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Review Article

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Posttraumatic Stress Disorder in Children: A Narrative Review

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ABSTRACT

Method: This narrative review summarizes research from the years 2019-2024 on posttraumatic stress disorder (PTSD) and posttraumatic stress symptoms (PTSS) in children.

Results: This research suggests that prevalence rates have been highly variable as a function of the stress experienced, for example, post-surgery (15%), following exposure to war (28%) and following head injury (34%). The negative effects have included cognitive dysfunction, aggression and other behavioral difficulties and the comorbidities include sleep disorders, somatic symptoms and depression. Predictors/risk factors have been the primary focus in this literature and have included parent risk factors including exposure to intimate partner violence, sexual and emotional abuse. Sensory modulation and cognitive processes have been implicated as, for example, negative attention bias and subjective threat. Injuries and hospitalizations have been predictors as has been exposure to explosions and earthquakes. The most frequently studied intervention has been cognitive behavioral therapy which has consistently reduced the symptoms of PTSD. Potential underlying biological mechanisms have included parent PTSD, pregnancy inflammation, and autonomic dysregulation including low cortisol and heartrate, although reduced cortical thickness (volume) in several areas of the brain has been the most frequently studied potential mechanism.

Discussion: The studies in this review highlight the prevalence and severity of posttraumatic stress disorder in children. However, they have been primarily based on mixed-age child and adolescent samples and the results have varied by the type of stress experienced and the severity of the stress.

Keywords: Posttraumatic Stress Disorder, Posttraumatic Stress, Children, Injury, Depression

Posttraumatic stress disorder (PTSD) is one of the most common disorders in children. Based on the DSMV, there are two distinct diagnoses with posttraumatic stress symptoms (PTSS) being a reaction to trauma that develops fairly quickly and is frequently a precursor to PTSD which may occur months or sometimes years later. This narrative review is focused on PTSD and posttraumatic stress symptoms (PTSS) in children and adolescents and summarizes 57 papers that were derived from a search on PubMed and PsycINFO using the terms posttraumatic stress disorder in children and the years 2019–2024. Exclusion criteria included case studies and non-English language papers. The publications can be categorized as prevalence data, negative effects of PTSD, comorbidities, predictors/risk factors for PTSD, interventions and potential underlying biological mechanisms. This review is accordingly divided into sections that correspond to those categories. Although some papers can be grouped in more than one category, 8 papers are focused on prevalence rates, 3 on negative effects, 3 on comorbidities, 21 on predictors/risk factors, 12 on interventions, and 10 on potential underlying biological mechanisms for PTSD in children.

Prevalence of PTSD in Children

The prevalence of posttraumatic stress disorder in children has varied widely as a function of the type of stress experienced and its severity (see table 1). In this recent literature, prevalence data were given on injuries, surgery, on COVID effects, and on other disasters including earthquakes and war.

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Table 1: Prevalence by type of stressor for children with PTSD (and first authors).

Type of stress		First author
Injuries		
Mild head injury		Sinopidis
Accidental injury		vanMeijel
Surgeries		
Orthopedic surgery		May
Pediatric surgery		Turgiose
Disasters		
COVID		Zhang
Exposure to earthquakes		Jin
Exposure to war		Manager

Injuries

In a study entitled "Posttraumatic stress as a psychological effect of mild head injuries in children", mild **head injury** symptoms were headaches, vomiting, loss of consciousness, transient amnesia, and the absence of focal neurological signs [1]. In this research, the children (N=175 children 6-14-years-old) were given the Child Trauma Screening Questionnaire (CTSQ) and their parents were given the Children's Revised Impact of the Event Scale (CRIES). Based on child report, the prevalence rate was 34% after one week but only 10% after one month. In contrast, based on parent report the prevalence rates were lower (19% after one week and 4% after one month). It's not clear whether the parents under-estimated or the children over-estimated the PTSD of the children.

In a longer term 2-to-4-year follow-up assessment following **accidental injury** in children and adolescents (N=147 youth 8-to-18-years-old), the prevalence of PTSD was 12% [2]. This prevalence only decreased by one percent at the four-year follow-up, suggesting permanent physical impairment in those with PTSD. No symptoms or fewer symptoms were reported for those who completed psychotherapy during that period. The stability of PTSD in this study is inconsistent with the previous study that showed significant decreases in PTSD over time by both child and parent report. This may relate to the sample of this study being older, as older age youth have been noted to be at greater risk for PTSD as can be seen in the next study on surgery.

