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Regular Article

Understanding posttraumatic stress trajectories in adolescent females: A strength-based machine learning approach examining risk and protective factors including online behaviors

Ann-Christin Haag[1], George A. Bonanno[1], Shuquan Chen[1], Toria Herd[2], Sienna Strong-Jones[2], Sunshine S.[2] and Jennie G. Noll[2]

[1]Department of Counseling and Clinical Psychology, Columbia University Teachers College, New York, NY, USA and [2]College of Health and Human Development, Department of Human Development and Family Studies, The Pennsylvania State University, University Park, PA, USA

Abstract

Heterogeneity in the course of posttraumatic stress symptoms (PTSS) following a major life trauma such as childhood sexual abuse (CSA) can be attributed to numerous contextual factors, psychosocial risk, and family/peer support. The present study investigates a comprehensive set of baseline psychosocial risk and protective factors including online behaviors predicting empirically derived PTSS trajectories over time. Females aged 12–16 years ($N = 440$); 156 with substantiated CSA; 284 matched comparisons with various self-reported potentially traumatic events (PTEs) were assessed at baseline and then annually for 2 subsequent years. Latent growth mixture modeling (LGMM) was used to derive PTSS trajectories, and least absolute shrinkage and selection operator (LASSO) logistic regression was used to investigate psychosocial predictors including online behaviors of trajectories. LGMM revealed four PTSS trajectories: resilient (52.1%), emerging (9.3%), recovering (19.3%), and chronic (19.4%). Of the 23 predictors considered, nine were retained in the LASSO model discriminating resilient versus chronic trajectories including the absence of CSA and other PTEs, low incidences of exposure to sexual content online, minority ethnicity status, and the presence of additional psychosocial protective factors. Results provide insights into possible intervention targets to promote resilience in adolescence following PTEs.

Keywords: adolescence; childhood sexual abuse; internet use; posttraumatic stress trajectories; resilience

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Childhood sexual abuse (CSA) has been shown to be associated with a wide range of psychosocial and health outcomes, including posttraumatic stress (reviewed in Hailes et al., 2019; Noll, 2021). Posttraumatic stress symptoms (PTSS), including reexperiencing, avoidance, negative alterations in cognitions and mood, and alterations in arousal and reactivity following exposure to a potentially traumatic event (PTE) (Diagnostic and Statistical Manual of Mental Disorders, 5th ed.; American Psychiatric Association, 2013), can be especially pronounced in CSA survivors (Chen et al., 2010). Umbrella reviews and meta-analyses report aggregate odds ratios ranging from 2.3 (95% CI 1.6–3.4) (Hailes et al., 2019) to 4.4 (95% CI 4.0–4.8) (Teicher & Samson, 2013) providing evidence for a long-term association between CSA and adult posttraumatic stress disorder (PTSD). While less is known about PTSD diagnoses in children and adolescents following CSA, sexual trauma has consistently been associated with the highest rates of PTSS (Copeland et al., 2007; Nooner et al., 2012). For example, one study of children aged 7–17 years with child protective services reports of child physical or sexual abuse reported a rate of 41% (Kolko et al., 2003). In a subsequent review including five studies of adolescent PTSD rates ($M = 15$ years), CSA survivors showed a mean PTSD prevalence rate of 47% (Nooner et al., 2012). Although the risk of subsequent PTSS after CSA has been reliably shown, symptom severity levels vary widely among CSA survivors and many never develop elevated PTSS (Collishaw et al., 2007; Copeland et al., 2007). This indicates that a considerable portion of children and adolescents do not develop maladjustment after maltreatment, but instead show resilient functioning (reviewed in Cicchetti, 2013). Research focused on those who manage to stave off trauma reactions may more accurately characterize, and better serve, the population of CSA survivors.

Over the past two decades, research on resilience has offered insights into how individuals might be affected by and/or adapt to PTEs through the examination of dynamic processes, whereby individuals display positive developmental outcomes despite experiencing what many might assume to be a significant adversity or trauma (e.g., Luthar & Cicchetti, 2000). Ann Masten (Masten, 2001; Masten et al., 2021) has stressed that resilience is not simply the opposite of risk, but rather the ability of a dynamic system to adapt successfully – that is, to make psychological and contextual adaptations that, when readily available and accessible, are specifically useful in overcoming hardship. In other words, when

Corresponding author: Ann-Christin Haag, email: ah3784@tc.columbia.edu.

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environmental supports and internal resources are intact, most children will readily adapt. As such, resilience can be considered the "ordinary" developmental course following PTEs. Because much of the literature on resilience in children has focused on chronic adversity such as maltreatment, poverty, institutional rearing, or discrimination (reviewed in Masten et al., 2021), it is unclear whether a similar conceptualization might hold for less-chronic PTEs. With a focus toward single-incident PTEs, Bonanno and colleagues have shown through a series of intriguing studies that indeed most people develop very few PTSS in the face of stressful life events due to the ability of flexible self-regulation or the ability to flexibly apply a variety of regulation or coping strategies to suit a given challenge (Bonanno, 2021; Galatzer-Levy et al., 2012). In a related new area of research, work by Ellis and colleagues has stressed how social and cognitive skills can develop in response to adversity, including harsh and unpredictable environments (Ellis et al., 2017) and that such stress-adapted skills can be leveraged for positive ends (Ellis et al., 2020). A shift away from a deficit-model framework, these strength-based approaches to resilience suggest that there are capacities that are likely to distinguish those individuals who show relatively little PTSS from those who develop symptoms later but then recover (Bonanno, 2005). Strength-based models of resilience from PTSS following a PTE are less well developed in children and adolescence as longitudinal studies that are uniquely suited to examine the trajectory of resilience are exceedingly rare. Such research is critical for expanding our understanding of ways to facilitate resilience for youth coping with adversity and trauma and for distinguishing children and adolescents who might flexibly utilize various strategies to stave off PTSS versus those who may be in need of more intensive intervention and treatment efforts.

Trajectories of adjustment after PTEs

Recent studies interested in elucidating meaningful heterogeneity in longitudinal courses of PTSS after major life stressors and PTEs have adopted sophisticated statistical approaches, including person-centered approaches, such as latent growth mixture modeling (LGMM), which allows for the identification of latent subgroups within the sample based on similarities in degree of PTSS severity and change over time. The most commonly observed prospective and longitudinal trajectories in studies of adults have included resilience (stable trajectory of healthy functioning), recovery (prolonged but ultimately waning disruption in functioning), delayed (disruptions in functioning that emerge following a significant delay), and chronic (continued disruption in functioning), with the resilience trajectory being the modal response across studies (see review by Galatzer-Levy et al., 2018). Comparable courses of adjustment to adversity have been described for children and adolescents both after single-incident traumas and after chronic or severe adversity (reviewed in Bonanno & Diminich, 2013), such as pediatric traumatic injury (Le Brocque et al., 2020), intimate partner violence (Meijer et al., 2019), witnessing the death of others (Hong et al., 2014), natural disasters (reviewed in Lai et al., 2017), and war (Punamäki et al., 2014). In addition, a few studies have investigated symptom trajectories in children and adolescents who experienced maltreatment. Most of these studies reported on trajectories of internalizing and externalizing behavior difficulties (Kim et al., 2009; Proctor et al., 2010; Tabone et al., 2011; Thompson et al., 2011; Woodruff & Lee, 2011), with two examining courses of depression and anxiety (Carlson & Oshri, 2018; Lauterbach & Armour, 2016) and one examining psychosocial functioning (Witt et al., 2019). Among these studies, there is heterogeneity regarding the number of symptom trajectories reported. Overall, one (Kim et al., 2009) to five (Tabone et al., 2011; Thompson et al., 2011) trajectories have been identified, with four studies converging at four similar trajectories (resilient, recovery, delayed, and chronic) to those that have been established in the adult literature (Lauterbach & Armour, 2016; Proctor et al., 2010; Witt et al., 2019; Woodruff & Lee, 2011). The fact that resilience was almost always identified across studies investigating symptom trajectories after maltreatment in children and adolescents points to the fact that the resilient trajectory is the most prevalent response across different contexts. This demonstrates consistency across developmental literatures as concerns psychosocial adjustment after PTEs.

