceived stress (r = 0.64), and symptoms of depression (r = 0.75). Items of mental health loaded highly and consistently onto one factor that accounted for 66% of the variance in the data. The principal factor accounted for 94% of the variance in measures of rumination, 87% for depression, 75% for trauma and stress, and 73% for anxiety. Women who endorsed greater numbers of maladaptive symptoms related to mental health (indicated by elevated factor scores) reported a decreased ability to sense and trust their bodily sensations and regulate thoughts and feelings related to these sensations. The general mental health factor did not relate to actual interoceptive awareness, as measured with a heartbeat tracking task. These results reveal a common and measurable mental health factor related to repetitive and body-related thoughts in people who are experiencing the everyday stress of living with a chronic disease.

1. Introduction

Within the field of clinical psychology, it has long been debated whether mental health and in particular, mental illnesses, are categorical in nature versus dimensional and/or continuous variables. In other words, are mental illnesses discrete entities with defined etiologies and treatment protocols or are symptoms continuous variables and thus, dependent on the degree to which particular symptoms or sets of symptoms are expressed within individuals? Indeed, the current edition of the Diagnostic and Statistical Manual of Mental Disorders acknowledges this debate by sustained inclusion of separate categories while incorporating so-called cross-cutting symptoms, such as sleep and memory disturbances (DSM-5; First, Williams, Karg, & Spitzer, 2015). In clinical research, mental symptoms are typically reported through subjective responses to standardized questionnaires. In a recent study, we examined mental health outcomes in adult women (n = 183), many of whom had experienced sexual trauma but did not necessarily meet the criteria for

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interoceptive sensibility and accuracy, and their relationships to common mental health outcomes. It was hypothesized that mental health outcomes are co-occurring within individuals and being reported by women with trauma history who were not diagnosed with PTSD or overtly seeking psychological treatment.

With these data in mind, we had the opportunity to study a relatively unique population of women and prospectively analyze their data to examine potential commonalities amongst reported symptoms in their everyday life. The participants were women living with the human immunodeficiency virus (HIV) in the city of Newark, New Jersey. Most of them were infected as children and therefore had been living with HIV for the majority of their adult life. The prevalence of mental illness symptoms in people with HIV is high. Out of a global survey of 486 women with HIV, 74% self-report feeling depressed since their diagnosis and 37% report suicidal ideation (Orza et al., 2015). Within the United States, women with HIV are 19% likely to meet criteria for generalized anxiety disorder, and these symptoms are highly comorbid with depression (Beer, Tie, Padilla, & Shouse, 2019). People with HIV are also more likely to experience a traumatic event, either prior to their diagnosis or as a result of contracting the virus. Twice as likely to experience trauma, 30% consider the diagnosis a trauma in and of itself (Gielen et al., 2007; Machtinger, Wilson, Haberer, & Weiss, 2012; Olley, Zeier, Seedat, & Stein, 2005; Wyatt et al., 2002). It has been estimated that 55% of women with HIV are victims of intimate partner violence with 42% meeting full criteria for PTSD (Machtinger et al., 2012; Martinez, Israelski, Walker, & Koopman, 2002). Women with HIV are more likely to ruminate, and experience higher perceived stress and depression (Nightingale, Sher, & Hansen, 2010; Yanes, Morse, Bin Hsiao, Simms, & Roberts, 2012). Other studies indicate that the stress and anxiety of living with HIV has a negative impact on sleep, appetite and concentration (Schulte et al., 2018).

Interoception refers to the mental awareness of the body’s physiological state and thus depends on the interaction between mental and physical processes. In particular, cardiac interoception refers to the awareness of one’s own heartbeats. Even though the heart beats approximately 100,000 times a day, people are generally unaware of it. This awareness relies on distributed signals from receptors and neural networks, including those related to temperature, pain, visceral sensations and activation of the autonomic nervous system. Three common dimensions of interoception have been proposed and include interoceptive accuracy, sensibility and awareness (Garfinkel & Critchley, 2013; Garfinkel, Seth, Barrett, Suzuki, & Critchley, 2015). Interoceptive accuracy refers to the objective measure of detecting or tracking body sensations, such as heartbeats, whereas interoceptive sensibility measures subjective interoception through self-report. Interoceptive awareness is defined as a person’s confidence in or beliefs about their own interoceptive accuracy or sensibility (Garfinkel & Critchley, 2013). Research on interoceptive processes are limited for people living with HIV. If anything, data suggest that people with HIV/AIDS are more aware of their body sensations (Gonzalez, Zvolensky, Parent, & Grover, 2001, 2016).