Surgery

The prevalence rates for surgery have been consistent across different types of surgery. In a study on **orthopedic surgery** (N= 176 8-18-year-old youth), the prevalence of PTSD was 15% [3]. Greater risk was noted in females, older age youth, and those who had experienced a previous surgery.

In a review of 16 studies on **pediatric surgery** (N=1187 children and their parents), 16% of the children experienced PTSD, although, surprisingly, a greater percent of the parents experienced PTSD (23%) [4]. The risk factors noted in this study were length of stay, social support, and parental mental health. The parental mental health factor was not surprising given the greater incidence of PTSD in the parents than their children following pediatric surgery. **Disasters COVID** has been considered a disaster for children by many researchers (see Field, 2021 for a review). In a study on children who had been hospitalized for COVID (N=61), the mental health of those children as they were discharged was compared to children who did not experience COVID (N= 91 7–to-18-year-old youth) [5]. PTSD was prevalent in 8 percent of the discharged youth versus 2% of the children in the control group. The PTSD symptoms were associated with anxiety and sleep problems as well as the caregivers' depression. These data were not surprising given that anxiety and sleep problems have been frequently comorbid with PTSD. The association with caregivers' depression is consistent with other reports of mental health problems in parents of children experiencing PTSD.

In a systematic review of 19 studies on the prevalence of mental health effects in children during COVID (less than 16-years-old), a surprisingly high prevalence of PTSD was noted (86%) [6]. The youth in these studies also experienced a high prevalence of depression (72%), anxiety (44%), and suicidality (31%). Comorbidity of these disorders may have contributed to the high prevalence of PTSD in this review. Significant variability of these prevalence rates was noted across countries.

Exposure to earthquakes has also led to PTSD. For example, the prevalence of PTSD was notable in children who experienced the Ya'an earthquake in China as long as three years later [7]. This earthquake resulted in 196 deaths and 11,470 injuries. PTSD was prevalent in 13% of the children who were exposed and depression was noted in 21% of the exposed children based on the CRIES and the short Mood and Feelings Questionnaire (MFQ). PTSD and depression were comorbid, as might be expected. Not surprisingly, the prevalence was greater in children who were left behind. Other PTSD risk factors noted in this study were being female, less than 15-years-old, having siblings, and having greater exposure to the earthquake.

Exposure to war is another disaster that children have experienced. One of the greatest prevalence rates was noted for children exposed to the 2014 war in the Gaza strip [8]. Over 34% experienced PTSD, although no gender or age differences were noted. Children in this study (6-to-15-years-old) experienced various exposures including bombardments (84%), combat situations (67%), and corpses (60%). Presumably the severity of PTSD also varied with the severity of the exposure

Negative Effects of PTSD on Children

Surprisingly, only a few studies appeared on the negative effects of posttraumatic stress on children in this recent literature (see table 2). They include cognitive dysfunction, aggression, and behavioral and emotional difficulties. In a longitudinal study on maltreated children (N=263), posttraumatic stress symptoms led to **dysfunctional cognition** as well as internalizing and externalizing symptoms [9]. The authors labeled this group of symptoms the "cognitive scar model".

In another study entitled "Intergenerational maltreatment in parent-child dyads from Burundi, Africa", child maltreatment was related to parents' experience of child maltreatment (N=227 dyads of parents and youth 12-to- 18-years-old) [10]. In this sample, child maltreatment was experienced by a significant number of parents (70%) and by their children (89%). The

maltreatment experienced by the children reputedly led to posttraumatic stress symptoms which, in turn, led to **aggressive behavior**

Table 2: Negative effects of PTSD on children (and first authors).

Negative effects	First author
Dysfunctional cognition	deHaan
Aggressive behavior	Charak
Behavioral and emotional difficulties	Forrest

Both **behavioral and emotional difficulties** were noted in 88% of PTSD youth two years after the 2012 earthquake in Italy if the children lived in the earthquake zone (N=682 children and adolescents 9-to-14-years-old) [11]. In a regression analysis, the number of traumatic events was the best predictor of behavioral and emotional difficulties followed by the severity of exposure (personal injuries and losses) and parental psychopathology. It is noteworthy that parent psychopathology was associated with these negative effects of PTSD on children, just as PTSD in parents is related to PTSD in their children in other research just described [10].

