



Gender Disparities in Traumatic Life Experiences and Antiretroviral Therapy Adherence Among People Living with HIV in South Carolina

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Abstract

People living with HIV are at increased risk for experiencing trauma, which may be linked to reduced adherence to antiretroviral therapy (ART), making it more difficult to achieve and maintain viral suppression. The current study sought to assess whether traumatic life experiences were associated with lower ART adherence among a diverse sample of people living with HIV in South Carolina. A cross-sectional survey was completed by 402 individuals receiving HIV care from a large immunology center. Principal component analysis revealed three primary categories of trauma experience (extreme violence/death-related trauma, physical and sexual assault, and accidental/disaster-related trauma). Multivariable logistic regression models using complete case analysis and multiple imputation were used to determine the associations between experiencing each trauma category and ART adherence. Complete case analysis showed that overall, participants who reported exposure to any trauma were 58% less likely to be adherent to their ART (adjusted OR 0.42; 95% CI 0.21–0.86) compared to respondents who did not experience trauma. Participants exposed to extreme violence/death-related trauma were 63% less likely to be adherent to their ART (adjusted OR 0.37; 95% CI 0.15–0.95) compared to respondents who did not experience trauma. Participants exposed to physical and sexual assault were 65% less likely (adjusted OR 0.35; 95% CI 0.16–0.77) and those who reported experiencing accidental/disaster-related trauma were 56% less likely (adjusted OR 0.44; 95% CI 0.21–0.93) to report being ART adherent compared to participants who did not experience trauma. Analyses with multiple imputation yielded similar findings as the complete case analyses. When the data were analyzed separately by gender, the associations between overall trauma, extreme violence/death-related trauma, and physical and sexual assault were statistically significant for men using complete case and multiple imputation analyses. There were no statistically significant associations between trauma and ART adherence among women. Findings highlight the need to adopt trauma-informed approaches and integrate trauma- and gender-specific interventions into HIV clinical care in the Southern United States.

Keywords Trauma · ART adherence · HIV · Men · Women

Introduction

Trauma exposure is widespread in the United States (US), with recent estimates suggesting that close to 90% of the general population have a lifetime exposure to one or more traumatic events [1]. The *Diagnostic and Statistical Manual of Mental Disorders-5th Edition* (DSM-5) defines trauma exposure as personally experiencing, witnessing, or being indirectly exposed (i.e., through the experience of a family member or close associate) to “actual or threatened death, serious injury, or sexual violence” [2]. Both types of traumatic events and individual responses to trauma span a wide continuum [3]. The events that can be included under the trauma umbrella, as well as the direct versus indirect nature of exposure, continue to be sources of debate within

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the field [4]. However, there is consensus that trauma differs in meaningful ways from other negative life events and that individuals who are exposed to traumatic events face heightened risk for mental health disorders, most notably posttraumatic stress disorder (PTSD), as well as a variety of other adverse outcomes [5, 6].

Exposure to trauma is particularly prevalent among people living with HIV, with multiple studies confirming that this population experiences higher rates of sexual abuse, physical abuse, and other traumas than the general population [7, 8]. Among women living with HIV, the estimated rates of intimate partner violence and childhood sexual abuse are 55.3% and 39.3%, respectively—rates that are more than double the national prevalence [9]. In general, women are significantly more likely than men to experience trauma-based psychopathology [10], and gender-based trauma is increasingly being recognized as a key driver of the HIV epidemic, particularly in sub-Saharan Africa [11–13].

A recent review by Brezing et al. [14] highlights the syndemic nature of trauma and HIV, with trauma—particularly sexual trauma—contributing in both direct and indirect ways to HIV risk [14]. Sexual traumas (e.g., childhood sexual abuse, rape, conflict-related sexual violence) may directly expose individuals to HIV, with forced sexual encounters carrying an increased risk for viral transmission due to the high likelihood of genital injuries (e.g., vaginal or rectal lacerations) [15, 16]. Trauma may also indirectly increase vulnerability for HIV through a host of psychological (e.g., PTSD, depression) and behavioral (e.g., substance use, high-risk sexual behaviors) sequelae [12]. The relationship between trauma and negative health outcomes often operates by a vicious cycle, in which trauma heightens risk for risky behaviors, which in turn increases risk for re-traumatization [14]. Schnurr and Green [17] provided a model for understanding the potential mechanisms that underlie the relationship between trauma and health, and posit that PTSD serves as the primary pathway through which trauma impacts various health outcomes, including behavioral health, perceptions of health-related conditions, and actual morbidity and mortality. According to this model, PTSD yields biological alterations (e.g., changes in immune response, alterations to the hypothalamic–pituitary–adrenal [HPA] axis), psychological alterations (e.g., comorbid psychopathologies, negative coping strategies), and changes in key attentional processes (e.g., altered perceptions, over- or under-attention to stimuli) that can negatively impact an individual's health [17].

