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Heightened Risk for Pain in Young Adult Women with a History of Childhood Maltreatment: A Prospective Longitudinal Study

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INTRODUCTION

Adults with chronic pain report a higher incidence of childhood maltreatment (i.e., physical, emotional, sexual abuse; neglect) than the general population, with rates up to 63% [15; 18; 42] compared to 12.5% among US adults [50]. Theoretical models identify maltreatment and adversity as risk factors for developing chronic pain, operating through psychological distress, social difficulties, and hyperarousal [32; 34]; however, many studies evaluating the prevalence of child maltreatment in adults with pain rely on retrospective reports [42]. Prospective studies evaluating pain in adulthood among those with known child maltreatment have not consistently found elevated risk [44], which may be explained by inconsistencies in reporting of maltreatment [4] and combining maltreatment and a broader conceptualization of adversity (e.g., natural disasters, family instability) [42]. If maltreatment uniquely contributes to pain, exposure to maltreatment would be expected to increase risk for pain in adulthood independent of adversity. Child adversity frequently co-occurs with maltreatment, and may also contribute to pain in adulthood [34]. Further, women are at heightened risk for chronic pain in adulthood [9]; therefore, understanding the connection between maltreatment and pain is a key women's health issue.

The association of child maltreatment and adult pain may be explained through the experience of post-traumatic stress symptoms (PTSS, [20]) which often follow child maltreatment. PTSS, characterized by re-experiencing traumatic events, heightened arousal to environmental stimuli, and avoiding stressful situations, are elevated in children and adults with chronic pain [2; 35], and associated with increased chronic pain [30] and reduced treatment responsiveness [7]. Child maltreatment and adult post-traumatic stress disorder together increase the risk for pain in middle adulthood [43]; longitudinal studies beginning

in childhood are necessary to identify whether child maltreatment and PTSS act together to increase risk for pain in adulthood. Child maltreatment is consistently associated with elevated PTSS [31] and dysregulation in stress and inflammatory pathways [8; 16; 19; 26; 40; 41] that are also observed in chronic pain, while findings related to adversity more broadly are variable. For this reason, it may be important to distinguish among types of child adversity when examining adult pain experiences.

The current study longitudinally examined associations among child maltreatment, adolescent PTSS, and pain in young adult women. It was hypothesized that women with a documented history of maltreatment would report more pain in the past week, higher pain intensity, and more pain locations than women without a maltreatment history. Further, child maltreatment was expected to increase adolescent PTSS, which in turn would explain the relations between child maltreatment and young adult pain experiences, such that elevated PTSS would be associated with more reports of experiencing pain and higher levels of pain in young adult women. Finally, child maltreatment was expected to increase adult pain over other forms of childhood adversity. Given that child maltreatment is less common than childhood adversity [17], distinguishing the effects of maltreatment and adversity may be relevant to improve screening procedures in the clinical care of pain patients, and help to further elucidate risk factors for the development of chronic pain.

METHODS

Participants

Data were obtained from a prospective cohort study, the Female Adolescent Development Study (FADS), aimed at examining the impact of child maltreatment and subsequent female health [36; 38]. The study included 477 adolescent females matched as case-control. A “case” (i.e., maltreated group) was defined as having a substantiated maltreatment report based on child protective services (CPS) records ($n = 273$; 31% substantiated allegations for physical abuse, 49% sexual abuse, 15% neglect, 5% multiple types) in the previous year. “Control” participants (i.e., comparison group; $n = 204$) were individually matched on gender, race, income, and family constellation (1 or 2-parent households), recruited from primary care clinics at a large pediatric hospital in the US Midwest and from the communities in which the maltreated females resided. Youth eligible to participate were: (1) adolescent females, (2) able to read and understand English, and (3) residing with a non-perpetrator of maltreatment for a minimum of 12 months, who could provide written informed consent. Control group participants had no self-report of maltreatment or evidence of maltreatment based on CPS records. Those in the control condition who were found to have experienced maltreatment based on CPS records were excluded ($n = 37$, original sample $N = 514$).

Procedures

Adolescent Assessment—Participants between the ages of 14 and 17 years were recruited for the FADS study beginning in 2008. Each participant in the maltreated group had endured at least one substantiated case of abuse or neglect within 12 months of study enrollment, where CPS investigators confirmed that child maltreatment had occurred.