However, only two studies have investigated PTSS after childhood maltreatment (Miller-Graff & Howell, 2015; Nugent et al., 2009) and neither focused exclusively on CSA survivors. These two studies revealed different numbers and types of PTSS trajectories. The first study applied LGMM in a sample of 201 youth (7–18 years) and identified two trajectories following family violence (including CSA, child physical abuse, and intimate partner violence) characterized as "resilient" (60.7%) and "persistent" (39.3%) (Nugent et al., 2009). The second study included a sample of 1,178 children and adolescents (4–18 years) and identified three distinct PTSS trajectories following childhood maltreatment (including physical abuse, CSA, emotional abuse, neglect, and witnessing violence) characterized as "resilient" (69.6%), "clinical-improving" (24.8%), and "borderline-stable" (5.6%) (Miller-Graff & Howell, 2015). Though the number of trajectories identified in these studies differed, there are notable and distinct differentiations among subgroups of youth after maltreatment which includes CSA. Given that it is difficult to disentangle CSA from other forms of maltreatment in these two studies and given the marked disruptive impacts that CSA can have on adolescent development, there is a glaring gap in (1) our understanding of PTSS trajectories following CSA and other PTEs, (2) whether characteristics of the trauma can differentiate survivors on distinct symptom trajectories, and (3) whether CSA differs from other PTEs in terms of the course of PTSS over time. Finally, more research is needed to understand the characteristics of those who remain resilient following a PTE and whether there are baseline psychosocial predictors that differentiate those who are resilient versus those who continue to suffer from PTSS. Such an understanding will advance knowledge of how to promote recovery from trauma.

Understanding heterogeneity in trajectories

Some clues about predictors of PTSS trajectories have been provided by the two extant studies conducted with maltreated youth. While both studies revealed younger age at onset and fewer reports of maltreatment and other traumatic experiences to increase individuals' likelihood of experiencing resilience as compared to chronic PTSS, Miller-Graf and Howell also found less exposure to family and community violence and lower levels of anger as significant predictors of resilience (Miller-Graff & Howell, 2015; Nugent et al., 2009).

As myriad studies provide insight into the deleterious sequelae of CSA, more comprehensive models could be examined in order to understand PTSS trajectories. As such, individual characteristics include difficulties with emotion regulation (Assed et al., 2020; Chang et al., 2018; Kim & Cicchetti, 2010), cognitive performance

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(Noll et al., 2010), and sexual development (Noll, 2021), as well as academic achievement (Trickett et al., 2011). Moreover, there is evidence that child maltreatment is associated with greater levels of impulsivity, substance use (Oshri et al., 2018; Thibodeau et al., 2015), and lowered self-esteem (Stern et al., 1995). Family and peer characteristics associated with CSA include lower levels of family functioning (Stern et al., 1995), more prominent insecure attachment (Ensink et al., 2019), and lower levels of peer acceptance (Kim & Cicchetti, 2010). On the other hand, greater social capital and social support have been reported to mitigate against consequences of child maltreatment (Kotch et al., 2014; Saluja et al., 2003).

Although extant research has described associations between CSA and a broad range of diverse characteristics, the inclusion of variables related to adolescents' growing digitalized world, including internet use, is rare. While the proliferation of the internet has undoubtedly brought numerous advantages, such as access to information or enhancement of social contacts, it has also brought with it increasing concerns about online safety of children. As such, access to online sexual contents, for example, is increasingly unfettered and sexually explicit content is widely available to internet users of all ages. Not surprisingly, a recent meta-analysis showed that more than 20% of adolescents reported unwanted online exposures to sexually explicit content (Madigan et al., 2018).

Recent research examining the link between time spent online and adolescent well-being is somewhat inconsistent, with results indicating positive, negative, and null associations (Odgers & Jensen, 2020; Orben, 2020; Orben & Przybylski, 2019). More specifically, pornography use has been linked to mental health problems in adolescents (Lim et al., 2017). Furthermore, research showed associations between cyberbullying and adolescent mental health, including heightened levels of depression (reviewed in Hamm et al., 2015), self-harm, suicidal behaviors (reviewed in John et al., 2018), and substance use (Díaz & Fite, 2019). Considering these results, there is a critical need for longitudinal research to elucidate the effects of internet use on adolescent well-being.

Adolescents who experience PTEs, particularly CSA, may be especially vulnerable to harmful internet uses and experiences that may disproportionally impact their adjustment outcomes. The traumatic sexualization associated with CSA can disrupt adolescents' sexual schemas by contributing to misconceptions and inappropriate attitudes toward sexual behaviors (Noll, 2021). This can render CSA survivors particularly vulnerable to disruptions in sexual development that can manifest in heightened risky sexual behaviors (Noll et al., 2019; Wilson & Widom, 2009) and elevated rates of pornography consumption (Burton et al., 2010; Noll et al., 2003). Indeed, a recent observational study of teen online behaviors showed that females who experienced substantiated CSA were more likely to be represented in a profile of elevated rates of pornography consumption than were comparison youth. Females in this profile were, in turn, more likely to experience both subsequent aberrant sexual development and internet-initiated victimizations (Noll et al., 2021). Studies have shown CSA survivors to be more likely to display high-risk internet behaviors, including choosing provocative self-representations online, and being exposed to sexual content online (Maas et al., 2019, Noll et al., 2009, 2013). Lastly, in line with CSA survivors being at an increased risk of subsequent revictimization, including peer victimization and bullying, they have also been shown to be at heightened risk for cyberbullying victimization online (Kennedy et al., 2021). This might reflect social and emotional developmental vulnerabilities, making CSA survivors more likely to be bullied for their actions and how they present themselves.

In summary, the findings show that internet use impacts adolescent development and poses particular challenges for CSA survivors. Thus, the inclusion of a comprehensive set of psychosocial predictors including online behaviors of adjustment after PTEs is warranted and may be useful in determining how to promote resilience in adolescents after CSA and other PTEs.

The present study

In a longitudinal design, the present study sought to model heterogeneity in PTSS trajectories overtime in a sample of adolescents who had experienced a broad array of PTEs including substantiated CSA. A comprehensive set of baseline predictors was then examined via machine-learning techniques to elucidate psychosocial predictors including online behaviors of trajectory membership, with particular attention to those characterizing resilient females. The aims of the present study were fourfold: (1) to identify PTSS trajectories in a sample of adolescents who experienced a broad array of PTEs including CSA; (2) to investigate the distribution of CSA survivors across the identified PTSS trajectories; (3) to explore CSA characteristics that might differentiate resilient CSA survivors from those in a chronic PTSS trajectories; and (4) to examine a comprehensive set of baseline psychosocial predictors including online behaviors of membership in a resilient PTSS trajectory. Given extant research on symptom trajectories after PTEs, we hypothesized four PTSS trajectories: chronic, emerging, recovering, and resilient. We further hypothesized that CSA survivors would be distributed across all four trajectories but will be more likely represented in a chronic PTSS trajectory as compared to participants with other types of self-reported PTEs. Furthermore, we hypothesized that indicators of more severe CSA would differentiate females across resilient and chronic PTSS trajectories. Finally, we hypothesized that predictors indicating heightened psychosocial adjustment would increase adolescents' likelihood of membership in a resilient versus a chronic PTSS trajectory.