While this model is useful, the majority of individuals exposed to both violent traumas (e.g., terror attack, assault) and non-violent traumas (e.g., natural disaster, accident) do not go on to develop PTSD—yet many still experience poor health outcomes [18]. Seminal work on stress response and allostatic load [19, 20] posits that even outside of the context of PTSD, exposure to traumatic events may yield

long-term consequences for health. According to McEwen's model [19], exposure to internal or external stressors trigger physiological responses within the body that typically enable an individual to respond to a threatening event (i.e., fight or flight response). This ability to respond to stress (i.e., allostasis) has been critical for survival over time; however, chronic overactivity or underactivity of the allostatic systems (e.g., autonomic nervous system; HPA axis; cardiovascular, metabolic, and immune systems) results in “wear and tear” of the body over time (i.e., allostatic load) that can lead to physical disease, as well as changes in cognitive functioning [21]. Therefore, individuals who are already vulnerable by virtue of exposure to stress and trauma may have even more difficulty adjusting to life's challenges across their life span.

For individuals living with HIV, a key challenge is to adhere to daily antiretroviral medication in order to achieve and maintain viral suppression. A review of studies on trauma and HIV [22] documents that trauma has been found to be associated with poor adherence for several HIV populations in the US, including racially, ethnically, and gender-diverse samples [23, 24], seroconcordant and serodiscordant heterosexual couples [25], and women living with HIV [26, 27]. A number of socio-demographic characteristics have been previously identified as predictors of ART and trauma. For instance, age [28], race/ethnicity [28], employment [29], education [28], income [30, 31], and time since diagnosis [32] have all been found to be associated with adherence, with studies finding that participants who were older, White, employed, more educated, wealthier, and who had been diagnosed for longer were more likely to be adherent to ART. Risk for trauma exposure may also be affected by some of these variables. For example, traumatic stress has been found to be positively correlated with age and negatively correlated with education among women living with HIV. Previously research has found that Black women living with HIV report less traumatic stress [33] compared to other women. Race has also been found to be a risk factor for traumatic symptoms among men living with HIV [34], and lower socioeconomic status has been linked to experiencing adverse life events [35] among US populations.

Studies that investigate links between trauma and adherence are particularly needed in the “Deep South” region of the US, which experiences a greater burden of HIV-related morbidity and mortality than any other region [36]. People living with HIV in Southern states also have lower 5-year survival rates compared to other regions—an indication of a poorly functioning HIV Care Continuum [37]. South Carolina is representative of these regional challenges, with only 53% of persons living with HIV statewide currently virally suppressed [38]. Therefore, the aims of the current study were three-fold: (1) Describe experiences of types of trauma among a diverse sample of people living with HIV attending a large immunology center in South Carolina; (2)

Determine the association between direct trauma exposure and self-reported ART adherence; and (3) Examine gender differences in the relationship between direct trauma exposure and self-reported ART adherence. Based on the existing literature, we hypothesized that: (1) Women living with HIV would report greater exposure to traumatic events; (2) Greater direct exposure to trauma would be associated with lower adherence; and (3) The association between direct exposure to trauma and ART adherence would be greater for women than men.

Methods

Data Source and Study Population

Data were collected from May 2018 to September 2018 from 402 people living with HIV and receiving care at a large, immunology center in South Carolina that provides comprehensive HIV services. To be eligible for the study, participants had to be at least 18 years of age, living with HIV, and willing to participate in the 35–40-min survey. Data were collected using pencil-and-paper questionnaires.

The study team coordinated with the clinic staff on data collection activities. Patients of the clinic who were living with HIV were introduced to the study by the clinic staff, and those interested in participating were directed to a member of the research team, who then invited them to participate in the anonymous survey. Enthusiasm for the survey among clinic patients was high, with more than 80% of invited participants enrolling in the study. Participants who agreed to participate provided informed consent, and the paper–pencil survey was administered in designated areas at the clinic. As the outcome of the study was ART adherence, we included 337 participants who reported being on ART at the time of the survey in the current analysis. All participants received a \$20 gift card for their participation. The study protocol was approved by the University of South Carolina Institutional Review Board.

Measures

Traumatic life experiences were measured using the *Life-time Events Checklist (LEC)* [39]. Participants were asked to report their exposure to a list of 17 traumatic events (e.g., sexual assault, physical assault, serious accident). Participants were instructed to select whether each event “happened to me”, “witnessed it”, “learned about it”, “not sure” and/or “doesn’t apply”. As the current study focused on direct exposure to or experiencing traumatic events, traumatic life experiences were operationalized by “happened to me” versus other (“witnessed it”, “learned about it”, “not sure”, “doesn’t apply”). Some participants endorsed items

14, “Sudden violent death (for example, homicide, suicide)”, and 15, “Sudden accidental death” as “happened to me”, suggesting that they knew someone who experienced these events and/or witnessed these events.