Participants in the non-maltreated comparison cohort were without maltreatment at the time of enrollment, based on participant report and CPS record review. This information was then verified later during an audit of CPS records to ensure that no participants in the comparison cohort had experienced substantiated abuse; as a result, 37 adolescent females were excluded from the comparison cohort in these analyses. The Institutional Review Board at Cincinnati Children's Hospital Medical Center (CCHMC) approved all aspects of this study. At the time of enrollment, a non-offending legal guardian who resided with the adolescent study participant provided informed consent for participation, and the adolescent provided assent to participate. Participants completed annual study visits measuring broad aspects of female health until the age of 19 years, with a retention rate of 97%. At age 18 years all study participants were re-consented and gave permission to be contacted for future research studies. During the adolescent phase of data collection, interviews to detect child maltreatment and adversity were conducted annually for all participants, along with self-report survey measures. The interviewer conducting the interview was blind to whether the child had substantiated maltreatment allegations. The caregiver consenting to participation also completed surveys reporting on the participant's health and psychosocial functioning. Between visits, participants were contacted quarterly by mail, email, and phone to assist with retention. Study participants also consented/assented to the use of Accurint®, a technology used to search public records and locate adults, to maintain contact with participants (if aged 18 years or older) and caregivers (if participants were under the age of 18 years).

Young Adult Assessment—In the fall of 2017, 5 years after FADS data collection ended, study participants were re-contacted and invited to participate in an online self-report survey. Participants were re-contacted via mailed letters to last known addresses, email to last known email address, phone calls to last known phone numbers, through social media, through address and phone number searches in Accurint®, and by searching online public and media records. Study participants who indicated they were interested in participating in a follow-up research study were sent a link via email to complete the online survey, which could be completed on a desktop or mobile device (e.g., phone, tablet). Participants who expressed interest but did not have reliable internet access were mailed a paper version of the survey to complete and return in a pre-paid stamped envelope. The Institutional Review Board at CCHMC approved all aspects of the young adult follow-up for this study.

Measures

Adolescent Predictor Variables

Child maltreatment status: Child maltreatment was dichotomous (0 = *no maltreatment*, 1 = *maltreatment*) determined based on substantiated sexual abuse, physical abuse, or neglect within 3–12 months of enrollment into the original study for the maltreated cohort, or the absence of a substantiated allegation of abuse or neglect and self-reported maltreatment experiences for the control cohort.

Post-traumatic Stress Symptoms (PTSS): PTSS were collected through participant report during the structured Comprehensive Trauma Interview (CTI; [5]), administered by a trained reviewer. The CTI is a validated structured interview protocol that captures trauma history

from birth to the time of administration (see [37] for full details). As part of the CTI, when participants self-identified traumatic experiences, they were asked to report (1) *re-experiencing symptoms* (6 yes/no items; e.g., “Have you ever felt as though what happened was re-occurring – like you were reliving it?”), (2) *trauma avoidance* (6 yes/no items; e.g., “Have you ever avoided doing things or getting into situations that reminded you of what happened?”), and (3) *arousal* (6 yes/no items; e.g., “Have you ever had trouble falling asleep or staying asleep because of what happened?”) using a validated scale [47] that is consistent with the Diagnostic and Statistical Manual of Mental Disorders IV [3]. Responses were summed to create a scale from 0 (*no symptoms*) to 6 (*all symptoms endorsed*) for each subscale, with higher scores indicating greater symptoms.

Young Adult Outcome Variables—Participants received a link via email and were invited to complete the survey online using CCHMC’s Research Electronic Data Capture (REDCap) system. Participants were instructed to answer questions about pain symptoms they had experienced over the past week, based on questions from the Brief Pain Inventory [12; 14] and the Widespread Pain Index [51; 52]. Survey responses were stored on a secure server.

Any pain: Participants were asked “Have you experienced more than ‘every day’ pain in the last week” (1 = *Yes*, 0 = *No*) to determine the presence of any pain.

Pain Locations: Participants were asked to indicate which locations they felt pain, across 19 body areas based on the Widespread Pain Index measure used as part of the American College of Rheumatology’s guidelines for classification of fibromyalgia [52]. The score for pain locations was based on the count of areas that participants endorsed.