These negative effects have been labeled effects of PTSD rather than risk factors for PTSD or comorbidities of PTSD. Although the authors of these studies have elected to treat these problems as negative effects of PTSD, directionality of these problems cannot be definitively determined and they are frequently reciprocal or comorbid.

Comorbidities of PTSD in Children

Other researchers have labeled concurrent problems of PTSD as comorbidities (see table 3). In this recent literature on PTSD in children, the comorbidities have included sleep problems, somatic symptoms and depression.

Table 3: Comorbidities of PTSD in children (and first authors).

Comorbidities	First author
Sleep fragmentation	Rolling
Somatic symptoms	Fernandez
Depression	Vibhakar

In a paper entitled "Nightmares and sleep disturbances in children with PTSD: A poly- sonographic and actigraphy evaluation", sleep was recorded for 24 hours in a lab and 16 days at home for 11 PTSD youth who varied widely in age (3-to-18-years-old) [12]. Greater **sleep fragmentation** was noted including increased time awake after sleep and sleep stage changes. These sleep problems were correlated with PTSD, insomnia and posttraumatic nightmare severity. Notably, this was a small sample with a wide age range, and 6 of the 11 youth had several traumatic experiences, suggesting a diversity of exposures. The data were further confounded by depression being comorbid with sleep problems.

Somatic symptoms are another comorbidity of PTSD in children. In a study entitled "Somatic symptoms and PTSS in children and adolescents in France", youth (N=63 7-to-17-years-old) who had been referred to a pediatric psychology trauma center were given the Patient Health Questionnaire for PTSS and Somatic Symptoms along with the Child PTSD Checklist [13] Somatic symptoms were correlated with the intensity of PTSS and with stomach pain and headaches. However, surprisingly, migraine headaches, palpitations, nausea, tiredness and sleep disorders only explained 6.5% of the variance in PTSS. This result highlights the importance of regression analysis in determining the degree to which other symptoms are contributing to or are comorbid with PTSD and PTSS.

In a systematic review and meta-analysis of 56 studies on the prevalence of **depression** in children exposed to trauma, 24 percent of those children had depression scores of medium size [14]. The odds of a depression diagnosis was 2.6 times greater in youth who had been exposed to intimate partner violence. The authors referred to this finding as "post- traumatic depression".

While sleep problems, somatic symptoms, and depression have been labeled comorbidities of PTSD in children, they could also be called effects or risk factors for PTSD. In cross-sectional studies such as these, directionality cannot be determined. It would be difficult to determine even in longitudinal studies with sampling starting as late as seven years, as it has in most of these studies. These symptoms likely occurred before 7 years of age. And by 14 years of age, which is often the oldest youth of these studies, the problems related to PTSD would likely be reciprocal or comorbid. Nonetheless, most of the studies of this literature have addressed the problems related to PTSD in children as risk factors/predictors.

Risk Factors/Predictors of PTSD in Children

The risk factors or predictors of PTSD in children covered in this recent literature could be categorized by their origins (see table 4). These include parent origin and child origin risk factors.

Table 4: Risk factors/predictors of PTSD in children of parent and child origin (and first authors).

Risk factor	First author
Parent Origin	
Family conflict	Ye
Intimate partner violence	Galano
Adverse childhood experiences	McRae
Sexual abuse	Mainali
Emotional abuse	Hoebner
Child Origin	
Gender-female greater prevalence	Lenfernik, Jin, May Memarzia, Triantyfallou, Zhou
-male greater risk for suicidality	McRae
Age-older	May, VanMeijel
-younger	Jin, Lenfernik
Sensory processing	Yochman
Negative appraisals, peritraumatic subjective threat, pain	Meier-Stedman
Negative attention bias	Alamdar
Subjective threat	Memarzia

Injuries	Hildebrand, Van Meijl
Hospitalizations	Rady, Nelson, Triantafylouu
Quarantine	Imran
Explosions	Maalouf, Li
Earthquake	Zhou, Andrades, Ge

Parent Origin Risk Factors

The parent origin risk factors include family conflict, intimate partner violence, adverse childhood experiences (ACEs), sexual abuse and emotional abuse. In a meta-analysis on 31 studies on family function and PTSD (N= 8684 children), **family conflict** was associated with a greater prevalence of PTSD [15]. In contrast, family affect, communication and cohesion were associated with less frequent PTSD. However, only small correlations were reported for both the family conflict and family affect relationships with PTSD.