Overall trauma was operationalized as directly experiencing any of the 17 traumatic events. The standardized Cronbach’s alpha values for the LEC were 0.87 for the overall study sample, 0.84 for men, and 0.91 for women in the current study. The LEC has shown temporal stability and convergence with another established measure of lifetime trauma, the *Traumatic Life Events Questionnaire (TLEQ)* [40].

ART adherence was measured by the question “How often do you miss a dose of ART medication over a typical month?” A 5-point scale ranging from *Never miss (1)* to *Miss at least 6 days (5)* was used to obtain responses. As our aim was to focus on ART adherence among populations that reported to be on ART at the time of the survey, we included 337 participants who answered “yes” to “Are you currently taking antiretroviral (ART) medications to treat your HIV?” ART adherence was operationalized using 100% adherence (i.e., Never miss) versus < 100% adherence [41]. Beillo et al. [41] report that operationalizing adherence in this manner helps to account for the likelihood that individuals will overestimate their ART adherence.

Confounders. Sociodemographic characteristics were considered for inclusion as confounders if previous literature suggested they were independently associated with traumatic experiences and ART adherence [28–35] but were not potential mediators of the association between traumatic life experiences and ART adherence. Therefore, potential confounders considered in the current study were: age, race, ethnicity, employment, income, education, and time since diagnosis.

Analytic Approach

Principal components analysis (PCA) with a promax (oblique) rotation was conducted to determine separate components for traumatic experiences based on factor structure correlations (“factor loadings”). Loadings > 0.55 were used to determine items for each component [42]. A dichotomous index score (yes/no) was calculated for each component based on the loaded items in a specific component (i.e., experiencing any of the loaded items versus not experiencing any of the items). Descriptive statistics were used to assess the distribution of sociodemographic characteristics and ART adherence. Positive responses to trauma items and trauma components were also assessed among the overall population, and among men and women. Gender differences were found in missing data for ART adherence where men were more likely to not report data on ART adherence compared to women.

There were no statistically significant differences by gender found in missing data on trauma. As self-reported ART adherence has shown to be a valid outcome indicator [43], a missing at random (MAR) assumption was made for the missing data. The MAR assumption suggests that the probability of the missing data related to ART adherence is dependent on gender but not on ART adherence itself. As a result, multiple imputation, which enables effect estimation under the MAR assumption, was performed. Crude and adjusted logistic regression models were used to determine the association between overall trauma (17 items), trauma components (extreme violence/death-related trauma, physical and sexual assault, and accidental/disaster-related trauma) and ART adherence. Adjusted models controlled for age (continuous), race, ethnicity, employment, income (continuous), education, and time since diagnosis (years). Separate models were run for the overall sample, men, and women; and using complete case analysis and multiple imputation. All analyses were conducted in SAS version 9.4 (SAS Institute, Cary, NC).

Results

Factorial Structure of Trauma Experience

Table 1 shows the factorial structure of traumatic life experiences of participants from PCA with a promax (oblique) rotation. A three-component solution was obtained. The first component was defined as *Extreme Violence/Death-related Trauma*. These items focused primarily on war or combat-related experiences and death. The second component was *Physical and Sexual Assault*. These items reflected experiences with physical and sexual assault (e.g., being beaten up, raped). The third component was defined as *Accidental/Disaster-related Trauma*. These items focused primarily on experiences involving accidents and natural disasters. The items that did not meet the loading criterion for either of three components were: “*Serious accident at work, home, or during recreational activity*”; “*Assault with a weapon (being shot, stabbed, threatened with a knife, gun, bomb, etc.)*”; “*Life-threatening illness or injury*”; and “*Any other stressful event or experience.*”

Table 1 Components derived for experiences of trauma based on factor structure correlations from principal component analysis and promax (oblique) rotated pattern