Average Pain Intensity: Participants reporting that they had experienced pain in the last week were asked to rate their average pain severity using an 11-point Numeric Rating Scale with response options ranging from 0 (*no pain*) to 10 (*pain as bad as you could imagine*; [13; 23]).

Covariates

Demographic variables.: Age in years at the time of enrollment and at the young adult follow-up was included. Minority status was based on self-report of race and ethnicity; due to limited heterogeneity, responses were recoded to 0 (*Minority*) or 1 (*White non-Hispanic*). Household income at baseline was based on caregiver report with responses ranging from 1 (*under \$10,000*) to 12 (*over \$120,000*).

Childhood Adversity.: Child adversity was calculated based on the number of events endorsed during the CTI with the adolescent, classified into three previously-validated categories [6]: unexpected tragedy (7 events, e.g., “Have you ever been very sick (e.g., needing hospitalization?)”); instability (3 events, e.g., “Did anyone close to you ever move away from you?”); and exposure to violence (8 events, e.g., “Have there been times when you have seen or heard adults that take care of you hit each other or hurt each other physically?”); confirmatory factor analysis indicated this model structure had good fit to the

data; CFI = 0.93, RMSEA = 0.02, SRMR = 0.04. Additionally, items from this self-report measure were used to identify maltreatment experiences by type (i.e., abuse only, neglect only, or both abuse and neglect).

Adolescent Pain.: At the baseline adolescent study visit, caregivers were asked to report lifetime and past two year prevalence of various conditions, including frequent abdominal pain, backaches, headaches, swollen or painful joints, pain or pressure in the chest, arthritis, and other physical complaints, which were coded to indicate pain (e.g., knee pain). These data were coded to indicate any caregiver report of lifetime pain or pain in the previous two years. Additionally, adolescents completed the Youth Self Report [1], which included a somatic symptoms subscale where adolescents could endorse whether they “sometimes” or “always” experienced general aches and pains, headaches, and stomachaches. These items were coded to indicate adolescent report of pain.

Analysis Plan

Descriptive statistics were calculated for the full sample and by maltreatment group. To evaluate the impact of attrition in young adulthood, differences in adolescent-reported variables (e.g., PTSS, age, household income, and childhood adversity) were evaluated using t-tests for continuous outcomes and chi square tests for categorical outcomes. Bivariate analyses examining PTSS and each young adult outcome by maltreatment group were also conducted, using t-tests for continuous outcomes and chi square tests for categorical outcomes.

To test the hypotheses that maltreatment would elevate risk for adolescent PTSS and young adult pain, and that adolescent PTSS would explain the relations between maltreatment and young adult pain, mediation path analyses were estimated using a SEM framework. Models were estimated using the lavaan package [46] in R version 3.5.0. Models estimated the direct effect of maltreatment group, determined at baseline, as a predictor of adolescent-reported PTSS subscales (i.e., re-experiencing, arousal, avoidance) and young adult physical pain (i.e., any pain in the past week, average pain intensity, number of pain locations), the direct effect of PTSS subscales on young adult physical pain, and the indirect effect of maltreatment group on adult pain through PTSS subscales, accounting for the effects of covariates listed above (see Figure 1 for conceptual model). In models estimating continuous outcomes, maximum likelihood estimation with robust standard errors was used; weighted least squares estimation with robust standard errors was used for categorical and count outcomes.

Finally, a set of models was estimated to test whether differing indicators of child adversity, based on self-report, were affiliated with pain in adulthood; in these models, child adversity scale scores were included as a predictor of each young adult pain outcome with PTSS subscales and other covariates (described above) included.