Intimate partner violence is another parent origin risk factor for PTSD. In a longitudinal study tracking the eight-year trajectory of posttraumatic stress symptoms in children exposed to intimate partner violence, 120 mother-child dyads were assessed starting at the preschool stage [16]. Associations were reported between the amount of intimate partner violence exposure, the mothers' PTSS and the children's PTSS outcomes. The children experienced a worsening of symptoms over the eight-year period, although it was not clear why the symptoms worsened unless it was related to the children's increasing age or increasing exposure to intimate partner violence.

Adverse childhood experiences (ACEs), also known as maltreatment experiences, have been notable risk factors for posttraumatic stress symptoms. In a study on 6-to-14-year-old males in residential treatment, ACEs led to posttraumatic stress symptoms which, in turn, led to suicidal behavior [17]. The specific PTSS clusters included intrusion and avoidance symptoms. It's not clear why only males were recruited for this study and why only two of the three PTSS clusters (intrusion and avoidance) were noted in this sample, but not the third PTSS cluster (hyperarousal).

PTSD has been noted to develop in one third of youth who have experienced **sexual abuse** [18]. In the National Inpatient Sample database on 6-to-17-year-old youth (N=24,243), 251 youth were noted to have PTSD plus sexual abuse [18]. Those youth with PTSD plus sexual abuse were more frequently non-white and Hispanic than the PTSD without sexual abuse group, and comorbidities were more prevalent in the sexually abused group including major depression disorder (23% versus 14%), substance abuse (20% versus 11%) and suicidal risk (36% versus 30%). It's not clear why these authors didn't select a random sample from the PTSD alone group to equalize the sample sizes of the two groups to enhance the power of the data analyses.

Emotional abuse by parents has also affected the severity of PTSD symptoms in youth [19]. In this study (N=287 children and adolescents), The Childhood Trauma Questionnaire that includes items on physical abuse and neglect, emotional abuse and neglect and sexual abuse (5 items/subscale) was given. Surprisingly, those who scored high on the emotional abuse subscale versus the other subscales had more severe PTSD symptoms. Fortunately, the symptoms decreased six months after the start of cognitive behavioral therapy.

Child Origin Risk Factors

The child origin risk variables include the demographics of gender and age, and cognitive processes including negative attention bias and subjective threat. Other risk factors for PTSD in children include the stressful experiences of COVID quarantine, injuries, hospitalizations and exposure to disasters including explosions and earthquakes.

This recent literature on ASD (acute stress disorder) and PTSD in children is mixed on the demographics of **gender and age**. Children with ASD have been classified according to the severity of ASD as low (42%), intermediate (43%) or high severity groups (15%) [20]. These children (N=2287 5-to-18-year-old youth) were participants in an international archive study conducted in the US, the UK, Australia, and Switzerland. The archive was entitled "Prospective studies of acute child trauma and recovery". The children in the intermediate and high severity groups were more likely to be female and younger. Other risk factors were having parents with no secondary education, having been in a road traffic accident or having witnessed interpersonal violence. Surprisingly, there was no reference to the percentage of children with acute stress disorder who later became classified as PTSD.

As already described, several studies on PTSD in children have referred to a greater prevalence or severity of PTSD in females and at least one study has suggested that PTSD symptoms in males were leading to suicidal behavior [3,7,17,21-23]. However, that sample was exclusively males. That PTSD is reportedly more prevalent in females may relate to females being more open about their PTSD and/or their notably greater prevalence of depression which is often comorbid with PTSD.

The data on age are mixed. A couple research groups have reported that older youth were at greater risk for PTSD but at a couple other groups suggested that younger children were at greater risk [2,3,7,20]. Further, the research group studying the effects of exposure to war reported that there were no gender or age differences.

Several cognitive processes have been implicated as risk factors for PTSD in children. These include sensory processing, negative appraisals, negative attention bias and subjective threat. In a study on children who were exposed to continuous traumatic stress (N=134 children age 5-to-11), The children's **sensory processing** scores were a significant predictor of PTSD [24]. The continuous stress in this study was due to political violence. One half of those experiencing PTSD had sensory processing problems.