The present study analyzed statistical relationships among mental and physical outcomes in a population of women living with HIV for most of their adult life and potentially experiencing stress and other related symptoms. To begin, we asked participants to report their levels of perceived stress, rumination, depression and anxiety. We assessed interoception, both with respect to accuracy and sensibility. Interoceptive accuracy of the heart was measured using a heartbeat tracking task (Garfinkel et al., 2015; Rae et al., 2020; Schandry, 1981). Interoceptive sensibility, defined here as beliefs about bodily sensations, was assessed through self-report with the Multidimensional Assessment of Interoceptive Awareness (Mehling, Acree, Stewart, Silas, & Jones, 2018; Mehling et al., 2012). Since their original publication in 2012, Mehling and colleagues have acknowledged that interoceptive “sensibility” is a better descriptor than “awareness” (Mehling et al., 2018). Factor analyses were used to detect the potential contribution of trauma-related and ruminative thoughts, perceived stress, depressive and anxiety symptoms to a central construct of mental health. We then examined the relationships between interoceptive sensibility and accuracy, and their relationships to common mental health outcomes. It was hypothesized that mental health outcomes would be highly correlated within individuals, and that the variance in these measures would account for the variance in rumination as well as interoception. It was further hypothesized that women who reported that they were more aware of their body’s physiological state would be more accurate at tracking their heartbeats.

2. Method

2.1. Participants

Thirty-eight female participants (95% Black/African-American, 2.5% Latina, 2.5% White) between the ages of 22–68 years (M_age = 45 years) living with HIV were recruited to participate in this study. Participants were recruited from the François-Xavier Bagnoud (FXB) Center, Rutgers University Hospital and St. Clare’s Housing Program in Newark, NJ, where individuals with HIV seek counseling and medical treatment.

2.2. Procedure

Participants were provided with information about the study and written informed consent was obtained in accordance with the Declaration of Helsinki. This study was carried out in accordance with the recommendations of the Institutional Review Board at Rutgers University. All research staff were certified by the Collaborative Institutional Training Initiative (CITI) for Human Subjects Research. Participants completed self-report questionnaire measures of trauma-related cognitions, ruminative thoughts, perceived...
stress, depression, anxiety, and interoception (outlined below). After completing questionnaire measures, participants completed the heartbeat tracking task during electrocardiography (ECG) recording.

2.2.1. Posttraumatic cognitions

The frequency and type of posttraumatic cognitions were assessed with the Posttraumatic Cognition Inventory or PTCI. The PTCI is a 33-item questionnaire that assesses altered cognitions related to traumatic life events (Foa, Ehlers, Clark, Tolin, & Orsillo, 1999). The PTCI assesses a person's reaction to the event after time has passed and includes items such as “I have to be on guard all the time,” “I feel like I don't know myself anymore,” and “I feel isolated.” We altered the prompt to ask participants about their thoughts and feelings related to “the most stressful event of your life.” This way, women with and without trauma history reported their thoughts and feelings related to an especially stressful past event.

2.2.2. Ruminative thoughts

The frequency and type of ruminative thoughts were assessed with the Ruminative Responses Scale or RRS (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). The RRS measures how often a person engages in specific thoughts related to sadness. The RRS contains 22 items including: “think about how alone you feel,” “think about how hard it is to concentrate,” or “think about “why do I always react this way?” Items are scored on a scale from 1 (almost never) to 4 (almost always). The RRS is scored as a summation of responses (min 22; max 88) as well as according to three subscales: (1) depressive ruminations, which relate to the rehearsal of depressive events, (2) brooding ruminations, which are often non-adaptive and emotion-laden, and (3) reflective ruminations, which are not as maladaptive but self-focused (Michl, McLaughlin, Shepherd, & Nolen-Hoeksema, 2013; Shors, Millon, Chang, Olson, & Alderman, 2017). Healthy young adults tend to self-report RRS scores of approximately 42–44, women with sexual violence history tend to report RRS scores of approximately 54, and depressed individuals tend to report RRS scores of approximately 60 (Millon et al., 2018; Nolen-Hoeksema et al., 1999; Shors et al., 2017).

2.2.3. Perceived stress

Subjective feelings of stress were assessed with the Perceived Stress Scale or PSS (Cohen, Kamarck, & Mermelstein, 1983). The PSS assesses a person’s self-reported ability on how well she has handled events from the past month. The PSS contains 10 items such as, “In the last month, how often have you felt nervous and stressed?” and “In the last month, how often have you felt that you were on top of things?” Items are scored on a scale from 0 (never) to 4 (very often). PSS scores ranging from 0 to 13 are considered low perceived stress, 14–26 indicate moderate perceived stress, and 27–40 indicate high perceived stress.