Method

Participants

This study is based on a sample ($N = 460$) of females who experienced substantiated CSA and matched comparisons further described in Noll et al. (2021). The sample was drawn from the catchment area of a large urban children's hospital located in the mid-west region of the U.S. Eligibility criteria included: (1) female adolescents aged 12–16 years, (2) the ability to read and understand English, and (3) a legal guardian or caregiver who could provide written informed consent and participate as an additional informant.

For the present set of analyses, a subsample of 440 females was included who either experienced substantiated CSA or at least one alternative self-reported PTE as assessed via the *Comprehensive Trauma Interview* (described below; CTI; Shenk et al., 2016) assessed at the baseline (Time 1) assessment. CSA females having experienced substantiated CSA within the previous 12 months were recruited from Child Protective Services (CPS) agencies in local counties ($n = 156$). Matched comparisons ($n = 284$) were included in the present study if they reported having experienced at least one PTE (physical abuse, emotional abuse, neglect, physical assault by peer, witnessing violence, serious illness or death of a loved one, severe illness, serious medical procedure, or natural

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Table 1. Types of other self-reported potentially traumatic events by study group

	CSA ($n = 156$)		DMC ($n = 153$)		CMC ($n = 131$)	
PTEs from trauma interview (CTI)	*n*	%	*n*	%	*n*	%
Physical abuse	47	30.1	18	11.8	13	9.9
Emotional abuse	64	41.0	38	24.8	27	20.6
Neglect	14	9.2	9	5.9	1	0.8
Physical assault peer	31	20.4	11	7.2	27	20.6
Witnessing domestic violence	50	32.9	36	23.5	16	12.2
Witnessing violence	155	99.4	122	79.7	62	47.3
Serious illness or death of loved one	122	80.3	122	79.7	113	86.3
Serious illness, painful, or scary medical procedure	84	53.9	64	41.8	59	45.0
Natural disaster	28	18.4	30	19.6	18	13.7

Note. $n = 284$; PTE = potentially traumatic event; CTI = comprehensive trauma interview (Shenk et al., 2016); CSA = childhood sexual abuse; DMC = demographically matched comparisons; CMC = census-matched comparisons.

disaster). The distribution of PTEs is presented in Table 1, with serious illness, death of a loved one, and witnessing violence being most frequently endorsed by comparison females. Twenty comparison females did not report any PTE and were thus excluded.

Comparison females included demographically matched comparisons (DMC; $n = 153$) and census-matched comparisons (CMC; $n = 131$). DMC females were demographically matched to one CSA female on race/ethnicity, family income, and age. CMC females were enrolled to mirror the sociodemographic makeup of the teen's hospital catchment region in terms of household income and race/ethnicity. DMC and CMC females were excluded from enrollment if they had any prior history of sexual abuse as assessed via statewide child welfare records.

Procedures

The 440 females included in analyses were assessed at the baseline assessment (Time 1) and two additional follow-up assessments completed annually at Time 2 ($N = 414$; 94.1%) and Time 3 ($N = 402$; 91.4%). Adolescents and caregivers traveled to dedicated lab spaces to complete in-person lab sessions conducted by clinically trained interviewers who were blind to study group designation. The initial lab session lasted approximately 2 hr, including structured interviews and questionnaires administered to adolescents and caregivers. All methods and procedures were approved by the Institutional Review Board (IRB) at the regional hospital where the study took place (IRB#2012-0613; Federalwide Assurance #00002988). A Federal Certificate of Confidentiality was also secured (CC-HD-12-83).

Measures

Other self-reported PTEs, CSA during study, and PTSS

The *Comprehensive Trauma Interview* (CTI) was administered at Times 1 to 3. It is a detailed semi-structured trauma interview developed for use with adolescents and adults and validated to assess a host of PTEs as well as resulting symptoms of posttraumatic stress. Thereby, a cutoff of 7 indicates PTSS levels of clinical relevance (Shenk et al., 2016). For the present analyses, a variable was created assessing the number of *other self-reported PTEs* at Time 1 using the CTI by summing up all endorsed lifetime PTEs. At Times 2 and 3, trained interviewers asked about events occurring during the previous 12 months using specific prompts to help participants' pinpoint the timing of event (i.e., " . . . since the last time we saw you?"). A variable was created aggregating the number of *self-reported CSA events during course of the study* by summing up all CSA events reported during the CTI at Times 2 and 3.

Contamination

In a few cases, we learned – either through the CTI or via CPS records – that DMC or CMC females experienced CSA over the course of the study ($n = 30$). To control for such potential "*contamination*" in the matched comparison groups, a variable coded as 1 = *self-reported or confirmed CSA* versus 0 = *no CSA* was added to analyses as a covariate.

CSA characteristics

For the examination of abuse characteristics in the sample of CSA females, several characteristics were gleaned from CPS records including (1) polyvictimization, that is, the total number of abusive events (i.e., sexual, physical abuse, and/or neglect) as recorded in the CPS record, (2) the age at onset of the index CSA, (3) duration of the CSA, (4) whether the perpetrator of the index event was a family member, (5) whether the index abuse entailed penetration, and (6) the age when the first abusive event happened.

Psychosocial variables

Commonly accepted, standardized questionnaires were used to assess psychosocial risk and protective factors including online behaviors. All psychosocial risk and protective factors including online behaviors used in the trajectory and prediction analyses along with their descriptive statistics are presented in Table 2. These include individual characteristics (number of self-reported PTEs, PTSS, self-esteem, low impulse control, substance use, sexual activity, poor emotional control, prosocial activities, and grades), characteristics of families and peers (peer substance use, peer risky sexual activity, quality of relationship with parents and friends, and parenting), and online predictors (time online, intentional exposure to sexual content online, and cyberbullied).

Demographics

Income was assessed on a 12-point scale in increments of \$10K from 1 = *<$10K*, 2 = *$10K–$19K*, 3 = *$20K–$29K*, up to 12 = *<$120K*. Racial/ethnic minority status was quantified via caregiver reports of the adolescent's ethnicity with 1 = *minority race/ethnicity* (including "African American," "Native American," "Asian," or "Hispanic") and 0 = *White*. Caregiver education was assessed on a 7-point scale ranging from 1 = *6^{th} grade or less* to 7 = *Masters or professional degree*.

Statistical analysis

Statistical analyses were performed in R Version 4.0.4 using the l*cmm* (Proust-Lima et al., 2017), *caret* (M. Kuhn 2020), *glmnet* (Friedman et al., 2010), *fbroc* (Peter, 2019), and *DMwR2* (Torgo, 2016) packages (R Core Team, 2021).