In a longitudinal study entitled "A core role for cognitive processes in the acute onset and maintenance of PTSS in children and adolescents" 226 youth (8-to-17-years-old) were assessed at two weeks and two months after an emergency room treatment [25]. Cognitive processes including **negative appraisals, peritraumatic subjective threat and pain** at two

weeks predicted most of the variance in PTSS at both two weeks and two months.

Attentional bias is another cognitive process that has had an effect on PTSD [26]. In this study on middle school children (N=909) who lived in the Yunnan Ludian earthquake – affected area, **negative attention bias** led to intrusive rumination which, in turn, led to PTSD. Positive attention bias led to reduced PTSD symptoms and also to deliberate rumination which led to post traumatic growth.

In a review of 32 studies **subjective threat** had a medium size effect on PTSD symptoms [21]. Feeling muddled or confused during trauma had a smaller effect. Subjective threat and PTSD symptoms were moderated by the percent of female participants.

Injuries have also been risk factors for PTSD. In a study on children hospitalized for injuries (N= 96 8 to 13-year-old youth), pain ratings and opioid data were collected at baseline and 12 weeks later [27]. Based on structural equation modeling, the worst pain was associated with both concurrent and later PTSD. Opioids did not mediate this relationship.

In another study on injuries, acute pain and PTSS severity were assessed in youth (N= 135 8-to-18-year-old youth) three months after accidental injury [2]. Severe pain was associated with the severity of PTSS at three months. However, it only contributed to 10% of the variance in PTSS severity.

Hospitalizations have also been a risk factor for PTSD. In a study on children after they had been admitted to the pediatric intensive care unit (N= 130 6-to-13-year-old youth), the Impact of the Event Scale Revised was given [28]. The pediatric intensive care unit group had more frequent PTSD than children admitted to the general ward (85% versus 6%).

In another study on children who had been admitted to the pediatric intensive care unit (N=69 8-to-17-year-old youth) the children and adolescents were assessed after 24 hours and again at three months [29]. Thirty-five percent of the parents had PTS and 10% had PTSD. Child acute stress led to PTS and parent acute stress plus less education predicted parents' PTS.

In a review of 16 studies on PTSD in children after **hospitalization**, the most frequent assessments were the Child Trauma Screening Questionnaire, and the Child Stress Disorders Checklist [22]. The significant risk factors were traumatic injuries, illness, hospital admission, being female, and PTSS in parents

A few **disasters** have been included in this literature on risks for PTSD, including quarantine, explosions, and earthquakes. In a rapid systematic review of studies on **quarantine** effects on children and adolescents, the most common diagnoses were acute stress disorder, adjustment disorder, grief, and PTSD [30]. These disorders have been noted to share similar symptoms and risk factors.

In research on children and adolescents following the 2020 Beirut port **explosion**, an online survey was conducted including measures of anxiety, depression, and PTSD [31]. More than 1,000 children were injured but the survey involved 801 children (8-17-years-old). 52% were diagnosed as having PDSD based on the CRIES, 64% had anxiety, and 33% depression. As might be expected, those whose homes were ruined had a greater odds of anxiety and PTSD and those who were displaced from their homes had a greater odds of PTSD.

In a longitudinal study of traumatic events, survivors of an **explosion** accident (N= 659 children and adolescents) were assessed at 4, 8 and 13 months after the disaster [32]. Latent difference score modeling of PTSD Checklist-5 scores suggested that intrusion levels predicted an increase in hyperarousal and negative changes in cognitions and mood symptoms as well as a subsequent increase in avoidance symptoms.

PTSD and growth were studied in 876 children at 6, 12 and 18 months following the Ya'an **earthquake** in China [33]. Multiple process growth mixture modeling analysis yielded 5 growth trajectory types. These types included recovery, growth, struggling, resistant and delayed symptoms. Females and those trapped or fearful had struggling symptoms and those with injury to self or family had delayed symptoms.

In another follow-up of children and adolescents who developed posttraumatic stress symptoms and posttraumatic growth after experiencing the strongest earthquake in recorded history followed by a tsunami in Chile (February 2010), the children and adolescents (N= 325 10- to-16-years-old) were given the Childhood PTSD Scale, the Rumination Scale for Children and the Revised Posttraumatic Growth Inventory for Children [34]. The scores on the PTSD and posttraumatic growth scales decreased from 12 to 24 months. The predictors of PTSD and posttraumatic growth were disruptive experiences, losses after the event and intrusive and deliberate rumination during the previous year.