2.2.4. Depressive symptoms

The potential presence of depressive symptoms was assessed with the Beck Depression Inventory-II or BDI-II (Beck, Steer, & Brown, 1996). The BDI-II contains 21 items related to feelings of sadness, satisfaction, guilt and changes in appetite/weight/interest in sex. Items are scored on a scale from 0 (not at all) to 3 (most severe). BDI-II scores from 0 to 13 indicate minimal depression, 14–19 indicate mild depression, 20 and above indicate moderate to severe depression (Beck et al., 1996).

2.2.5. Anxiety symptoms

The potential presence of anxiety symptoms was assessed with the Beck Anxiety Inventory or BAI (Beck, Epstein, Brown, & Steer, 1988). The BAI contains 21 items and has been used in clinical populations to assess anxiety: 14 items relate to somatic symptoms of anxiety and 7 items assess cognitive and subjective features of anxiety and panic. Items are scored on a scale from 0 (not at all) to 3 (most severe). BAI scores less than 15 indicate minimal to mild anxiety, 16–25 indicate moderate anxiety, and scores greater than 26 indicate severe anxiety (Antony, Orsillo, & Roemer, 2001).

2.2.6. Interoceptive sensibility

Interoceptive sensibility was assessed with the Multidimensional Assessment of Interoceptive Awareness Version 2 or MAIA-2 (Mehling et al., 2018). The MAIA-2 contains 37 items related to the awareness of bodily sensations, including pain or discomfort, the connection between bodily sensations and emotional states, the ability to regulate distress, and viewing one's body as safe and trustworthy. Items are scored on a scale from 0 (never) to 5 (always). The MAIA-2 has 8 subscales corresponding to noticing, not-distracting, not-worrying, attention regulation, emotional awareness, self-regulation, body listening, and trusting. Higher MAIA scores overall indicate better interoceptive sensibility.

2.2.7. Interoceptive accuracy

Interoceptive accuracy was measured with the heartbeat tracking task (Rae et al., 2020; Schandry, 1981) while recording ECG. One electrode was attached to the participant’s right wrist, one to the left ankle, and the ground electrode was also attached to the right wrist. Participants sat upright in a chair with their feet flat on the floor. During the task, participants were asked to sit facing the wall (away from the researcher) and to minimize movement. The participant was instructed to silently count her own heartbeats, without taking her pulse, when verbally signaled to start and stop by the researcher. At the stop signal, the participant reported the number of heartbeats counted. Six trials were conducted with randomized durations of 25, 30, 35, 40, 45 and 50 s and a 10-second break between trials.

ECG data were collected from the wrists using a J&J Engineering C2® physiograph and digitized to 1024 samples per second. Raw ECG data were imported to WinCPRS® (Absolute Aliens Oy, Turku, Finland) or ARTiiFACT (Kaufmann, Sütterlin, Schulz, & Vögele,
(R-R waves (one heartbeat to the next) or interbeat intervals. Interbeat interval data were analyzed with 4 samples per second. Reported heartbeats ($n_{\text{beats reported}}$) were compared to the actual number of heartbeats recorded from the interbeat intervals during ECG ($n_{\text{beats real}}$). Accuracy scores during the heartbeat tracking task were scored according to two different formulas, depending on whether the person substantially overestimated or underestimated their heartbeats (Garfinkel et al., 2015; Rae et al., 2020).

People typically underestimate their number of heartbeats. The following “standard accuracy” formula was used for underestimators (i.e., participants who did not estimate more than twice the number of actual heartbeats) (Rae et al., 2020):

$$1 - \frac{|n_{\text{beats real}} - n_{\text{beats reported}}|}{n_{\text{beats real}}}$$

Fig. 1. Mental Health Outcomes. Column scatterplots of (A) posttraumatic cognitions as assessed by the Posttraumatic Cognitions Inventory, (B) ruminative thoughts as assessed by the Ruminative Responses Scale, (C) perceived stress as assessed with the Perceived Stress Scale, (D) depressive symptoms as assessed with the Beck Depression Inventory, and (E) anxiety symptoms as assessed with the Beck Anxiety Inventory in women with HIV. The number of trauma-related thoughts were highly correlated to the number of ruminative thoughts (F), and moderately correlated with reported levels of perceived stress (G), and depression (H) in women with HIV. The number of ruminative thoughts were highly correlated to reported levels of perceived stress (I), and symptoms of depression (J) and anxiety (K). Reported levels of perceived stress were highly correlated with symptoms of depression (L) and moderately correlated with symptoms of anxiety (M). Finally, symptoms of anxiety and depression (N) were highly correlated in women with HIV.
In addition to the formula above, a second formula ("alternative accuracy") was used for overestimators (i.e., participants who substantially overestimated the number of actual heartbeats). The average of the reported and actual beats in the denominator was used to mitigate overestimation (Garfinkel et al., 2015):

\[ 1 - \left( \frac{\text{beats}_{\text{real}} - \text{beats}_{\text{reported}}}{\left( \text{beats}_{\text{real}} + \text{beats}_{\text{reported}} \right)/2} \right) \]

The average accuracy score across all six trials was calculated for each individual. Only one participant substantially overestimated her heart rate, and these data were calculated according to the alternative accuracy formula. All other interoceptive scores were calculated according to the standard accuracy formula, per Rae et al. (2020).