Analyses for hypothesis 1

Latent growth mixture modeling (LGMM) was performed to identify trajectories of PTSS. We explored intercept, slope, and quadratic parameters as either random or fixed effects. In the final

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Table 2. Psychosocial risk and protective factors including online behaviors used in the LGMM and LASSO regression analyses

Construct	Measure	Min–Max	α	*M*/*n*	*SD*/%
Individual characteristics					
Other self-reported PTEs	Comprehensive Trauma Interview (CTI; Shenk et al., 2016); Experiences Questionnaire Screen; 13 PTEs/items (0 = *no*, 1 = *yes*); range 0–13	0–10	.61	3.12	1.97
Posttraumatic stress symptoms	Comprehensive Trauma Interview (CTI; Shenk et al., 2016); total posttraumatic stress disorder symptoms; 18 items (0 = *no*, 1 = *yes*); range 0–18; a cutoff of 7 indicates symptom levels of clinical relevance	0–18	.87	6.49	4.66
Self-esteem	Self-Perception Profile for Adolescents (Harter, 1988); Global Self-Esteem; 5 items (1 = *very false for me* to 4 = *very true for me*), range 1–20	5–20	.79	13.76	3.55
Low impulse control	Barratt Impulse Control Measure (BI; Patton, Stanford, & Barratt, 2004); total score; 30 items (0 = *rarely* to 3 = *always*); range 0–90	11–64	.79	34.55	9.77
Substance use	Monitoring the future survey (Johnston, O'Malley, Bachman, & Schulenberg, 2005), subscale: substance use; 18 items (0 = *0 occasions* to 6 = *40 or more occasions*); range 0–108	0–29	.72	1.74	3.96
Sexual activity	Sexual Attitudes and Activities Questionnaire (SAAQ; Noll et al., 2003); subscale: lifetime sexual activity; 7 items (0 = *none, never* to 5 = *more than 10 partners*); range 0–35	0–31	.93	4.49	6.02
Poor emotional control	Abbreviated Version of the Behavior Rating Inventory of Executive Function (BRIEF; LeJeune et al., 2010); caregiver-report; subscale: emotional control 3 items (0 = *never a problem* to 2 = *often a problem*); range 0–6; higher scores indicate poorer emotional control	0–6	.85	1.26	1.61
Prosocial activities	Teens' reports about the frequency at which they participate in extracurricular activities (e.g., sports teams, clubs, volunteer activities), 1 = *a few times per year or less* to 5 = *one time per week or more*	0–30	NA	7.44	6.75
Grades	Teens' reports of their current (or most recent) grades from *0 = Fs 1 = Ds and Fs, 2 = Ds, 3 = Cs and Ds, 4 = Cs, 5 = Bs and Cs, 6 = Bs, 7 = Bs*, and *8 = As*	0–8	NA	5.93	1.64
Family/peer predictors					
Peer substance use	Monitoring the future survey (Johnston, O'Malley, Bachman, & Schulenberg, 2005), subscale: peer substance use; 5 items (0 = *none* to 4 = *all*); range 0–20	0–20	.87	3.13	3.83
Peer risky sexual activity	Sexual Attitudes and Activities Questionnaire (SAAQ; Noll et al., 2003); 8 items assessing sexual activity including risky sexual behaviors, such as "one-night stands" or unprotected sex (0 = *definitely not* to 5 = *definitely yes*); range 0–40	8–40	.93	16.04	9.17
Quality of relationship parents & friends	Inventory of Parent & Peer Attachment (IPPA-R; Armsden & Greenberg, 1987); 3 subscales: relationship quality with mother figure, father figure, and friends; 16 items each (0 = *almost never true* to 5 = *almost alwaystrue*); range 0–80	Mo: 0–80 Fa: 0–80 Friends: 19–75	Mo: .93 Fa: .93 Friends: .85	Mo: 66.49 Fa: 52.29 Friends: 63.12	Mo: 13.99 Fa: 26.29 Friends: 8.14
Parenting	Child Report of Parenting Behavior Inventory-30 (CRPBI-R; Schulderman & Schulderman, 1988); 2 subscales: parental warmth and control; 10 and 20 items (1 = *not like my parent* to 3 = *like parent*); ranges 1–30 and 1–60	Warmth: 7–60 Control: 7–115	Warmth: .92 Control: .74	Warmth: 45.77 Control: 74.49	Warmth: 12.97 Control: 18.84
Online predictors					
Time spent online	Teens were asked to indicate the total amount of time they spend online compared to offline; 1 item (0 = *I mainly spend my time offline* to 4 = *I mainly spend my time online*)	0–4	NA	2.34	1.02
Intentional exposure to sexual content	Online Experiences Scale (OES; Noll et al., 2013); subscale: intentional seeking exposure to online sexual contents; 8 items (0 = *never/ /strongly disagree* to 4 = *very frequently/20 or more times/strongly agree*); examples: "*I find it exciting to chat about sex online.", "I choose sexy photos of myself for my profile picture., "I like going to websites that include sexual stuff.*"; range 0–32	0–26	.75	2.83	2.97
Cyberbullied (%)	Comprehensive Trauma Interview (CTI; Shenk et al., 2016); 1 item "Were there times when you have been bullied, harassed or threatened by someone online?" (0 = *no*, 1 = *yes*)	NA	NA	78	18.0

Note. Max *N* = 440; LGMM = latent growth mixture modeling; LASSO = least absolute shrinkage and selection operator; PTE = potentially traumatic event; NA = not applicable; Mo = mother figure; Fa = mather figure.

models, both slope and intercept variances were allowed to be freely estimated. Quadratic parameters were nonsignificant and thus removed to facilitate model convergence. Model solutions from 1 to 5 classes were compared by model fit indices, including AIC, BIC, sample-size adjusted BIC (SSABIC), entropy, and LMR-LT.

Univariate ANCOVA was used for comparisons of PTSS across the trajectories. Post hoc pairwise comparisons were adjusted for

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Table 3. Demographic and descriptive information for the full sample and by study group

	Full sample ($n = 440$)		CSA ($n = 156$)		DMC ($n = 153$)		CMC ($n = 131$)		
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	Test statistic
Time 1 age	14.25	1.25	14.44^{a}	1.41	14.27	1.55	13.99^{a}	1.13	$F(2, 437) = 4.66$, $p = .010$
% Minority status	58.0		71.2^{a}		66.7^{b}		32.1^{ab}		$\chi^2(2) = 51.97$, $p < .001$
Income	4.51	3.31	3.09^{a}	2.64	3.44^{b}	2.39	7.45^{ab}	3.07	$F(2, 436) = 111.58$, $p < .001$
Caregiver education	4.71	1.21	4.13^{ab}	1.22	4.75^{ac}	1.04	5.36^{bc}	1.04	$F(2, 437) = 44.03$, $p < .001$
Other self-reported PTEs (CTI)	3.12	1.97	3.92^{ab}	2.23	2.94^{ac}	1.68	2.41^{bc}	1.60	$F(2, 433) = 24.04$, $p < .001$
Time 1 PTSS	6.49	4.67	8.52^{ab}	4.93	5.57^{a}	4.01	4.96^{b}	4.10	$F(2, 388) = 25.02$, $p < .001$

Note. CSA = childhood sexual abuse; DMC = demographically matched comparisons; CMC = census-matched comparisons; PTE = potentially traumatic event; CTI = *Comprehensive Trauma Interview*. Omnibus ANCOVA $F(12, 766) = 21.07$, $p < .001$. Means designated with the same superscripts indicate statistically significant differences based on Tukey-adjusted post hoc comparisons ($p < .05$).

multiple testing using Tukey's Honesty Significant Difference test (Tukey, 1991) to control for experiment-wise Type 1 error.

Analyses for hypothesis 2

To empirically describe the distribution of CSA females across resultant trajectories, multinomial logistic regression analyses evaluated the differential odds for being represented in the trajectories for CSA versus DMC/CMC females, controlling for covariates (Time 1 age, income, racial/ethnic minority status, and contamination).

Analyses for hypothesis 3

T-tests and Chi^2-tests were used to compare CSA characteristics of CSA females across a resilient and a chronic trajectory. *P*-values were adjusted for multiple testing using the false discovery rate method (Benjamini & Hochberg, 1995).