In still another study on PTSD in children and adolescents who survived an earthquake (N=2099), predictors of PTSD were studied [32]. The earthquake experience, every- day functioning, somatic symptoms, and sleep problems were significant predictors of PTSD. The authors suggested that their study had the limitations of being self-report data with limited generalizability.

Interventions

Several different interventions have been explored in this research on PTSD in children. These include cognitive behavioral therapy, Telehealth, parent training, art therapy, and medications.

Cognitive Behavioral Therapy

Cognitive behavioral therapy (CBT) is the most frequently studied intervention for children with PTSD and is also considered the most effective intervention. In a review on psychological interventions specifically for treating youth who had been sexually abused, 22 studies were included (N=1478 youth) [35]. These studies involved a 6 and 12-month follow-up of those who had received CBT and CCT (child-centered therapy) for trauma in the US, the UK, Iran, and Australia. CBT was included in 14 studies and CCT in 8 studies. Both CBT and CCT reduced PTSD symptoms. However, as the authors

suggested, the sample sizes were small, there was variability on the training as well as the duration of treatment and the age of participants and there was bias in selection, detection, performance, attrition and reporting.

In another recent systematic review of psychotherapeutic interventions, trauma-focused CBT was considered the most effective for children 6-to-12-years-old who were experiencing PTSD [36]. Similarly, in an umbrella review, CBT was considered the most effective therapy for children with PTSD [37].

Cognitive behavioral therapy with a trauma focus has also been noticeably effective based on a review of 25 studies (N=1686 youth) [38]. Less traumatic symptoms occurred after CBT with a trauma focus, which was, in turn, moderated by the level of baseline distress.

Cognitive behavioral therapy has also been effectively delivered in groups. In a study entitled "Systematic review and meta-analysis: group – based interventions for treating PTSD in children and adolescents", 42 studies were included (N=5998) [39]. The children who were randomized to group-based interventions had fewer PTSD symptoms and fewer depression symptoms than those who were in active or passive control groups. This was particularly true for CBT groups. The authors acknowledged the limitation of the heterogeneity of the studies included in their meta-analysis.

In still another systematic review and meta-analysis, 11 randomized controlled trials were included (N=1942) [40]. Group trauma-focused CBT was the most effective by the end of treatment and at the follow-up assessment for reducing PTSD symptoms and depression symptoms. However, most of the studies were small sample studies.

The efficacy of this intervention for multiple versus single traumatic experiences has been assessed in a meta- analysis on 51 randomized controlled trials (N= 4297 children and adolescents) [41]. The intervention was equally effective for those youth who had experienced single and multiple traumas. The authors suggested, however, that their meta-analysis needed more active control condition studies

Further evidence for the efficacy of CBT has appeared in research on dropout rates. In a paper entitled "Meta-analysis of dropout rates from evidence–based psychological treatments for PTSD in children", 40 randomized controlled trials were included. The overall dropout rate was 12%. The dropout rate for trauma focused CBT was 10%. The dropout rate was surprisingly lower for group versus individual therapy and for lay versus professional delivery.

Other Interventions

Other interventions have received less attention. But at least one study has appeared on Telehealth, web-based parent training, art therapy, and medications.

In a study entitled "Telehealth delivery of the child and family traumatic stress intervention", 5 to 8 sessions of **telehealth** were provided for 129 racially and ethnically diverse caregiver – child dyads [43]. A significant decrease occurred in PTSD symptoms in both the children and their caregivers. The effect sizes were notably large in this study.

Table 5: Interventions for PTSD in children (and first authors).

Interventions	First Authors
Cognitive behavioral therapy	Caro, Gkintoni, Correll
Trauma-focused Cognitive behavioral therapy	deHaan
Cognitive behavioral therapy in groups	Davis
Group Trauma-based Cognitive Behavioral Therapy	Xie
Cognitive Behavioral Therapy for multiple vs. single stressors	Hoppen
Cognitive Behavioral Therapy lower dropout rate	Simmons
Telehealth	Goslin
Web-based training for parents	Eshkalak
Art psychotherapy	Braito
Medications	Jagtiani

In a paper entitled "The effectiveness of **web – based training for parents** on PTSD in children", (N=110 10-to-18 years old), the youth were assigned to a four-week training on a website versus routine care [44]. The website group received lower scores on the Child Revised Impact of Event Scale (CRIES) while the scores increased for the control group. However, these were not randomized controlled groups.