2.3. Data analyses

Statistical tests were performed using IBM SPSS Statistics. Correlational analyses were performed between five dependent measures of mental health (scores from the PTCI, RRS, PSS, BDI and BAI) within individuals. An exploratory factor analysis was performed to determine the existence of a shared common construct among the dependent measures of mental health. Three participants did not fully complete all questionnaire measures and therefore were omitted from analyses of mental health outcomes. Correlational analyses among factor scores, self-reported interoceptive sensitivity and interoceptive accuracy were performed within individuals to determine additional relationships.

3. Results

3.1. Relationships among mental health outcomes

Group means and standard errors of trauma-related thoughts (as assessed with the PTCI), rumination (as assessed with the RRS), perceived stress (as assessed with the PSS), depression (as assessed with the BDI), and anxiety (as assessed with the BAI) are shown in Fig. 1A–E. Correlational analyses indicated that mental health outcomes were moderately to highly correlated within individuals (Table 1). Numbers of trauma-related thoughts were highly correlated with numbers of ruminative thoughts, \( r = 0.77, p < 0.001 \) (Fig. 1F), and moderately correlated with reported levels of perceived stress, \( r = 0.44, p < 0.01 \) (Fig. 1G) and symptoms of depression \( r = 0.52, p = 0.001 \) (Fig. 1H), but not with symptoms of anxiety, \( r = 0.31, p > 0.05 \). Ruminative thoughts were highly correlated with reported levels of perceived stress, \( r = 0.64, p < 0.001 \) (Fig. 1I), and symptoms of depression, \( r = 0.75, p < 0.001 \) (Fig. 1J) and anxiety, \( r = 0.62, p < 0.001 \) (Fig. 1K). Reported levels of perceived stress were highly correlated with symptoms of depression, \( r = 0.57, p < 0.001 \) (Fig. 1L) and moderately correlated with symptoms of anxiety, \( r = 0.42, p < 0.05 \) (Fig. 1M). Finally, symptoms of depression and anxiety were highly correlated within women with HIV, \( r = 0.64, p < 0.001 \) (Fig. 1N).

3.2. Subtypes of ruminative thoughts

All three subtypes of ruminative thoughts (depressive, brooding and reflective) were moderately to highly related to trauma-related cognitions, perceived stress, depression and anxiety (Fig. 2). Depressive ruminations highly correlated with trauma-related cognitions, \( r = 0.71, p < 0.001 \) (Fig. 2A), perceived stress \( r = 0.65, p < 0.001 \) (Fig. 2B), depressive symptoms \( r = 0.76, p < 0.001 \) (Fig. 2C), and anxiety symptoms \( r = 0.63, p < 0.001 \) (Fig. 2D). Brooding ruminations highly correlated with trauma-related cognitions, \( r = 0.74, p < 0.001 \) (Fig. 2E), perceived stress \( r = 0.63, p < 0.001 \) (Fig. 2F), depressive symptoms \( r = 0.63, p < 0.001 \) (Fig. 2G), and anxiety symptoms \( r = 0.50, p < 0.01 \) (Fig. 2H). Reflective ruminations significantly correlated with trauma-related cognitions, \( r = 0.67, p < 0.001 \) (Fig. 2I), perceived stress \( r = 0.35, p < 0.05 \) (Fig. 2J), depressive symptoms \( r = 0.57, p < 0.001 \) (Fig. 2K), and anxiety symptoms \( r = 0.51, p < 0.01 \) (Fig. 2L).