Analyses for hypothesis 4

Least absolute shrinkage and selection operator (LASSO) logistic regression analysis was conducted to identify a set of strongest predictors for membership in a resilient versus a chronic trajectory. Missing data (3.4%) were imputed with K-nearest neighbor imputation. LASSO regression, a form of supervised machine learning, is particularly useful for a large number of predictors, as investigated in the present study, as it applies a penalization that reduces coefficients of less important predictors to zero, addresses the issues of multicollinearity and model overfitting/maximizing generalizability and improves interpretability (McNeish, 2015; Tibshirani, 1996). To select the optimal shrinkage parameters (i.e., lambda) for the LASSO models and obtain mean cross-validation estimates of model performance, 10-fold cross-validation with three repetitions was performed when building each model as recommended by Kuhn and Johnson (2016). As class imbalance was encountered when comparing membership in the resilient versus the chronic trajectory, i.e., more than 70% of the observations belong to the resilient trajectory, upsampling was used within the resampling process. To evaluate model performance, the area under the receiver operating characteristic curve (AUC) was used, with model fits being classified into fail (.50–.59), poor (.60–.69), fair (.70–.79), good (.80–.89), and excellent (.90–1.00). To obtain a 95% CI of AUC scores, we conducted 5000-sample bootstrap. The resultant optimal lambda parameters were used to refit the models to obtain the predictor coefficients needed to rank relative importance of predictors.

Results

Descriptive statistics

Descriptive statistics for all baseline predictor variables used in the analyses are presented in Table 2. Table 3 includes the sample demographics and characteristics of other self-reported PTEs and PTSS by study group. The final sample consisted of 440 females, averaged 14.25 years in age ($SD = 1.25$) at Time 1. Females were racially and ethnically diverse with more than half of the females ($n = 255$, 58.0%) self-identifying as racial or ethnic minority (45.2% African-American, 40.2% White, 0.2% Native American, 1.4% Asian, 9.1% multiracial, and 3.9% Hispanic ethnicity). The mean annual family income was around $35,000. CMC females were of higher income and lower percent minority race/ethnicity than both CSA ($t = 13.19$, $p < .001$; $\chi^2(1) = 43.72$, $p < .001$) and DMC ($t = 12.15$, $p < .001$; $\chi^2(1) = 33.81$, $p < .001$) females. CMC females were also about 5 months younger at Time 1 than CSA females ($t = 2.99$, $p = .002$). Caregivers of teens who experienced CSA reported lower levels of education than both DMC ($t = -4.96$, $p < .001$) and CMC ($t = -9.09$, $p < .001$) caregivers. CSA females had greater numbers of other self-reported PTEs (CTI) than both DMC ($t = 4.31$, $p < .001$) and CMC ($t = 6.60$, $p < .001$) females. Finally, CSA females reported more PTSS as compared to both DMC ($t = 5.63$, $p < .001$) and CMC ($t = 6.38$, $p < .001$) females.

Identification of PTSS trajectories

Table 4 displays the fit statistics for each symptom trajectory. Although the BIC and sample-size adjusted BIC indicated a better fit for the 3-class model, the differences in BICs were small and AIC, entropy, and LMR-LRT indicated the 4-class model provided the best overall fit to the data. Additionally, the 4-class model is consistent with previous research on the number and characteristics of PTSS trajectories following PTEs (e.g., Bonanno & Diminich, 2013; Galatzer-Levy et al., 2018; Lauterbach & Armour, 2016; Proctor et al., 2010; Witt et al., 2019; Woodruff & Lee, 2011). As such, our derived 4-class model is defensibly interpretable and was thus retained, confirming hypothesis 1. The trajectories were labeled: (1) "resilient" (low-stable; $n = 223$, 52.1% of sample), characterized by low PTSS at baseline (intercept = 3.47, $SE = 0.41$, $p < .001$) that did not change over time (slope = −0.29, $SE = 0.18$, $p = .102$); (2) "emerging" PTSS (increasing over time; $n = 40$, 9.3% of the sample), characterized by low PTSS at baseline (intercept = 1.89, $SE = 3.80$, $p = .497$) that grew considerably worse over time (slope = 2.64, $SE = 1.52$, $p = .08$); (3) "recovering"

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Table 4. Fit indices and entropies for latent growth mixture models

Nb of classes	AIC	BIC	SABIC	LMR-LRT, *p*-value	Entropy
1	6549.19	6573.55	6554.51	–	–
2	6452.90	6493.49	6461.75	<.001	0.60
3	6437.17	6493.99	6449.57	<.001	0.70
4	6433.98	6507.04	6449.92	.031	0.71
5	6442.58	6531.89	6462.07	1.000	0.52

Note. SABIC = sample-size adjusted Bayesian information criterion; LMR-LRT = Lo-Mendell-Rubin likelihood ratio test. A significant test indicates that a solution with a given number of classes provides a better fit to the data than a solution with one fewer class.

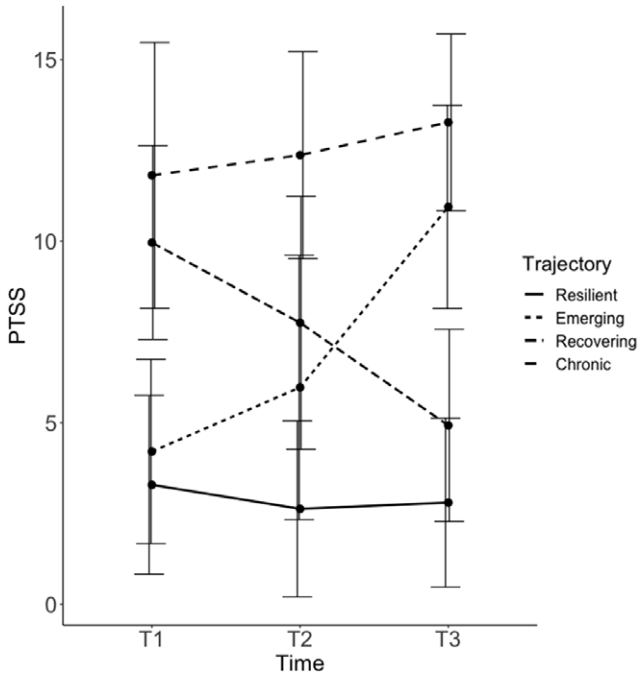

Figure 1. Results of latent growth mixture modeling. Observed means and 95% CIs of the four PTSS trajectories are presented across time. PTSS = posttraumatic stress symptoms. T1–T3 = time 1–3.

(decreasing over time; $n = 82$, 19.2% of the sample), characterized by high PTSS at baseline (intercept = 11.78, $SE = 1.44$, $p < .001$) that improved markedly over time (slope = −2.33, $SE = 0.67$, $p < .001$); (4) "chronic PTSS" (high-stable; $n = 83$, 19.4% of the sample), characterized by high PTSS at baseline (intercept = 10.94, $SE = 0.91$, $p < .001$) that only changed minimally over time (slope = 0.69, SE = 0.34, $p = .045$). The mean posterior probabilities were adequate for the resilient (0.87), the Recovery (0.76), and the chronic PTSS (0.90) trajectories, and acceptable for the emerging PTSS (0.70) trajectory. The observed means and 95% CIs of the four trajectories across time are presented in Figure 1.

Means and standard deviations of PTSS severity are presented in Table 5 by time point and trajectory. Females in the resilient trajectory showed consistently low levels of PTSS over time, the means for which never exceeded the clinical cutoff of 7 (Shenk et al., 2016). Females in the emerging PTSS trajectory did not report PTSS at a clinically relevant level at Time 1 but showed clinically significant PTSS by Time 3. The opposite was observed for the Recovering trajectory where females reported clinically relevant levels of PTSS with waning symptoms over time to nonclinical levels by Time 3. Finally, females in the chronic PTSS trajectory reported the highest levels of PTSS and met the clinically significant cutoff at all three assessments over time.