Item number	Item description	Extreme violence/death-related	Physical/sexual assault	Accidental/disaster-related
5	Exposure to toxic substance (dangerous chemicals, radiation, etc.)	0.61	0.31	0.27
10	Combat or exposure to a war-zone (in the military or as a civilian)	0.56	0.00	0.40
11	Captivity (for example, being kidnapped, abducted, held hostage, prisoner of war)	0.72	0.45	0.26
13	Severe human suffering	0.56	0.34	0.20
14	Sudden violent death (for example, homicide, suicide)	0.73	0.41	0.21
15	Sudden accidental death	0.64	0.21	0.22
16	Serious injury, harm, or death you caused to someone else	0.74	0.22	0.23
6	Physical assault (being attacked, hit, slapped, kicked, beaten up, etc.)	0.36	0.59	0.53
8	Sexual assault (rape, attempted rape, made to perform any type of sexual act through force or threat of harm)	0.35	0.85	0.24
9	Other unwanted or uncomfortable sexual experience	0.35	0.84	0.22
1	Natural disaster (flood, hurricane, tornado, earthquake, etc.)	0.27	0.12	0.70
2	Fire or explosion	0.30	0.14	0.63
3	Transportation accident (car accident, boat accident, train wreck, plane crash, etc.)	0.11	0.41	0.73
Items that did not meet the loading criteria for any of the three components				
4	Serious accident at work, home, or during recreational activity	0.47	0.37	0.47
7	Assault with a weapon (being shot, stabbed, threatened with a knife, gun, bomb, etc.)	0.47	0.33	0.55
12	Life-threatening illness or injury	0.16	0.43	0.49
17	Any other very stressful event or experience	0.39	0.49	0.34

Bold represents loadings > 0.55 of items in components and subscales

Note Items 4, 7, 12, and 17 did not meet the loading criteria for either of the components

Sociodemographic Characteristics and ART Adherence

Table 2 shows the distribution of sociodemographics and self-reported ART adherence among the participants in the study. Almost half (49.8%) of participants reported being 100% adherent to their ART over a typical month, 58% of women and 47% of men (data not shown). There were statistically significant differences by age, sex and ethnicity in self-reported adherence. For participants aged 50 and older, a higher percent reported being 100% adherent (46.1%) than not (29.7%). However, among participants aged 35–49, a higher percent reported being less than 100% adherent versus 100% adherence (41.9% vs. 30.3%). A higher percent of men reported being less than 100% adherent versus 100% adherence (71.1% vs. 60.3%) while among women, a higher percent reported being 100% adherent versus less than 100% adherence (39.7% vs. 29.0%). A higher percent of Hispanic respondents reported 100% adherence versus less than 100% adherence (7.1% vs. 1.4%). There were also statistically significant differences in ART adherence by overall, physical and sexual assault and accidental/disaster-related trauma. Participants who reported experiencing trauma tended to be less adherent compared to participants who did not experience trauma. There were no statistically significant differences in self-reported ART adherence by race, education, employment, income, and time since diagnosis. Differences in self-reported ART adherence by extreme violence/death-related trauma were borderline statistically significant ($p=0.054$).

Gender Differences in Trauma Experience

The distribution of the 17 trauma items and trauma components overall and among men and women are shown in Table 3. There were statistically significant differences by gender in responses to items 5 (*Exposure to toxic substance [dangerous chemicals, radiation, etc.]*); 8 (*Sexual assault [rape, attempted rape, made to perform any type of sexual act through force or threat of harm]*); 9 (*Other unwanted or uncomfortable sexual experience*); and 14 (*Sudden violent death [for example, homicide, suicide]*). A higher proportion of women tended to report experiencing these types of trauma compared to men.

Trauma Experience and ART Adherence

Multivariable Analyses–Complete Case

Table 4 shows the association between overall, extreme violence/death-related trauma, physical and sexual assault, accidental/disaster-related trauma, and self-reported ART adherence using complete case analysis. After adjusting

for age, race, ethnicity, employment, income, education, and time since diagnosis, among the overall population, participants who reported overall trauma were 58% less likely to be adherent to their ART (adjusted OR 0.42; 95% CI 0.21–0.86) compared to respondents who did not experience trauma. Those who were exposed to extreme violence/death-related trauma were 63% less likely to be adherent to their ART (adjusted OR 0.37; 95% CI 0.15–0.95) compared to respondents who did not experience trauma. Participants exposed to physical and sexual assault were 65% less likely (adjusted OR 0.35; 95% CI 0.16–0.77) and those who reported experiencing accidental/disaster-related trauma were 56% less likely (adjusted OR 0.44; 95% CI 0.21–0.93) to report being adherent to their ART compared to participants who did not experience trauma.

Among men living with HIV, after adjusting for age, race, ethnicity, employment, income, education, and time since diagnosis, complete case analysis results showed that participants who reported overall trauma were 67% less likely to be adherent to their ART (adjusted OR 0.33; 95% CI 0.14–0.81) compared to respondents who did not experience trauma. Men who were exposed to extreme violence/death-related trauma were 79% less likely to be adherent to their ART (adjusted OR 0.21; 95% CI 0.06–0.75) compared to men did not experience trauma. Male participants exposed to physical and sexual assault were 73% less likely (adjusted OR 0.27; 95% CI 0.09–0.77), and those who reported experiencing accidental/disaster-related trauma were 66% less likely (adjusted OR 0.34; 95% CI 0.13–0.87) to report being adherent to their ART compared to male participants who did not experience trauma. There were no statistically significant associations between overall trauma or specific trauma components and self-reported ART adherence among women.