3.3. Exploratory factor analysis of mental health outcomes

An exploratory factor analysis was used to test for a shared construct(s) which could account for variance in the responses to standardized mental health surveys. The five dependent measures of mental health (PTCI, RRS, PTCI, BDI, BAI) were entered into the

Table 1

<table>
<thead>
<tr>
<th></th>
<th>RRS</th>
<th>BDI</th>
<th>PSS</th>
<th>PTCI</th>
<th>BAI</th>
</tr>
</thead>
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<tr>
<td>RRS</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BDI</td>
<td>0.75***</td>
<td>1.00</td>
<td></td>
<td></td>
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<tr>
<td>PSS</td>
<td>0.64***</td>
<td>0.57***</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTCI</td>
<td>0.77***</td>
<td>0.52**</td>
<td>0.44**</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>BAI</td>
<td>0.62***</td>
<td>0.64***</td>
<td>0.42*</td>
<td>0.31</td>
<td>1.00</td>
</tr>
</tbody>
</table>

* p < 0.05.
** p < 0.01.
*** p < 0.001.
Fig. 2. Subtypes of Ruminative Thoughts. Depressive ruminations highly correlated with (A) trauma-related cognitions, (B) perceived stress, (C) depressive symptoms and (D) anxiety symptoms. Brooding ruminations also highly correlated with (E) trauma-related cognitions (F) perceived stress, (G) depressive symptoms, and (H) anxiety symptoms. Reflective ruminations significantly correlated with (I) trauma-related cognitions, (J) perceived stress, (K) depressive symptoms, and (L) anxiety symptoms.
factor analysis. The responses to the questionnaires loaded highly and consistently onto a principal factor (Eigenvalue 3.30), which accounted for 66% of the variance in the sample. A Scree plot of components extracted from the factor analysis and corresponding Eigenvalues indicated a principal factor with an Eigenvalue above 3 (Fig. 3A). The principal factor accounted for 94% of the variance in RRS scores, 87% of the variance in BDI scores, 75% of the variance in PTCI and PSS scores, and 73% of the variance in BAI scores (Table 2). Exploratory factor analysis was used to assign each person a factor score. These scores were normally distributed, as indicated by a non-significant Shapiro-Wilk test of a null of normality ($p > 0.05$) and skewness and kurtosis values of 0.07 and -0.46 respectively.

3.4. Mental health outcomes and interoception

Means and standard errors from MAIA subscales are reported in Table 3. Correlations were performed among the factor scores of mental health and self-reported interoceptive sensibility (MAIA scores). Within each individual, mental health factor scores inversely related to overall interoceptive sensibility ($r = -0.40, p < 0.05$) (Fig. 3B), and two subscale measures of interoceptive sensibility: self-regulation, $r = -0.50, p < 0.01$, and trusting one’s body, $r = -0.46, p < 0.01$ (Fig. 3C, D). These data suggest that women who reported greater numbers of symptoms related to mental health (indicated from factor scores) reported decreased ability to sense and trust bodily sensations and regulate thoughts and feelings related to these sensations.

There was no correlation between mental health factor scores and interoceptive accuracy scores (assessed with the heartbeat tracking task), $p > 0.05$. Neither was there a correlation between interoceptive sensibility (MAIA scores) and interoceptive accuracy, $p > 0.05$.

Fig. 3. Mental Health and Interoception. (A) Scree plot of the number of components (represented on the x-axis) and corresponding Eigenvalues per component (y-axis) extracted from the exploratory factor analysis of the five questionnaire measures of PTCI, RRS, PSS, BDI and BAI. Factor scores of mental health inversely correlated with (B) interoceptive sensibility overall as well as the (C) self-regulation and (D) body trusting subscales of the Multidimensional Assessment of Interoceptive Awareness (MAIA). Women with fewer numbers of mental health symptoms (assessed with factor scores) reported higher levels of interoceptive sensibility, higher levels of self-regulation, and higher levels of trusting one’s body, when assessed with self-report ($n = 35$).
concentration and fatigue. As a group, women reported mild to moderate levels of depressive symptoms with a mean of 16 (Fig. 1E).

The Beck Depression Inventory (BDI) assesses feelings of sadness or guilt, thoughts related to suicide, and changes or difficulty with sleep, appetite, energy, and concentration. The Posttraumatic Cognitions Inventory (PTCI) assesses intrusive thoughts, avoidance, numbing, and other aspects of trauma-related symptoms. The Perceived Stress Scale (PSS) measures the degree to which situations and events in one's life are appraised as stressful. The Ruminative Responses Scale (RRS) assesses the tendency to repetitively rehearse thoughts, which are often about the past, future, or potential dangers.

An exploratory factor analysis was performed on five dependent measures of mental health (trauma, rumination, perceived stress, depression, anxiety) in women with HIV. This process identified the amount of variance for each measure of mental health that was accounted for by the general factor. Our goal was to reduce the number of dependent measures as they were highly related (Table 1) and compute a score of mental health for each participant to assess differences across individuals. The five questionnaires loaded highly and consistently onto a general factor and the factor collectively explained 66% of the variance in the data (Table 2). The general factor, which we refer to as the mental health factor, accounted for the greatest amount of variance in the Ruminative Responses Scale (94%).