Locating females who experienced CSA in PTSS trajectories

As depicted in Figure 2 and in line with hypothesis 2, CSA females were the most likely to be represented in the chronic PTSS trajectory (69.9%), while CMC females had the highest percentage representation in the resilient trajectory (39.9%) and DMC females in the emerging trajectory (42.5%). As shown in Table 6, when compared to the chronic trajectory, the odds for CMC females to be represented in the resilient trajectory were 12.65 times greater than for CSA females and the odds for DMC females were 6.33 times greater than for CSA females. When compared to the chronic trajectory, DMC females were 3.28 times more likely than CSA females to be represented in the Recovering trajectory, but there were no statistically significant differences comparing to the odds for CMC versus CSA females across these two trajectories. Lastly, as compared to the chronic trajectory, the odds for CMC and DMC females to be represented in the emerging trajectory were 21.25 and 7.52 times greater (respectively) than for CSA females (Table 6).

To test hypothesis 3, CSA characteristics were examined to further differentiate the CSA females in the resilient versus chronic trajectories. Findings displayed in Table 7 indicate that CSA females in the resilient trajectory reported fewer other self-reported PTEs ($t = -5.14$, $p < .001$) and fewer CSA events during the course of the study ($t = -2.52$, $p = .041$) compared to CSA females in the chronic trajectory. No significant differences were found regarding polyvictimization, age at onset of the index CSA, duration of the index CSA, whether the CSA perpetrator was a family member, whether the index CSA included penetration, or the age when the first maltreatment event happened, as gleaned from CPS records (Table 7).

Baseline psychosocial predictors of PTSS trajectories

Testing hypothesis 4, predictive accuracy for the LASSO model examining psychosocial predictors including online behaviors of membership in the resilient versus the chronic PTSS trajectory was good (AUC = .87; 95%CI .82, .91). Results of the LASSO model are displayed in Table 8. Nine of the 23 individual, family/peer, and online variables tested were retained in the model. The most important predictors were fewer other self-reported PTEs and not having experienced CSA. Importantly, low incidences of intentional exposure to sexual content online were the third most important predictor of the resilient trajectory. Females who reported greater levels of self-esteem, a better quality of relationship with friends, and being of racial/ethnic minority were more likely to be in the resilient trajectory. On the other hand, females characterized by lower impulse control, poorer emotional control, and who reported elevated rates of substance use were less likely to be represented in the resilient trajectory as compared to the chronic trajectory. A plot of retained predictors presented in descending order of variable importance is shown in Figure 3.

Discussion

The present study examined trajectories of PTSS derived in a sample of females with substantiated CSA and matched comparison females who did not experience CSA, but who reported various levels of alternative PTEs. Consistent with our hypotheses, results identified four distinct trajectories of PTSS over the course of three

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Table 5. Means and SDs of PTSS in the four identified trajectories

	Resilient		Emerging		Recovering		Chronic		
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
T1 PTSS	3.29	2.46	4.41	2.54	9.96	2.67	11.82	3.66	$F(3, 387) = 230.67$, $p < .001$
T2 PTSS	2.62	2.43	5.97	3.64	7.75	3.48	12.37	2.85	$F(3, 370) = 215.24$, $p < .001$
T3 PTSS	2.80	2.33	10.95	2.80	4.93	2.65	13.28	2.44	$F(3, 374) = 362.83$, $p < .001$

Note. PTSS = posttraumatic stress symptoms; CSA = childhood sexual abuse; DMC = demographically matched comparisons; CMC = census-matched comparisons. All means are statistically significantly different based on Tukey-adjusted post hoc comparisons ($p < .050$), except Time 1 resilient versus emerging ($t = 1.67$, $p = .237$).

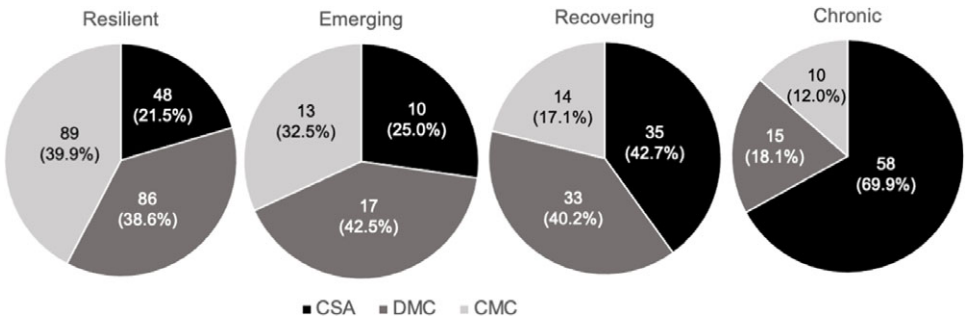

Figure 2. Distributions of females in the three study groups across the four latent PTSS trajectories. CSA = childhood sexual abuse; DMC = demographically matched comparisons; CMC = census-matched comparisons.

assessments during adolescence: resilient, emerging, recovering, and chronic. In line with the existing literature regarding childhood and adult adversity (Bonanno, 2021; Masten et al., 2021), resilience was the most common response. The identification of these four trajectories is remarkably consistent with extant literature regarding psychological adjustment after a variety of PTEs examined in both in adults (Galatzer-Levy et al., 2018) as well as children and adolescents (Bonanno & Diminich, 2013) and in particular in adolescents after maltreatment (Lauterbach & Armour, 2016; Proctor et al., 2010; Witt et al., 2019; Woodruff & Lee, 2011). More specifically, regarding PTSS following maltreatment, our findings add to the two existing studies in adolescents (Miller-Graff & Howell, 2015; Nugent et al., 2009), by revealing the two additional trajectories, emerging and recovering. Further, our results show that the four identified trajectories apply to a broad sample including both adolescents after substantiated CSA and other non-CSA PTEs.

Further, our findings indicate that CSA females were much less likely to be represented in the resilient trajectory as compared to their demographically similar or census-matched peers. Moreover, the LASSO regression findings showed that other self-reported PTEs and CSA were the most important predictors of membership in the resilient versus the chronic trajectory. While these results overlap with what has been found in previous studies examining predictors of symptom trajectories in youth after maltreatment (Miller-Graff & Howell, 2015; Nugent et al., 2009), they also underscore the unique contribution of CSA to the disruption of adolescent development (Noll et al., 2019) and in the development of PTSD (Noll, 2021). Fewer alternative self-reported PTEs (e.g., witnessing violence, serious illness, or death of a loved one) and fewer self-reported CSA events during the course of the study assessed via the CTI distinguish CSA survivors in the resilient trajectory from those in the chronic trajectory. This finding is not surprising given the myriad of studies showing abuse severity and dose–response relationships between child maltreatment and a host of mental and physical health outcomes (Kendler et al., 2000; Newbury et al., 2018). Our results further show that participants who reported more CSA events over the course of the study were more likely to be in the chronic trajectory than either the resilient or the recovering trajectory groups suggesting unremitted PTSS due to repeated PTE exposures (see Table 6). Even in the face of these findings, it is remarkable that over 30% of the CSA sample was included in the resilient trajectory suggesting that many survivors of abuse possess resilient qualities such that they are likely to exhibit healthy adjustment despite such egregious experiences.