A systematic review of 17 articles on **art psychotherapy** also appeared in this literature. The art therapy was notably effective for children who had experienced trauma and had received a diagnosis of PTSD [45].

Surprisingly, only one review of research on **medications** appeared in this literature on PTSD in children. In this recent review of 10 studies, clonidine and guanfacine were effective in treating nightmares, hyper-arousal, aggression and sleep disturbances as well as re-experiencing avoidance and hyper-arousal symptoms [46].

Potential Underlying Biological Mechanisms for PTSD in Children

Several potential underlying biological mechanisms have been suggested For PTSD in children. These include parental PTSD, prenatal inflammation, autonomic dysregulation as noted in low cortisol and low heart rate, and brain involvement reflected in abnormal EEGs and reduced cortical volume.

In a paper entitled, "Parental preconception PTSS and maternal inflammation prospectively predict short telomere length in children", blood spots were taken from mothers (N= 127) and fathers (N= 84) during the second and third trimester of pregnancy [47]. The **mothers' PTSD** predicted shorter telomere length in their children and the **fathers' PTSD** also predicted shorter telomere length in their children. In addition, greater second trimester C-reactive protein (a marker of inflammation)

predicted shorter telomere length as well as PTSD in the children. Telomeres protect the ends of chromosomes from splitting (like the ends of shoelaces). Shorter telomere length is associated with stress and is a risk factor for disease.

Autonomic dysregulation has been associated with abnormal cortisol levels and heart rate. In research on the relationship between changes in **cortisol** and PTSD in children (N= 71 8–15-years-old), assessments were made at the beginning of COVID and every three months following the start of COVID [48]. A greater increase in cortisol at the beginning of COVID was related to less PTSD. And an increase in PTSD symptoms occurring over time was related to a reduction in cortisol levels. Low cortisol levels in the children with PTSD are consistent with low cortisol levels found in adults with PTSD.

In a study entitled "Resting heart rate associations with violence exposure and PTSS: sex differences in children", children were seen at age 9 (N= 91) [49]. In this sample, children with greater exposure to violence had greater PTSS and lower resting **heart rate**. The resting heart rate and PTSS relationship was greater in females. The females with lower-than- normal heart rate had greater PTSS.
Several studies have focused on **measures of brain activity and volume** as potential mechanisms. They include EEG studies and fMRI research. In one EEG study entitled "Frontal alpha asymmetry in children with trauma exposure" (N=165), **left frontal alpha asymmetry** was noted [50]. Avoidance of environmental stimuli coincided with this asymmetry.

In another EEG study, EEG was recorded during an emotional face – matching task in children of mothers with interpersonal violence – related PTSD [51]. Both the mothers and the children (N=47) showed attentional bias toward fearful and angry faces. They also showed **decreased activation of the right dorsolateral prefrontal cortex** in response to fearful and angry faces.

In research entitled "Mapping structural covariance network in children and adolescents with PTSD after earthquake" (N=35 PTSD children after the earthquake and N= 24 traumatized healthy control children), **cortical thickness was decreased in the left medial orbitofrontal cortex** of the PTSD children [33]. Altered structural covariance was noted in six regions based on MRI imaging data. These included the default mode network, midline cortex structures, motor cortex, auditory association cortex, limbic system, and visual cortex.

In a study entitled "Smaller hippocampal volume is associated with PTSS in children with cancer" (N=18 children with cancer-related PTSD), **smaller hippocampal volume** was associated with more severe PTSS at baseline [52]. The children were provided a four-week martial arts meditative intervention, and those with more severe PTSS had smaller hippocampal volume even after the Intervention. But the correlation was only .21.

In other brain volume research, data on children with PTSD symptoms from the ABCD study were analyzed [53]. In this sample (N= 11,848 children with a mean age of 10), traumatic events were associated with PTSD in the children. Environmental factors explained most of the variance in traumatic stress and PTSD. Genetic factors accounted for most of the variance in the **volumes of a minority of cortical and in most of the subcortical** regions of interest.

Metabolite concentrations have also been assessed in children and adolescents with PTSD (N= 28 children with PTSD and 24 children who were matched trauma-exposed controls) [54]. Older children had more left amygdala concentrations and younger children had more right amygdala concentrations. **Right amygdala volume was lower than left amygdala volume** in children with PTSD. The authors suggested that these data demonstrated dysfunction of both neurons and glial cells involved in the pathology of pediatric PTSD.