Multivariable Analyses–Multiple Imputation

Table 5 shows the crude and adjusted associations between trauma and ART adherence using multiple imputation. Among the overall sample, overall trauma (adjusted OR 0.51; 95% CI 0.27–0.97), extreme violence/death-related trauma (adjusted OR 0.43; 95% CI 0.19–0.98), and physical and sexual assault (adjusted OR 0.34 95% CI 0.17–0.69) were negatively associated with ART adherence. Among men, overall trauma (adjusted OR 0.25; 95% CI 0.11–0.58), extreme violence/death-related trauma (adjusted OR 0.14; 95% CI 0.04–0.45), and physical and sexual assault (adjusted OR 0.17; 95% CI 0.07–0.46) retained and strengthened their statistically significant negative associations with ART adherence. The adjusted associations between trauma and ART adherence were not statistically significant among women.

Table 2 Distribution of sociodemographics and self-reported ART adherence among people living with HIV

Characteristic and type of trauma	Total N = 337 (100%) N (%)	Adherent N = 157 (49.8%) N (%)	Not adherent N = 158 (50.2%) N (%)	<i>p</i> -value ^a
Age (mean, SD)	45.0 (13.3)			0.023
18–24	14 (4.3)	5 (3.3)	9 (5.8)	
25–34	69 (21.1)	31 (20.4)	35 (22.6)	
35–49	117 (35.8)	46 (30.3)	65 (41.9)	
50+	118 (38.8)	70 (46.1)	46 (29.7)	
Sex				0.046
Male	215 (65.2)	94 (60.3)	108 (71.1)	
Female	115 (34.9)	62 (39.7)	44 (29.0)	
Race				0.130
Black	258 (77.0)	113 (72.0)	128 (81.5)	
White	62 (18.5)	36 (22.9)	23 (14.7)	
Other	15 (4.5)	8 (5.1)	6 (3.8)	
Ethnicity				0.020
Hispanic	12 (4.2)	9 (7.1)	2 (1.4)	
Non-hispanic	274 (95.8)	117 (92.9)	137 (98.6)	
Education				0.480
Less than high school	30 (11.0)	10 (8.3)	17 (12.7)	
High school	78 (28.6)	37 (30.8)	32 (23.9)	
Some college	103 (37.7)	46 (38.3)	51 (38.1)	
Bachelor's/post-grad	62 (22.7)	27 (22.5)	34 (25.4)	
Employed				0.146
Yes	145 (53.7)	58 (48.7)	77 (57.9)	
No	125 (46.3)	61 (51.3)	56 (42.1)	
Income				
< \$10,000	108 (34.0)	51 (33.8)	49 (32.7)	
\$10,000 to \$49,000	167 (52.5)	73 (48.3)	86 (57.3)	
≥ \$50,000	43 (13.5)	27 (17.9)	15 (10.0)	
Time since diagnosis				0.371
≤ 5 years	79 (24.4)	43 (28.5)	32 (21.1)	
> 5 years to ≤ 10 years	80 (24.7)	39 (25.8)	37 (24.3)	
> 10 years to ≤ 20 years	89 (27.5)	35 (23.2)	45 (29.6)	
> 20 years	76 (23.5)	34 (22.5)	38 (25.0)	
Overall trauma				0.020
Yes	228 (70.2)	99 (65.6)	118 (77.6)	
No	97 (29.9)	52 (34.4)	34 (22.4)	
Extreme violence/death-related				0.054
Yes	75 (43.6)	31 (37.4)	38 (52.7)	
No	95 (56.4)	52 (62.7)	34 (47.2)	
Physical and sexual assault				0.005
Yes	130 (57.3)	49 (48.5)	72 (67.9)	
No	97 (42.7)	52 (51.5)	34 (32.1)	
Accidental/disaster-related				0.029
Yes	165 (63.0)	71 (57.7)	84 (71.2)	
No	97 (37.0)	52 (42.3)	34 (28.8)	

Bolded *p*-values are statistically significant at $p < 0.05$

^a *P*-values are based on the Chi square statistic

Table 3 Distribution of positive responses to trauma items and trauma components overall and among men and women