RESULTS

Descriptive and Bivariate Statistics

Adolescent Outcomes—Descriptive statistics for all variables included in the analysis are provided in Table 1. The majority ($n = 422$) of original study participants were located for the young adult assessment time point; 403 (85% of maltreated, 84% of non-maltreated participants) were able to participate. Factors limiting ability to participate included active deployment with the military, incarceration, or being deceased. Online surveys were completed by 383 women (80% of maltreated, 81% of non-maltreated participants). Variables collected in adolescence were evaluated for those who did ($n = 383$) and did not ($n = 94$) participate in the young adult follow-up. Those results indicated that the sample retained into adulthood was significantly older at baseline ($M = 15.32$, $SD = 1.10$) compared to those who were lost to follow-up ($M = 15.04$, $SD = 0.96$, $t(158.38) = 2.45$, $p = .02$). Women who participated in the young adult follow-up also had significantly higher household income in adolescence ($M = 4.08$, $SD = 2.95$) compared to women who were lost to follow-up ($M = 3.16$, $SD = .14$, $t(179.41) = 3.39$, $p < .01$). All other variables were not significantly different between the two groups, and variables did not differ by maltreatment status (p 's $> .10$).

Additionally, women with confirmed maltreatment had lower household income ($t(414.63) = 2.30$, $p = .02$) compared to women with no confirmed maltreatment and significantly higher PTSS re-experiencing sum scores, $t(463.13) = -7.87$, $p < .01$; PTSS arousal sum scores, $t(474.52) = -7.61$, $p < .01$; and PTSS avoidance sum scores, $t(463.86) = -8.13$, $p < .01$. The majority (76%) of caregivers of study participants disclosed lifetime pain symptom for their adolescent daughters, and 53% endorsed pain symptom for their adolescent daughters in the previous two years (74% in the maltreatment and 80% in the comparison sample for lifetime pain symptoms; 49% in the maltreatment and 59% in the comparison sample for past two year pain symptoms). These differences were not significant between the maltreatment and comparison groups for lifetime pain ($\chi^2 = 1.37$, $p = 0.24$) or pain in the previous two years ($\chi^2 = 1.41$, $p = 0.24$). Three items assessing pain complaints in the past six months (abdominal pain, headache, other pain) were also reviewed from the Youth Self Report somatic symptoms subscale. The majority (83%) of participants endorsed some pain in the past year (88% of maltreated youth, 78% of the comparison sample). These differences were statistically significant ($\chi^2 = 7.91$, $p < 0.01$). Of note, these pain assessments are limited; they do not reflect a clinical pain diagnosis but rather overall somatic symptoms, and no measure of chronicity, intensity, or duration was assessed. Finally, women with confirmed maltreatment reported higher childhood adversity [unexpected tragedy: $t(443.81) = -5.25$, $p < .01$; family instability: $t(473.41) = -7.86$, $p < .01$; exposure to violence: $t(464.48) = -12.60$, $p < .01$] and lower household income, $t(414.63) = 2.30$, $p = .02$.

Young Adult Outcomes—Bivariate analyses comparing adolescent and young adult variables for women with and without confirmed child maltreatment indicated that women who experienced confirmed maltreatment were more likely to report experiencing pain in the past seven days, $\chi^2(1) = 3.87$, $p < .05$. The experience of pain did not significantly differ

among women experiencing neglect only (1% of the sample), abuse only (67% of the sample), and abuse or neglect (13% of the sample, $\chi^2 = 7.22, p = 0.07$). Number of pain locations was also higher in women with confirmed maltreatment, $t(380.72) = -2.44, p = .02$, respectively. Among those who reported any pain, average pain intensity was higher for women with a history of confirmed maltreatment, $t(171) = -2.45, p = .02$.

Irrespective of maltreatment status, bivariate analyses indicated that PTSS symptoms in adolescence were associated with experiencing any pain in the past seven days ($t's(381) = 2.29 - 3.88, p's < .05, r's = .12 - .19$ across the different PTSS subscales) and number of pain areas affected ($t's(381) = 2.98 - 4.01, p's < .01, r's = .15 - .20$ across the different PTSS subscales), but were not associated with average pain intensity ($r's = .04 - .07, p's > .10$ across the different PTSS subscales), which was only assessed for women who reported experiencing any pain in the past seven days.