### Table 2

<table>
<thead>
<tr>
<th>Subscale (# of items)</th>
<th>Mean (Standard Error)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not-Distracting (6)</td>
<td>2.67 (.24)</td>
<td>0–5.00</td>
</tr>
<tr>
<td>Not-Worrying (5)</td>
<td>2.62 (.17)</td>
<td>0–4.80</td>
</tr>
<tr>
<td>Attention Regulation (7)</td>
<td>2.96 (.21)</td>
<td>0–5.00</td>
</tr>
<tr>
<td>Emotional Awareness (5)</td>
<td>3.56 (.21)</td>
<td>0–5.00</td>
</tr>
<tr>
<td>Self-Regulation (4)</td>
<td>3.23 (.26)</td>
<td>0–5.00</td>
</tr>
<tr>
<td>Body-Listening (3)</td>
<td>3.05 (.24)</td>
<td>0–5.00</td>
</tr>
<tr>
<td>Not-Worrying (5)</td>
<td>2.62 (.17)</td>
<td>0–4.80</td>
</tr>
<tr>
<td>Total (37)</td>
<td>24.65 (1.19)</td>
<td>8–37</td>
</tr>
</tbody>
</table>

4. Discussion

In 2009, the National Institutes of Mental Health launched the Research Domain Criteria (RDoC), in order to outline research foci that centered on domains of functioning shared across diagnostic criteria of mental illness (Insel & Cuthbert, 2009; Insel et al., 2010). These guidelines arose from concerns about the efficacy of pharmacological treatments for mental illness, as well as the use of discrete diagnostic categories that did not necessarily capture underlying etiology or treatment response (Insel et al., 2010). Current assessments of mental health and everyday function tend to remain focused on symptoms which are specific to discrete categories of illness, although there is greater appreciation for cross-cutting dimensions and co-morbidity (Van Dorn et al., 2016). To this end, factor analyses are a promising analytical tool to detect commonalities across measures and uncover shared symptoms across different mental states. Few studies employ such a strategy; those that do suggest shared states and behaviors across people with specific diagnoses (Black, Panayiotou, & Humphrey, 2019; Pezzoli, Antfolk, & Santtila, 2017; Van Dorn et al., 2016). Less is known about how dysfunctional thoughts and feelings manifest and potentially coalesce in people who do not meet criteria for a clinical diagnosis. And existing studies do not necessarily test how similar types of questions on standardized mental health surveys capture overlapping states.

An exploratory factor analysis was performed on five dependent measures of mental health (trauma, rumination, perceived stress, depression, anxiety) in women with HIV. This process identified the amount of variance for each measure of mental health that was accounted for by the general factor. Our goal was to reduce the number of dependent measures as they were highly related (Table 1) and compute a score of mental health for each participant to assess differences across individuals. The five questionnaires loaded highly and consistently onto a general factor and the factor collectively explained 66% of the variance in the data (Table 2). The women reported moderate, subclinical levels of mental health symptoms; yet those who reported higher numbers of thoughts related to trauma and rumination were experiencing greater perceived stress, and more depressive and anxiety symptoms (Fig. 1). Thus, these symptoms were highly related within individuals, and in part, might share physiological mechanisms.

The general factor, which we refer to as the mental health factor, accounted for the greatest amount of variance in the Ruminative Responses Scale (94%). The RRS assesses to what degree a person has the tendency to repetitively rehearse thoughts, which are oftentimes negative and about the past. These thoughts are highly related to depressive symptoms, particularly in women (Millon et al., 2018; Nolen-Hoekema et al., 1999; Shors et al., 2017; Nolen-Hoekema, 2012). These data suggest that the general factor of mental health was accounting for much of the variance in the data related to ruminative thoughts. At the same time, ruminative thoughts were strongly correlated with scores of trauma, perceived stress, depression and anxiety (Fig. 1F, I–K). Depressive, brooding and reflective ruminative subtypes were also highly related to other mental health outcomes (Fig. 2). These data suggest that the presence of mental health symptoms may predict ruminative thought processes, though we are not able to determine causality. On average, women with HIV reported moderate numbers of ruminative thoughts with a mean of 45 (Fig. 1B), which is lower than observed for women who report sexual violence history or who have been diagnosed with major depressive disorder (Millon et al., 2018; Shors et al., 2017).