Trauma item/trauma component	Overall N (%)	Men N (%)	Women N (%)	<i>p</i> -Value ^a
1. Natural disaster (flood, hurricane, tornado, earthquake, etc.)	73 (22.2)	40 (19.1)	32 (28.3)	0.059
2. Fire or explosion	39 (11.8)	25 (11.9)	13 (11.4)	0.894
3. Transportation accident (car accident, boat accident, train wreck, plane crash, etc.)	142 (43.4)	89 (42.2)	51 (46.8)	0.431
4. Serious accident at work, home, or during recreational activity	53 (16.0)	31 (14.8)	21 (18.3)	0.411
5. Exposure to toxic substance (dangerous chemicals, radiation, etc.)	17 (5.1)	6 (2.9)	11 (9.6)	0.009
6. Physical assault (being attacked, hit, slapped, kicked, beaten up, etc.)	92 (27.8)	53 (25.2)	34 (29.8)	0.374
7. Assault with a weapon (being shot, stabbed, threatened with a knife, gun, bomb, etc.)	55 (16.6)	38 (18.1)	17 (14.9)	0.466
8. Sexual assault (rape, attempted rape, made to perform any type of sexual act through force or threat of harm)	72 (21.7)	35 (16.7)	34 (29.6)	0.007
9. Other unwanted or uncomfortable sexual experience	64 (19.2)	31 (14.7)	30 (26.1)	0.012
10. Combat or exposure to a war-zone (in the military or as a civilian)	15 (4.5)	11 (5.2)	4 (3.5)	0.470
11. Captivity (for example, being kidnapped, abducted, held hostage, prisoner of war)	18 (5.5)	10 (8.9)	8 (3.8)	0.058
12. Life-threatening illness or injury	113 (34.2)	73 (34.9)	39 (34.2)	0.897
13. Severe human suffering	24 (7.3)	13 (6.2)	10 (9.1)	0.340
14. Sudden violent death (for example, homicide, suicide)	22 (6.8)	6 (2.9)	15 (13.4)	<0.001
15. Sudden accidental death	27 (8.2)	15 (7.1)	11 (9.7)	0.428
16. Serious injury, harm, or death you caused to someone else	18 (5.4)	9 (4.3)	8 (7.1)	0.279
17. Any other very stressful event or experience	74 (22.6)	45 (21.5)	28 (25.2)	0.454
Component 1: extreme violence/death-related	75 (43.6)	44 (40.4)	28 (48.3)	0.326
Component 2: physical and sexual assault	130(57.3)	74 (53.2)	51 (63.0)	0.160
Component 3: accidental/disaster-related	165 (63.0)	102 (61.1)	61 (67.0)	0.343

Bolded *p*-values are statistically significant at $p < 0.05$

Note: Yes versus No for Items 1–17 means “Happened to me” versus Did not happen to the individual. However, participants who endorsed “Yes” for items 14 and 15 suggest that they knew someone who experienced these events and/or witnessed these events

^a*p*-values are based on the Chi square statistic

Table 4 Association between overall trauma and components and self-reported ART adherence among people living with HIV/AIDS in South Carolina using complete case analysis

Trauma	Crude OR	95% CI	Adjusted OR ^a	Adjusted 95% CI ^a
Overall				
Overall trauma	0.55	0.33–0.91	0.42	0.21–0.86
Extreme violence/death-related	0.53	0.28–1.01	0.37	0.15–0.95
Physical and sexual assault	0.45	0.25–0.78	0.35	0.16–0.77
Accidental/disaster-related	0.55	0.32–0.94	0.44	0.21–0.93
Men				
Overall trauma	0.51	0.27–0.95	0.33	0.14–0.81
Extreme violence/death-related	0.42	0.19–0.95	0.21	0.06–0.75
Physical and sexual assault	0.42	0.20–0.85	0.27	0.09–0.77
Accidental/disaster-related	0.51	0.27–0.99	0.34	0.13–0.87
Women				
Overall trauma	0.52	0.20–1.36	0.56	0.13–2.39
Extreme violence/death-related	0.66	0.21–2.12	2.66	0.30–23.9
Physical and sexual assault	0.41	0.15–1.15	0.62	0.13–2.90
Accidental/disaster-related	0.49	0.18–1.31	0.39	0.08–1.86

Bolded odds ratios and 95% confidence intervals are statistically significant at $p < 0.05$

^aAdjusted effect estimates controlled for age (continuous), race, ethnicity, employment, income (continuous), education, time since diagnosis (years)

Table 5 Association between overall trauma and components and self-reported ART adherence among people living with HIV/AIDS in South Carolina using multiple imputation