Mediation Path Analyses

A series of mediation path analysis models were estimated using child maltreatment as the primary predictor variable directly associated with young adult pain (i.e., any pain, average pain, total pain locations) and indirectly associated through PTSS (i.e., re-experiencing, arousal, avoidance) with age, minority status, and adolescent household income as covariates. Adolescent age was not significantly associated with outcomes and was removed from analytic models. Models had acceptable fit (DWLS = 99.24, $\chi^2(12) = 74.53, p < .01$). The results of those models are summarized in Table 2. PTSS fully mediated the relations between child maltreatment and experiencing any pain in adulthood, such that once PTSS and covariates were accounted for, maltreatment significantly increased PTSS re-experiencing, arousal, and avoidance symptoms, and re-experiencing and arousal significantly predicted experiencing pain in the last seven days (indirect effect $B = 0.35, SE = 0.13, p < .01$; see Figure 2a). Effect sizes (Cohen's d) indicate generally small effects of maltreatment status and PTSS symptoms on pain outcomes, a moderate effect of maltreatment on PTSS symptoms, and moderate cumulative effect of maltreatment and PTSS on experiences of any pain in adulthood.

Consistent with bivariate results, there was no significant indirect effect of child maltreatment on average pain severity ratings through PTSS for women who reported experiencing pain (indirect effect $B = -0.09, SE = 0.14, p = .50$; see Figure 2b). Rather, child maltreatment was associated with higher average pain ratings in young adulthood, as was lower household income in adolescence.

Finally, there was a significant indirect effect of child maltreatment on total pain locations through PTSS-avoidance (indirect effect $B = 0.29, SE = 0.16, p = .05$; see Figure 2c). Specifically, maltreatment significantly increased PTSS re-experiencing, arousal, and avoidance symptoms, and avoidance significantly predicted an increase in the number of areas with pain ($B = 0.11, SE = 0.04, p = .02$).

To understand the impact of child adversity, an additional set of analyses were estimated where cumulative assessments of unexpected tragic events, indicators of family instability, and exposure to violence were added as covariates in regression models predicting adult pain

outcomes. Collinearity among adversity indicators and maltreatment status prevented testing a model where all adversity and maltreatment indicators were included. For that reason, we report here the models including maltreatment and each indicator of adversity, as well as PTSS scales and demographic covariates. In those multivariate models, only cumulative exposure to violence was associated with pain outcomes (additional results available by request). Specifically, cumulative exposure to violence was significantly associated with an increased likelihood of experiencing any pain in adulthood ($B = 0.12$, $SE = 0.05$, $p = .01$) above and beyond the effect of maltreatment status, PTSS, and other covariates (see Table 3). Effect sizes (Cohen's d) of the association of cumulative exposure to violence and PTSS symptoms on any pain in adulthood indicated small effects. Cumulative exposure to violence was not significantly associated with average pain intensity or total pain areas affected.

DISCUSSION

This study is among the first to evaluate mechanisms linking child maltreatment and young adult pain, utilizing a prospective, longitudinal design in a community sample of adolescents with and without maltreatment histories. Results indicate that the link between childhood maltreatment and pain in adulthood is not simple, unraveling some inconsistencies reported in the literature. As hypothesized, women with a child maltreatment history were significantly more likely to experience pain and report a higher number of pain locations in young adulthood. Further, among women who experienced any pain, those who were maltreated reported somewhat higher pain intensity. Results also showed that elevated PTSS during adolescence were associated with pain in adulthood and more widespread pain.

Importantly, child maltreatment completely operated through adolescent PTSS to impact the experience of any pain and widespread pain in adulthood. However, in women reporting any pain in the past week, pain intensity was directly affected by child maltreatment history. More nuanced relations were also found between PTSS symptoms and young adult pain outcomes, such that re-experiencing and arousal were associated with experiencing any pain, while avoidance was associated with number of pain locations. Indicators of child adversity more broadly defined were not generally related to young adult pain outcomes once maltreatment status and adolescent PTSS were taken into account. The only exception was for cumulative exposure to violence and experiencing any pain in young adulthood, where a significant direct effect was identified. Given that family violence encompassed forms of maltreatment that overlapped with confirmed maltreatment from the child welfare record and other definitions of child abuse [53], this finding provides further evidence that maltreatment may be particularly important for predicting pain, beyond other forms of child adversity. Together, these findings explain inconsistencies in the literature linking child maltreatment and adversity to pain in adulthood. Specifically, it appears that vulnerability to pain in adulthood is related at least in part to PTSS, and that not all forms of child adversity are universally associated with the emergence of young adult pain symptoms. Importantly, direct effects of maltreatment, childhood exposure to violence, and PTSS on pain in adulthood were small; however, the combination of maltreatment and PTSS represented moderate effect sizes.