Individuals exposed to adversity, but who remain on normative developmental trajectories likely utilize a wide array of resilience-promoting strategies indicative of underlying processes that facilitate adaptation. Resilience is a complex construct that is possibly influenced by individual characteristics that may vary by situation, among contexts, and over time. A proposed mechanism underlying resilience is flexible self-regulation, which has been defined as the ability to adapt emotional responses according to the demands of a specific situation (Bonanno, 2021). Flexible emotional self-regulation has repeatedly been shown to serve as a buffering agent against negative outcomes in psychological adjustment in adults after adverse events (Bonanno et al., 2004; Westphal et al., 2010). This is well in line with findings from the present study showing that greater emotional control is predicting the resilient trajectory. This indicates that individuals following the resilient trajectory likely do not allow small events to trigger big reactions, they do not get upset easily, or have outbursts for little reason. Our results also show that individuals in the resilient trajectory are less likely to use substances which also suggests some control over a tendency to give in to addictive behaviors and/or the ability to resist the influence of peer pressure to use substances (Allen et al., 2012).

Although today's adolescents acquire unique skills in navigating a digital world with virtually unlimited access to the internet, they also face unique challenges that set the current generation apart from previous generations when access to sexually explicit

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Table 6. Multinomial logistic regression analyses for study groups predicting trajectories (controlling for covariates)

	Resilient[b]			Recovering[b]			Emerging[b]		
	Exp(B)	95%CI[c]	*p*	Exp(B)	95%CI	*p*	Exp(B)	95%CI	*p*
DMC[a]	6.33	3.08, 13.01	<.001	3.28	1.51, 7.17	<.001	7.52	2.65, 21.33	<.001
CMC[a]	12.65	4.79, 33.37	<.001	2.42	0.79, 7.41	.122	21.25	5.22, 86.43	<.001
Time 1 age	0.77	0.61, 0.98	.031	1.08	0.83, 1.41	.554	0.87	0.63, 1.22	.422
Income	1.03	0.92, 1.16	.563	1.05	0.93, 1.19	.451	0.92	0.77, 1.09	.348
Minority status	3.14	1.62, 6.08	<.001	2.20	1.06, 4.53	.033	2.83	1.12, 7.15	.028
Contamination	1.15	0.29, 4.59	.841	1.36	0.29, 6.28	.694	1.88	0.38, 9.31	.439
Self-reported CSA during study	0.21	0.08, 0.54	.001	0.32	0.12, 0.85	.023	1.92	0.74, 5.01	.182

Note. PTSS = posttraumatic stress symptoms; DMC = demographically matched comparisons; CMC = census-matched comparisons.
[a]CSA (childhood sexual abuse) serves as reference class.
[b]The chronic PTSS trajectory serves as reference class.
[c]95% Wald CI.

Table 7. CSA characteristics of females in the resilient and chronic PTSS trajectories

	Resilient ($n = 48$)	Chronic ($n = 58$)	
	M (SD)/*n* (%)	*M (SD)*/*n* (%)	Test statistic
Polyvictimization* (CPS records)	3.65 (4.01)	3.38 (3.19)	$t = 0.38$, $p = .704$
Age at onset index CSA (years)	11.71 (2.64)	10.77 (3.45)	$t = 1.55$, $p = .161$
Duration (years)	0.23 (1.32)	0.97 (1.90)	$t = -2.23$, $p = .056$
Perpetrator is family (yes/no)	20 (37.0%)	34 (63.0%)	$\chi^2(1) = 3.02$, $p = .082$
Penetration (yes/no)	26 (50.0%)	26 (50.0%)	$\chi^2(1) = 0.92$, $p = .338$
Age at first abuse (years)	5.77 (4.89)	7.38 (4.95)	$t = -1.51$, $p = .168$
Other self-reported PTEs (CTI)	2.77 (1.63)	4.93 (2.48)	$t = -5.14$, $p < .001$
Self-reported CSA during study (CTI)	6.29 (3.31)	9.88 (4.59)	$t = -2.52$, $p = .041$

Note. CSA = childhood sexual abuse; PTSS = posttraumatic stress symptoms; CPS = child protective services; CTI = *comprehensive trauma interview*. False discovery rate adjusted *p*-values presented.
*The variable "ploy victimization" denotes the total number of abusive events (i.e., sexual, physical abuse, and/or neglect) as recorded in the CPS record.

material was limited and subject to regulation. Results presented here demonstrate that intentionally seeking exposure to sexual content online was retained as the third most important predictor, indicating a lower likelihood for the resilient versus the chronic PTSS trajectory. It has been shown that pornography use is associated with adolescent negative mental health and risky behavioral outcomes (Kohut & Štulhofer, 2018; Lim et al., 2017). Increased risky sexual behaviors, for example, but also sexually permissive attitudes and sexual solicitations (Brown et al., 2006; Collins et al., 2011; Helweg-Larsen et al., 2012; Lo & Wei, 2005) bear unique risks for online exploitations and subsequent offline revictimizations. Such behaviors could explain why PTSS might remain elevated over time for females who are exposed to sexual contents online. In addition, risky sexual behaviors also indicate elevated risk for sexually transmitted diseases, HIV infection, and unintended pregnancy – all aspects of sexual development that could impede and/or complicate recovery from PTEs. As detailed in the introduction, navigating the internet safely and being exposed to sexual contents online appear to be especially challenging for CSA females.

Another intriguing finding from this study was that racial and ethnic minority status was a significant predictor of the resilient trajectory even when family income level was not. Though racial and economic disparities are often intertwined and even conflated, these results suggest that there are unique resilient competencies of racial and ethnic minority youth that are not explained by potentially co-occurring poverty. Much of the literature examining developmental outcomes for racial and ethnic minority youth takes a deficit-based approach, which implies that racial and ethnic minority youth have innate deficits that constitute disadvantage (Slopen & Williams, 2021). Adaptation-based approaches, on the other hand, emphasize how racial and ethnic minority youth raised in disadvantageous environments often develop competencies that allow them to thrive in difficult contexts (Ellis et al., 2017). Through a complex interaction of laws, procedures, policies, and culture, racial and ethnic minority youth in the US undeniably experience disproportionate hardship as compared to their white counterparts and such systemic racism continues to create unequal access to health, education, housing, employment, and wealth for these youth (Cobbinah & Lewis, 2018). Experiences of racism, including racially discriminatory encounters and racial microaggressions, can further exacerbate this cultural inequality, especially for youth who experience the intersectionality of multiple minority identities (e.g., intersection of sexism and racism; Crenshawt, 1989;

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Table 8. Coefficients for psychosocial predictors including online behaviors in LASSO logistic regression analyses

Time 1	Resilient trajectory
Individual predictors	
CSA	−.71
Other self-reported PTEs	−.71
Time 1 age	–
Income	–
Minority status	.09
Caregiver education	–
Self-esteem	.19
Low impulse control	−.09
Substance use	−.05
Sexual activity	–
Poor emotional control	−.09
Prosocial activities	–
Grades	–
Family/peer predictors	
Peer substance use	–
Peer risky sexual activity	–
Quality relationship friends	.07
Quality relationship mother	–
Quality relationship father	–
Warm parenting	–
Controlling parenting	–
Online predictors	
Time spent online	–
Cyberbullied	–
Intentional exposure to sexual content	−.24

Note. LASSO = least absolute shrinkage and selection operator; CSA = childhood sexual abuse; PTE = potentially traumatic event; LASSO coefficients represent the final model, identified through ten-fold cross-validation repeated three times to identify the optimal lambda (penalization) parameter. Standardized coefficients presented.