Trauma	Crude β	95% CI	Adjusted β^a	Adjusted 95% CI ^a
Overall				
Overall trauma	0.58	0.37–0.93	0.51	0.27–0.97
Extreme violence/death-related	0.67	0.38–1.21	0.43	0.19–0.98
Physical and sexual assault	0.38	0.22–0.64	0.34	0.17–0.69
Accidental/disaster-related	0.54	0.33–0.89	0.55	0.29–1.04
Men				
Overall trauma	0.48	0.27–0.85	0.25	0.11–0.58
Extreme violence/death-related	0.44	0.21–0.95	0.14	0.04–0.45
Physical and sexual assault	0.37	0.19–0.72	0.17	0.07–0.46
Accidental/disaster-related	0.51	0.28–0.94	0.47	0.21–1.06
Women				
Overall trauma	0.58	0.25–1.34	0.71	0.21–2.44
Extreme violence/death-related	0.40	0.14–1.16	3.57	0.59–21.5
Physical and sexual assault	0.54	0.22–1.31	0.44	0.11–1.75
Accidental/disaster-related	0.41	0.17–1.00	0.46	0.13–1.63

Bolded odds ratios and 95% confidence intervals are statistically significant at $p < 0.05$

^aAdjusted effect estimates controlled for age (continuous), race, ethnicity, employment, income (continuous), education, time since diagnosis (years)

Discussion

To the best of our knowledge, this is the first study to conduct a PCA of lifetime trauma experiences among people living with HIV. Participants in the current sample reported experiencing a wide variety of traumas—ranging from natural disasters and accidents to physical and/or sexual assault. PCA was used to derive broad categories of trauma (extreme violence/death-related, physical and sexual assault [44], and accidental/disaster-related [44]). Experiencing traumatic life events and specific categories of trauma were associated with a lower likelihood of ART adherence in the overall sample. Among men, overall trauma, extreme violence/death-related trauma, and physical and sexual assault were negatively associated with ART adherence in complete case and multiple imputation analyses.

The results of this study are consistent with previous research on the overlapping vulnerabilities of trauma and HIV [14] and demonstrate that a significant portion (71.0%) of a large, clinic-based sample of people living with HIV in South Carolina report direct exposure to traumatic events. In addition, in line with previous research, we found particularly high levels of trauma exposure among women [9], with women significantly more likely than men to report exposure to toxic substances (e.g., chemicals, radiation), sexual assault, unwanted sexual experiences, and sudden violent death. Many of these individuals are likely to be resilient in the face of such adversities and are able to adapt and quickly resume normal functioning [45, 46]. However, research suggests that a significant portion of trauma-exposed individuals do not fare so well, with a recent review finding that 6.5%

to 87.5% of individuals exposed to various types of trauma develop PTSD within one year [18].

The statistically significant association between traumatic life experiences and ART adherence in the current study supports and contradicts previous research. One previous study found a negative statistically significant association between traumatic life experiences and ART adherence [47]. In this study, van den Berg et al. [47] measured lifetime trauma with one question “Have you ever been abused, threatened, or the victim of violence?” (yes vs. no) and ART adherence with the question “Rate your ability to take all your medications” with responses ranging from 0 (*Very poor*) to 6 (*Excellent*). In contrast, Whetten et al., [48] found that adverse childhood experiences, rather than adulthood trauma, were linked to incomplete adherence to ART among individuals living with HIV recruited from hospital-based clinics in Kilimanjaro, Tanzania. This difference in findings could be explained by the differences in study populations and the operationalization of primary variables. For example, Whetten et al. [48] operationalized adulthood trauma primarily as death-related events with only three items: (1) Homicide of a close family member or friend; (2) Non-homicidal death of a child; and (3) Non-homicidal death of a spouse/partner. ART adherence was operationalized by three questions, which included self-report of the last time the participant has missed a dose, use of a 0–100% analog scale to show percentage of ART taken, and doses missed in the last month [48]. In addition, Whetten et al. did not examine potential gender differences in this association.

An unexpected finding in the current study was that the associations between overall trauma, trauma components,

and ART adherence were not statistically significant among women, even though a higher proportion of women reported several specific types of trauma. McEwen's model [19] states that exposure to internal or external stressors trigger physiological responses in the body, which can lead to physical disease, as well as changes in functioning. Additional research is needed to determine if this model may apply more specifically to men living with HIV as among this population, traumatic life experiences (especially extreme violence/death-related trauma, and physical and sexual assault) are associated with lower adherence to ART. In addition, previous studies have shown that the effect of traumatic experiences on health outcomes and behaviors may be more statistically significant for men compared to women [49, 50]. For instance, research examining the gender differences in adverse childhood experiences found that sexual abuse was associated with major depression in men, but this relationship was weaker [49] or non-existent [50] in women. Dale et al., found that Black women living with HIV reported sexual, physical and emotional trauma both in childhood and as adults [51]. However, these women also reported finding ways to adhere to their ART therapy in spite of their traumatic experiences [51]. Indeed, ad hoc analyses found that majority of women in the current study population were Black women (77%).