Relations between childhood maltreatment and pain in adulthood

Childhood maltreatment and pain in adulthood have been inconsistently associated [15; 21; 28; 33; 34; 42; 44]. Potential explanations for the variability in previous study findings include inconsistent assessments of maltreatment and adversity, a wide range of methods for establishing maltreatment status, and mediated pathways to adult pain outcomes. Our study used a rigorous standard to establish maltreatment status, which was distinct from other forms of adversity in childhood. Maltreatment status was based on confirmed child welfare record review, with maltreated adolescents recruited within 12 months of substantiation of abuse or neglect. In addition to maltreatment status, adolescents completed the CTI [5], which screened for exposures to a range of adversity, including natural disasters and self-reported exposure to sexual abuse, physical abuse, and other violence. To date, most research has not distinguished between maltreatment (i.e., abuse or neglect) and the broader category of adversity (e.g., parental divorce, natural disasters) occurring in childhood and adulthood [42]. As a result, it has been unclear whether the development of pain in adulthood is better attributed to adversity broadly or to specific types of adversity (e.g., maltreatment). It is possible that maltreatment and other adversity in childhood represent a continuum of early life stressors that impact adult chronic pain [21; 33; 34]. However, in the current study, self-reported exposure to violence was associated with experiencing pain in young adulthood, whereas cumulative measures of other life stressors and adversity were not. One important reason for attending to how adversity is defined and measured is that there may be differential effects of adversity type and timing on physiology [17; 22; 29]. Some adversities, including child maltreatment, have more consistently been associated with altered stress responses in the hypothalamus-pituitary-adrenal (HPA) axis in adulthood [19]. Given the role of the HPA-axis in response to pain and the development of chronic pain syndromes [10], distinguishing maltreatment and other forms of childhood adversity may be critical for identifying who is at risk for chronic pain in adulthood. It is also notable that pain did not significantly differ among women experiencing abuse, neglect, or both; however, limitations in sample size and diversity in maltreatment experiences within these broad categories make it difficult to draw conclusions and more research is needed.

This study also used prospective longitudinal methodology and objectively substantiated childhood maltreatment to establish the presence of substantiated maltreatment in the maltreated cohort *and* the absence of maltreatment in the comparison cohort. Recent research has demonstrated inconsistencies in prospective and retrospective reporting of child maltreatment, with up to 50% of participants providing inconsistent reports when assessed in adolescence and adulthood [4]. This raises the possibility that the impact and risk pathways of childhood maltreatment on pain could differ as a function of child (prospective) vs. adult (retrospective) assessments [4]. The longitudinal design of this study minimized the risk of reporting inconsistencies over time.

Finally, we found that PTSS symptoms in adolescence were important for explaining the relations between child maltreatment and adult pain. Consistent with other studies demonstrating the link between PTSS and pain [2; 7; 10; 20; 30; 35; 45], this study found that higher levels of PTSS were linked to a higher likelihood of reporting any pain, and a greater number of total areas affected by pain, and that these relations were likely not

bidirectional. Together, these findings interpreted in the context of the existing literature suggest that as adolescents experience maltreatment and subsequent elevation in PTSS, pain may be a secondary consequence.

Our findings also extend studies linking child maltreatment and adult PTSD with adult pain [43] by demonstrating that PTSS around the time of maltreatment explains associations between maltreatment and pain in adulthood. One mechanism that could explain the relations among maltreatment, PTSS, and pain is inflammation. PTSS may increase inflammatory markers, triggering physiological changes in nociceptor functioning, leading to increased pain. There has been variability in studies linking maltreatment and inflammation, however, and more research is needed [27]. Further, it is worth noting that the impact of adolescent PTSS on pain varied by type of symptom, such that individuals who re-experience their symptoms and are experiencing hyper-arousal as a result of their trauma may be at particular risk for developing pain in adulthood. It is possible that re-experiencing maltreatment exposures and maintaining a state of hyper-arousal is activating stress responses and triggering dysregulation in a way that avoidance does not. In addition to these mechanisms, impairment in other psychological (e.g., attentional control, self-regulation) and behavioral (e.g., sleep disturbances) factors can co-occur with maltreatment and PTSS [11; 24; 39] and exacerbate pain [48; 49]. More work is needed, including replication of these findings, to better understand why particular profiles of PTSS are related to some indicators of pain but not others.