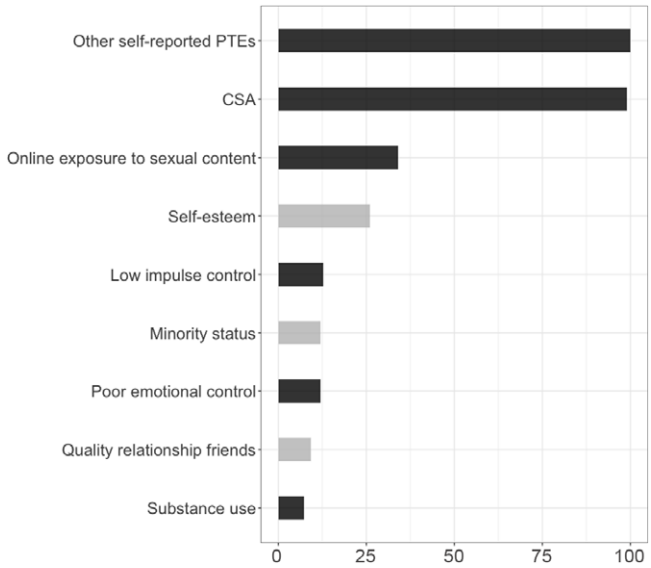

Figure 3. Variable importance of predictors retained in the LASSO logistic regression model. Bars filled in black present negative coefficients, i.e., females being less likely to be in the resilient PTSS trajectory. Bars filled in gray display positive coefficients, i.e., females being more likely to be in the resilient PTSS trajectory. PTE = potentially traumatic events; CSA = childhood sexual abuse.

Lewis et al., 2017). Results presented here suggest that racial/ethnic minority females may foster resilience competencies that can be protective against chronic PTSS following PTEs. Extant literature has demonstrated that racial and ethnic minority youth often adopt significant coping mechanisms and stress-adapted skills, known as "hidden talents," that are specialized to extract resources from their environment and overcome both individual and structural adversities (Ellis et al., 2020). Such skills include reappraisal, decision-making, and resolution of the discriminatory experience (Anderson & Stevenson, 2019). Other research suggests that racial identity centrality and/or racial group identification can serve as a buffer against distressing experiences of racism (Barrow et al., 2007; Chae et al., 2011) and gendered racism (Lewis et al., 2017), fostering resilience among Black/African American women from adverse health consequences. In this sense, because of systemic oppression and racial discrimination, families teach future generations to prepare for these biases and likewise promote cultural customs, traditions, and pride (Hughes et al., 2006). This "ethnic racial socialization" encourages identity consolidation (Schwartz, 2007), which is an active developmental process in the adolescent years and associated with various protective factors, such as increased self-esteem (e.g., Bracey et al., 2004). In summary, more research focusing on strength-based approaches is needed to disentangle the interplays of race/ethnicity and trauma reactions.

This study used validated instruments and a structured interview to assess psychosocial variables, a longitudinal design, and advanced methods such as machine learning to handle a large set of predictor variables. Unique strengths further include a relatively large sample of adolescents with substantiated CSA as well as a diverse set of alternative PTEs and a comprehensive set of psychosocial predictors including online behaviors assessed at baseline that served to differentiate PTSS trajectories. However, several limitations should be mentioned. First, the online variables used in this study were assessed via self-report. Given that adolescents are likely to underestimate the frequency of internet use or exposure to online sexual contents, results may be underestimated (Boase & Ling, 2013). On the other hand, our results provide impactful first insights into associations between online variables and a resilient versus chronic course of PTSS following potential trauma and therefore clues as to how the online environment of today's youth might be impacting development and adjustment to adversity. Second, the sample consisted of only females limiting generalizability to males. However, female adolescents are more likely to experience CSA (Finkelhor et al., 2014) and report higher rates of PTSD than males (reviewed in Alisic et al., 2014). Females have been shown to be disproportionately impacted by exposure to online sexual contents (Kohut & Štulhofer, 2018) and have been more likely to be classified as high-risk internet users as compared to males (Victorin et al., 2020). Lastly, recent simulation studies (Depaoli et al., 2019; Shader & Beauchaine, 2021) indicated that group identification in LGMM can be impacted by non-normally distributed data. However, this concern is attenuated when intercept effect sizes are large, which is the case in the present study (e.g., intercept effect size of resilient and chronic: Cohen's $d = 1.02$). Given that LGMM has been shown to be more effective when

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intercept effect sizes were large (Shader & Beauchaine, 2021), examining the two latent groups with the least (i.e., resilient) and most (i.e., chronic) prevalent PTSS avoids differentiating latent groups that were potentially artifacts of the methodology. However, since the non-normal distribution of PTSS in the present study (range of skewness Time 1–Time 3 = 0.48–0.69, range of kurtosis Time 1–Time 3 = 2.11–2.32) remains a concern for class misidentification (Depaoli et al 2019), it is critical to consider this limitation when interpreting findings.

The present study focused on the analysis of the resilient versus chronic trajectories without hypothesizing any effects that might be observed across the recovering and emerging trajectory groups. As such, it will be important for future research with larger samples to add clarity for these alternative courses of PTSS, which are characterized by pathways of recovery and possible "sleeper effects" (Finkelhor & Berliner, 1995) since this may have important implications for clinical practice and the prevention of PTSD. In addition, based on the results of the present study, it will be important for future studies to include racial/ethnical minority status in both unconditional and conditional modeling as opposed to considering such variables as mere covariates. Such analyses could also include various racial/ethnical subgroups to elucidate differential patterns of outcomes following PTEs, and moderated mediation analyses in the examination of differential mechanisms that can illuminate tailored treatments for CSA survivors from varying social contexts.

This study examined four distinct PTSS trajectories following CSA and other PTEs with resilience being the most common course. This observation has broad implications for the behavioral sciences, as it indicates that individuals are heterogeneous in their response to adversity but that the majority adapt without undue dysfunction. Importantly, results show that a considerable portion of CSA survivors (i.e., more than 30%) follow a resilient trajectory and, as such, posttraumatic stress reactions are not inevitable for CSA survivors. Findings also provide important insights into vulnerable adolescents who are likely to benefit from preventive interventions to stave off PTSS following PTEs by indicating a broad array of psychosocial indicators which differentiate those who are resilient from those on a more chronic course of PTSS. Results thus indicate that interventions aimed at enhancing self-esteem, emotion regulation, and impulse control skills as well as those preventing substance use may serve as protective factors fostering resilience for adolescents who experience PTEs. Importantly, aspects of the adolescent online environment – an often overlooked and nuanced aspect of today's developing teens – were also implicated in the differentiation of resilience from chronic PTSS. Learning how to navigate and engage on the internet safely and appropriately has become a key task of adolescent development, and our results indicate that this task may be especially challenging for teens who experience potential trauma, with the exposure to sexually explicit online content having particular salience in terms of exacerbating the ill effects. Hence, results emphasize that strength-based interventions for trauma recovery should include education about internet safety. As such, targeted secondary prevention within the child welfare system that includes the complexities of online sexual exposures will likely enhance recovery. This could include augmentations to evidence-based treatments such as trauma-focused cognitive behavior therapy (Cohen & Mannarino, 2015) which include sessions on safety planning where internet safety and pornography prevention could be addressed. Finally, findings presented here emphasize the need for investment in policies that expand trauma-informed approaches to care for youth exposed to PTEs. For example, given the link between trauma-informed care and better mental health outcomes in youth with PTSS, expansion of trauma-informed care training to service providers and educators may be better supported and incentivized. Further, universal trauma screening starting as early as possible helps target interventions and quantifies the risk of maladjustment later on (Menschner & Maul, 2016). Moreover, increasing access to health insurance for youth will increase access to a number of support services with implications for more upstream prevention, including previously mentioned evidence-based interventions (Murphey & Dym Bartlett, 2019).

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Conflicts of interest. None.

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