The factor analysis further indicated that the general factor accounted for 87% of the variance in scores from the Beck Depression Inventory. The BDI assesses feelings of sadness or guilt, thoughts related to suicide, and changes or difficulty with sleep, appetite, concentration and fatigue. As a group, women reported mild to moderate levels of depressive symptoms with a mean of 16 (Fig. 1E).
Nevertheless, several women scored higher than 20 on the BDI, which is indicative of moderate to severe levels of depression. Prior research indicates depressive symptoms and fatigue are highly related in women living with HIV (Voss, Portillo, Holzemer, & Dodd, 2007). Our data extend these prior findings to indicate that BDI scores were highly related to other impairments in mental health within individuals. Women who had greater difficulties with sleep, concentration and fatigue (indicated with the BDI) reported that they had a greater tendency to ruminate and were endorsing more symptoms related to trauma, stress and anxiety.

The general factor accounted for 73% of the variance in each of the two scales related to stress and trauma, the Perceived Stress Scale and the Posttraumatic Cognitions Inventory. The PSS asks the responder to report their feelings of stress over the last month. Self-reported levels of perceived stress were moderate with a mean of 18 (Fig. 1C). These data are similar to others which report scores averaging 16–17 on the PSS scale in majority African-American samples (Muhammad et al., 2019; Rehm & Konkle-Parker, 2017). It is noted that we did not compare women with and without HIV. But a large cohort study of over 1,000 women with HIV across the United States compared to approximately 500 women without HIV reported comparable PSS scores ranging from 10 to 24 in both groups (Rubin et al., 2015). Overall, the data reported here indicate that women were not necessarily endorsing higher levels of perceived stress than other reports from female populations with or without HIV. Nevertheless, individual differences were prevalent, as nearly half of the women reported PSS scores greater than 20, which is indicative of high levels of stress and nervousness in the present context. Moreover, perceived stress strongly correlated with symptoms of depression (r = 0.57) and moderately correlated with anxiety (r = 0.42) (Fig. 1L-M), indicating those women who were reporting higher levels of perceived stress were also experiencing high levels of anxiety and depression. The PSS does not ask participants to identify their stressors but rather is a global assessment of how a person feels she can handle daily events. Most of the participants acquired the virus many years ago, but they still live with the illness itself and its related stigma, as well as potential health and work-related challenges of inner city living.

Scores for the PTCI were elevated, with a mean of 95, which is slightly higher than women with neither HIV or trauma history (Millon et al., 2018). The mean response was substantially lower than scores reported by women with sexual violence history but without HIV (who averaged around 121) (Millon et al., 2018). However, in the prior study, a third (33%) of the women met diagnostic criteria for PTSD and reported higher numbers of trauma-related and rumination thoughts compared to women without PTSD. In the present study, we did not assess trauma-related cognitions in women without HIV and did not interview for mental health diagnoses. Others report that 36% of this population consider the HIV diagnosis a trauma in and of itself (Olley et al., 2005). Overall, the presence of negative thoughts and feelings related to past trauma(s) in women with HIV suggests that they are experiencing ongoing stress, regardless of biological therapies which prevent the development of Acquired Immune Deficiency Syndrome (AIDS).

The general factor accounted for 73% of the variance in Beck Anxiety Inventory scores (Table 2). Questions on this scale assess feelings of numbness, nervousness and fear, as well as being unable to relax or breathe. As a group, self-reported levels of anxiety averaged around 13, indicative of mild levels of anxiety (Fig. 1D). These responses are similar to those reported for women living with HIV in the United States, with an average score of 12 (Walch & Rudolph, 2006). We also observed substantial individual differences. Approximately 23% reported scores higher than 20. Within individuals, anxiety symptoms were highly correlated with depressive symptoms (r = 0.64; Fig. 1N), which is generally consistent with other studies (Morrison et al., 2002). Anxiety was also highly correlated with rumination thoughts (r = 0.62; Fig. 1K) and moderately correlated with perceived stress (r = 0.42; Fig. 1M). Collectively, these data indicated that the responses to items included in the five questionnaires related to mental health were highly related and were measuring similar thoughts and symptoms in women with HIV.

4.1. Interoceptive sensibility relates to mental health outcomes

Women who reported greater numbers of mental health symptoms reported less interoceptive sensibility as assessed with the Multidimensional Assessment of Interoceptive Awareness or MAIA (Fig. 2B). MAIA subscale responses were analyzed separately as they may reflect distinct processes related to interoception (Calli, Ambrosini, Picconi, Mehlings, & Committi, 2015; Mehlings et al., 2012). Two subscales of the MAIA, those of self-regulation and body trusting, inversely correlated with mental health factor scores (Fig. 2C, D). These data suggest that women felt less able to regulate and trust their body sensations compared to women with fewer mental health symptoms. The self-regulation subscale references the ability to regulate psychological distress by attending to bodily sensations (Mehling et al., 2012). Items include, “When I bring awareness to my body I feel a sense of calm”, “I can use my breath to reduce tension”, and “When I am caught up in thoughts, I can calm my mind by focusing on my body/breathing.” The body trusting subscale includes items such as, “I am at home in my body” and “I trust my body sensations” and assesses the extent to which a person views one’s body as safe and trustworthy (as opposed to unfamiliar or anxiety-provoking). Mehlings et al. developed the trusting subscale to capture one’s ability to observe how their own emotions affect their own behavior (2012). For example, the body trusting subscale measures to what extent a person feels she understands her bodily sensations contributes in a helpful way to decision making or overall health (Mehling et al., 2012).