Methodological Limitations and Future Research Directions
This recent literature on PTSD/PTSS in children has several methodological limitations that relate to different definitions/ diagnoses, sampling, measures, and methods across studies. These limitations are highlighted by several systematic reviews that have been conducted but could not be submitted to meta-analyses because of significant variability of methods and measures across studies that resulted in their failure to meet criteria for meta-analysis. Although there is a sufficient literature for meta-analyses to be conducted, the authors of the meta-analyses suggest that they were limited by small samples and the heterogeneity of the samples on age and the severity of the exposure to stress.

The definitions and diagnostic criteria for PTSD have varied across studies with some researchers sampling children who simply have symptoms of PTSD as in PTSS or who meet the diagnostic criteria for PTSD. That is not surprising given the range of stress severity from exposure to intimate partner violence to sexual abuse, head injury, earthquake and war.

Most of the studies are cross-sectional making it difficult to determine directionality. And very few researchers have traced the longitudinal course of PTSD in the same children. Typically, the samples have been children and adolescents combined making it difficult to determine the problems, effects and comorbidities that are unique to the children. The studies have also lacked comparison groups of children without PTSD.

The use of different scales in different studies has also made it difficult to compare results across studies. And the child-report data and parent-report data have been inconsistent with the children more frequently reporting their PTSD than the parents. Both types of self-report data are more subjective and less definitive than the more objective physiological measures like cortisol assays and fMRIs that appeared in studies on potential underlying biological mechanisms.

Most of the studies have focused on risk/ predictor variables. The researchers have typically measured one versus multiple variables even though the children and adolescents have frequently experienced multiple stressful events. Those few multiple variable studies have lacked logistic/linear regression analysis or structural equations modeling to determine the relative significance of the different variables contributing to PTSD. The significant mediating/moderating variables in some of the studies suggest the importance of assessing multiple variables in the same samples.

The limited literature on the negative effects and comorbidities of PTSD was surprising given that research on other disorders of children and adolescents has shown that PTSD is often accompanied by sleep problems, anxiety and depression. The absence of research on peer influences, social media and internet use in this literature was also surprising given the frequency of these effects on other disorders in children and adolescents.

Most of the recent intervention studies have focused on cognitive behavioral therapy (CBT), especially trauma-based CBT which was not surprising since CBT is one of the most popular therapies for adult PTSD and for children and adolescents with other disorders. Although parent training and art therapy appeared in this literature, surprisingly, other alternative therapies that have been effective for reducing PTSD in general like massage therapy, tai chi, yoga and exercise have not appeared in this literature [55-60]. The data suggesting that group CBT has been effective suggests that these alternative therapies could be effectively conducted in groups. Although parenting problems like conflict and intimate partner violence as well as sexual and emotional abuse have been risk factors for PTSD in children and adolescents, parents, surprisingly, have not been involved in these intervention studies.

The potential underlying biological mechanism literature has been primarily fMRI research, although those samples are small likely due to the expense of the research. The results have been highly variable in terms of the activated areas of the brain which likely relates to the different age groups and the different severity of the PTSD being measured in the children and adolescents. Some data have suggested that PTSD has been more severe in adolescents than in children, although other data have reported greater severity in younger children.

Despite these methodological limitations, this literature has highlighted the prevalence of PTSD in children and adolescents. The prevalence may have recently increased as the overuse of social media and the internet has increased. The prevalence of PTSD highlights the need for more intervention research. The data on risk variables have helped identify children and adolescents who need therapy and the intervention data have informed clinicians on potential treatments for those with PTSD. Further research is needed to specify the relative significance of the risk variables for identifying those children and adolescents and the specific intervention techniques that are effective in reducing PTSS and PTSD.

Table 6: Potential underlying biological mechanisms for PTSD in children (and first authors).

Mechanism	First Authors
Parental preconception PTSS	Rinne
Prenatal inflammation	Rinne
Low cortisol	Bilodeau-Houle
Low resting heart rate	Wiltshire
Left frontal asymmetry	Im
Decreased activation right dorsolateral prefrontal cortex	Perizzolo
Lower volume in left medial orbitofrontal area	Mo
Smaller hippocampal volume	Evanski
Variance in volumes of cortical and subcortical regions	Bustamante
Right amygdala volume lower than left amygdala volume	Wang

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