When comparing complete case and multiple imputation analyses, among the overall sample, overall, extreme violence/death-related trauma, and physical and sexual assault were associated with ART adherence. Similarly, among men, the association between accidental/disaster-related trauma and ART adherence attenuated to non-significance using multiple imputation. The latter differences also highlight the importance of carefully considering missing data and performing robustness analyses to bring to the forefront important findings, which may warrant additional research and alternate methodologies.

For people living with HIV, taking ART every day and exactly as prescribed is critical to achieving viral suppression for improving and maintaining good overall health. In addition, evidence now suggests that an undetectable viral load significantly reduces the risk that HIV can be transmitted to another person [26, 52, 53]. Therefore, effectively treating symptoms associated with trauma exposure may yield benefits for the individual living with HIV and also may be a key strategy to reduce secondary transmissions through treatment as prevention ("TasP").

In 2016, South Carolina ranked 7th in the nation for HIV diagnoses among adults and adolescence (i.e., 18.1 diagnoses per 100,000 individuals) [54], and the state has experienced significant increases in HIV among multiple age groups from 2012 to 2016, including adults aged 25–29 (7.9% increase), 50–59 (7.6% increase), and 60 and older (8.3% increase) [38]. Therefore, effective strategies that

can promote viral suppression among people living with HIV and reduce new HIV infections are urgently needed. Adopting trauma-informed care and integrating trauma- and gender-specific interventions into HIV clinical care may be essential components of a comprehensive approach geared towards improving adherence among vulnerable HIV populations. Currently few interventions have been empirically tested that specifically address trauma among HIV-positive populations, with the vast majority designed for populations outside of the US [55]. In addition, very few trauma interventions have been developed or tailored for the needs of men living with HIV or transgender individuals [55]. Future research initiatives are urgently needed—particularly in the US South—to better understand impacts of trauma among people living with HIV and identify effective interventions and target populations.

Limitations and Strengths

There are a number of limitations that should be considered when interpreting study findings. First, we assessed trauma exposure but did not measure individuals' subjective responses to the trauma. Therefore, we were unable to assess psychopathologies (e.g., traumatic stress, symptoms of PTSD) that likely play a key role in mediating the relationship between trauma and adherence. In addition, adherence was measured through self-report. While we adopted a conservative definition of adherence (e.g., 100% self-reported adherence in past month), to offset the potential overreporting of adherence, future studies should utilize more objective markers of adherence (e.g., plasma samples, unannounced pill counts, electronic pill monitoring). Finally, our PCA yielded four items that did not load on any of the three components of trauma exposure, likely due to the general nature of these items. One limitation in using PCA is that the interpretation of the results of dimension reduction can be challenging [56]. However, in the current study, applying PCA to examine trauma helped to identify specific types of trauma and elucidate their relationship to ART adherence. Future research may wish to eliminate those items from the scale and/or perform additional validation studies of the LEC [39].

Nevertheless, the study also had some strengths. We operationalized traumatic life experiences using PCA. This approach facilitated assessing the impact of different types of trauma based on correlations in the data. In addition, the standardized Cronbach's alphas for the LEC for the overall population, men and women suggested strong internal consistency of the scale when used with a population of people living with HIV in South Carolina [57]. Adjusted analyses controlled for sociodemographic confounders, which may alter the "true" association between traumatic life experiences and ART adherence.

Conclusions

Traumatic stress and PTSD symptoms associated with trauma exposure can have detrimental effects on a person's overall quality of life and daily functioning. Specifically, for people living with HIV, trauma exposure may create substantial barriers to ART adherence, and, hence, viral suppression. This study represents an important first step in exploring links between trauma exposure and ART adherence among people living with HIV in South Carolina. Meaningful improvements in adherence will require comprehensive and integrated approaches that address trauma-related barriers and pay due attention to the syndemic nature of HIV and trauma. While providing appropriate trauma-informed services to people living with HIV is a key first step, greater efforts are also needed to understand underlying societal causes of trauma, including poverty, gender-based violence, and racism, that contribute in direct and indirect ways to HIV vulnerability. In addition, future studies may consider analyzing specific types of trauma as knowing their specific impacts will have important implications for trauma-informed care and interventions geared towards improving behavioral and overall health outcomes. Men living with HIV may benefit greatly from trauma-informed care and trauma-focused interventions geared towards improving ART adherence, especially with a focus on extreme violence/death-related trauma and physical and sexual assault. Due to the higher rates of HIV among men who have sex with men (MSM), heterosexual men are not usually targeted for HIV-related intervention and prevention programs [58–60]. As the association between trauma and ART adherence was significant for men (in general), the findings suggest that trauma-focused initiatives and interventions should target men living with HIV, in spite of their sexual orientation.

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Compliance with Ethical Standards

Conflict of interest All the authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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