Initially, Mehlings et al. developed the MAIA to isolate the conscious detection of bodily sensations (in their words, a “nonjudgmental awareness”). In so doing, they sought to avoid conflating this construct with maladaptive worry or anxiety about bodily sensations, which can include hypervigilance or pain catastrophizing. The scale addresses interoceptive processes along a continuum, with maladaptive hyperawareness on one end, and a complete lack of awareness, which is also maladaptive, at the other end. Either extreme would be considered unhealthy, whereas a healthy, adaptive level of conscious awareness of one’s bodily signals is a balance between extremes. It is noted that we do not report physiological outcomes in this study, nor did we assess interoceptive sensibility in women without HIV. However, means ranged from approximately 2.5–3.5 (reported in Table 3). These numbers are consistent with those reported by individuals without HIV (Mehling et al., 2012), suggesting that women living with HIV do not necessarily feel less or more aware of their bodies than other populations.
As with the other measures, there was a range of responses to the MAIA subscales. Multiple women in this study reported the highest score of 5 on both the self-regulation and body-trusting subscales. Given the potential ceiling effect in the subscale scores, it is difficult to determine how interoceptive awareness related to mental health for those women who were presumably high functioning. However, those women who reported that they were less able to regulate their thoughts and feelings and less willing to trust their body sensations were also experiencing higher levels of anxiety, depression and perceived stress. We were not able to determine causal patterns in these relationships; however, it might have been the case that anxiety or stress impeded awareness of bodily sensations or that an inability to attend to bodily sensations in a healthy manner elicited anxiety or stress. Others have reported that people higher in anxiety were less trusting of their bodily sensations (e.g., Mehling et al., 2012). In this population, anxiety could interfere with attention to pain sensations, which are frequent among persons living with the HIV virus.

4.2. Interoceptive accuracy did not relate to interoceptive sensibility

We had predicted that women who were more accurate at tracking their heartbeats would also feel as if they were more aware of their bodily sensations. However, these two measures of interoception were not related within individuals. Others have reported similar dissociations (e.g., Calì et al., 2015; Khalsa et al., 2008). For example, people with high numbers of anxiety symptoms were more accurate at tracking their heartbeats (Domschke, Stevens, Pfeiderer, & Gerlach, 2010), and yet a similar population reported less interoceptive sensibility as assessed with the MAIA (Mehling et al., 2018). Most studies have not directly compared the two types of interoceptive processes or have tested them in clinical samples (Dunn, Dalgleish, Ogilvie, & Lawrence, 2007; Dunn, Galton et al., 2010; Dunn, Stefanovitch et al., 2010; Schaan et al., 2019). The women in our study did not undergo a clinical interview for mental disorders. However, as a group, they reported moderate levels of mental health symptoms (Fig. 1) and most would likely not meet diagnostic criteria for mental illness. This may in part explain the absence of a relationship between interoceptive accuracy and sensitivity. All this being said, the data here suggest that people who feel that they are less aware of sensations in their own body are not necessarily less aware, at least with respect to feeling one’s own heartbeat.

5. Conclusions

Women with HIV reported that they are living with a relatively high degree of perceived stress, along with feelings of depression and anxiety, coupled with high numbers of trauma-related and ruminative thoughts. These thoughts and feelings tended to correlate within individuals, with correlations ranging from 0.4 to 0.8. They also tended to relate to a perceived inability to regulate or trust their internal bodily states. When these corresponding measures of mental health were subjected to factor analyses, all measures loaded highly and consistently onto a principal factor, which accounted for 94% of the variance in ruminations. This finding suggests either a close relationship between ruminative thoughts and mental health symptoms within individuals or rather that items within the surveys are measuring similar phenomena, or both. These data extend our previous studies suggesting that subjective responses to standardized questionnaires used in many clinical studies tend to correlate within individuals by indicating that a great deal of the variance in responses can be accounted for by individual responses (Millon et al., 2018; Shors et al., 2017). While standardized questionnaires capture symptoms associated with distinct mental illnesses such as MDD and PTSD, they also reveal the relationship among everyday thoughts and feelings in people living with a chronic illness such as HIV.

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