Limitations and Future Directions

There are several limitations to this study. First, measures of pain symptoms were based on adult self-report; no data on the onset of pain, chronicity, frequency, interference, or pain-related disability were collected. Pain measures were designed to assess fibromyalgia symptoms - as such, participants without fibromyalgia may have responded differently to these items. Second, this represents pain in early adulthood, and is missing the presence and trajectory of pain during adolescence; thus, it is unclear how pain developed during adolescence, a critical developmental period associated with the onset of pain conditions [25]. Third, while we are able to link post-traumatic symptoms experienced at the time of maltreatment, these symptoms may not clearly map onto current diagnostic criteria for PTSD and may miss some aspect of traumatic reactions captured by current screenings (i.e., negative cognitions and mood). Finally, only women are represented; findings might differ for men experiencing maltreatment and chronic pain.

Despite these limitations, this study makes several important contributions to the literature. First, it is one of the few studies to prospectively follow cohorts of maltreated women, confirmed by child welfare record review, and demographically-similar peers to understand pain onset in young adulthood. Second, study findings provide some clarification on inconsistencies in the existing literature. In doing so, this study expands the existing literature to create a foundation for future research on the relations between maltreatment and young adult pain. Additional studies examining more comprehensive assessments of pain, pain chronicity, and clinical pain diagnoses using validated measures and protocols are warranted - particularly that follow women longitudinally during periods where chronic pain

are known to emerge. These study findings also warrant replication with cohorts of men. Finally, other mechanisms (e.g., stress physiology, altered pain processing) may explain links between maltreatment and pain, which are also activated with elevated PTSS. While more research is needed, these findings provide some preliminary evidence that maltreatment increases vulnerability to pain in adulthood, and raises the possibility that treating the sequelae of maltreatment (e.g., PTSS) may aide in reducing risk for chronic pain later in adulthood.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Conceptual model linking child maltreatment to young adult physical pain.

Figure 2.
Mediation models estimated to evaluate direct and indirect effects of child maltreatment on young adult pain through adolescent PTSS

Table 1.

Descriptive Statistics for Maltreated and Comparison Adolescent and Young Adult Women.

Variable	Maltreated			Comparison		
	N	M (SD)	%	N	M (SD)	%
Adolescent						
Demographics						
White non-Hispanic	273	--	46.2	204	--	47.1
Age	273	15.20 (1.10)		204	15.35 (1.04)	--
Household Income	266	3.64 (2.74)		201	4.25 (2.93)	--
Confirmed Maltreatment	273	--	57.2	204	--	42.8
Post-traumatic Stress Symptoms						
Re-experiencing	273	2.85 (1.52)	--	204	1.82 (1.33)	--
Arousal	273	3.04 (2.14)	--	204	1.72 (1.65)	--
Avoidance	273	3.22 (1.91)	--	204	1.89 (1.66)	--
Child Adversity						
Unexpected Tragedy	272	3.27 (1.51)	--	203	2.55 (1.46)	--
Instability	272	1.16 (0.92)		204	0.59 (0.66)	--
Exposure to violence	272	3.28 (1.97)	--	204	1.40 (1.27)	--
Young Adult						
Age at Assessment	206	24.85 (1.26)		141	24.65 (1.46)	--
Experienced Pain	218	--	49.5	165	--	39.4
Average Pain Intensity (0–10)	108*	5.92 (2.33)	--	65	5.02 (2.35)	--
Number of Areas Affected (0–19)	218	1.50 (2.19)	--	165	1.02 (1.71)	--
		None	50.5		None	60.6
		1–2 areas	26.6		1–2 areas	22.4
		3–4 areas	11.9		3–4 areas	12.7
		5–6 areas	6.9		5–6 areas	3.0
		7+ areas	4.1		7+ areas	1.2

* Note: Average Pain Intensity ratings were only completed by those endorsing any pain in the past week.

Table 2.

Mediation path models estimating direct and indirect effects of child maltreatment history on young adult pain through adolescent post-traumatic stress symptoms (PTSS).

Variables	Any Pain			Average Pain Intensity			Total Pain Areas Affected		
	B	SE	d	B	SE	d	B	SE	d
Direct Path to Pain Outcome									
Maltreatment status	-0.11	0.19	-0.22	0.40 [*]	0.22	0.17	-0.09	0.26	-0.04
Age	0.00	0.05	0.00	-0.07	0.06	-0.03	0.00	0.07	0.00
Minority status	0.12	0.14	0.24	-0.03	0.18	-0.01	0.34	0.20	0.17
Income	-0.05 [*]	0.02	-0.10	-0.08 ^{**}	0.03	-0.03	0.04	0.03	0.02
PTSS re-experiencing	0.14 ^{**}	0.05	0.28	-0.09	0.06	0.04	0.06	0.05	0.03
PTSS avoidance	0.04	0.04	0.08	-0.02	0.04	-0.01	0.11 [*]	0.04	0.05
PTSS arousal	0.11 ^{**}	0.03	0.22	0.00	0.04	0.00	0.06	0.04	0.03
Total direct effect	0.24 [*]	0.14	0.49	0.31	0.17	0.13	0.20	0.20	0.10
Indirect Path to Pain Outcome									
Maltreatment to PTSS re-experiencing	0.93 ^{**}	0.16	0.64	0.89 ^{**}	0.24	0.61	0.89 ^{**}	0.24	0.61
Maltreatment to PTSS avoidance	1.25 ^{**}	0.27	0.69	1.24 ^{**}	0.31	0.68	1.24 ^{**}	0.31	0.68
Maltreatment to PTSS arousal	1.39 ^{**}	0.24	0.72	1.69 ^{**}	0.37	0.90	1.69 ^{**}	0.37	0.90
Total indirect effect	0.35 ^{**}	0.13	0.74	-0.09	0.14	-0.04	0.29 [*]	0.16	0.14
Intercept/threshold estimates									
Pain outcome	-0.54	1.34	--	-3.13	1.73	--	0.72	1.90	--
PTSS re-experiencing	-2.86 [*]	1.48	--	-3.48	2.21	--	-3.48	2.21	--
PTSS avoidance	-2.17	1.90	--	-2.72	2.60	--	-2.73	2.60	--
PTSS arousal	-4.92 [*]	2.15	--	-6.40 [*]	3.19	--	-6.39 [*]	3.19	--
Variance estimates									
Pain outcome	0.91	--	--	0.99	--	--	0.95	--	--
PTSS re-experiencing	1.96 ^{**}	0.21	--	1.93 ^{**}	0.31	--	1.93 ^{**}	0.31	--
PTSS avoidance	3.11 ^{**}	0.29	--	2.71 ^{**}	0.37	--	2.71 ^{**}	0.37	--
PTSS arousal	3.76 ^{**}	0.45	--	3.61 ^{**}	0.61	--	3.61 ^{**}	0.61	--

* p < .05,

** p < .01

Table 3.

Path models estimating direct effects of child maltreatment history, cumulative exposure to violence-related adversity, and adolescent post-traumatic stress symptoms (PTSS) on young adult pain.

Variables	Any Pain			Average Pain Intensity			Total Pain Areas Affected		
	B	SE		B	SE		B	SE	
Intercept/threshold	-0.16	1.34	--	-3.41 [*]	1.73	--	1.45	1.96	--
Cumulative exposure to violence	0.12 ^{**}	0.06	0.24	0.07	0.06	0.03	0.11	0.06	0.05
Age	-0.02	0.05	-0.04	-0.06	0.07	-0.03	-0.01	0.08	-0.01
Minority status	0.02	0.15	0.04	-0.04	0.19	-0.02	0.29	0.22	0.14
Income	-0.05 [*]	0.03	-0.10	-0.09	0.03	-0.04	0.04	0.03	0.02
Maltreatment status	0.04	0.16	0.08	0.25	0.20	0.11	0.05	0.23	0.02
PTSS re-experiencing	0.09	0.07	0.18	-0.17	0.10	-0.07	-0.04	0.10	-0.02
PTSS avoidance	-0.10	0.06	-0.20	0.00	0.07	0.00	0.10	0.08	0.05
PTSS arousal	0.09	0.05	0.18	0.06	0.06	0.03	-0.01	0.07	-0.01

^{*}
p < .05,

^{**}
p < .01