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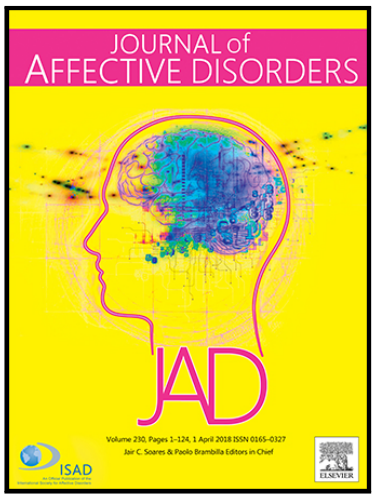

A systematic review and meta-analysis on the prevalence of depression in children and adolescents after exposure to trauma

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Highlights

- 24.2% of youth had clinically significant depression symptoms or diagnosis.
- Depression was assessed via validated self-report measures or diagnostic interviews
- Girls had greater odds of depression than boys.
- Interpersonal violence yielded higher depression rates than other types of trauma
- The effect of trauma exposure on depression scores was medium in size

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A systematic review and meta-analysis on the prevalence of depression in children and adolescents after exposure to trauma

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A systematic review and meta-analysis on the prevalence of depression in children and adolescents after exposure to trauma

Abstract

Background

Depression is often reported as co-occurring with post-traumatic stress disorder in children and adolescents, but its prevalence within trauma-exposed child and adolescent samples is not well understood.

Methods

Our meta-analyses addressed two questions: I. What is the prevalence of depression (either based on structured interview or cut-off on a self-report measure) in children and adolescents after exposure to trauma? II. Does trauma exposure increase the severity or rates of depression comparative to another comparison group of children and adolescents with milder exposure or no exposure to trauma?

Results

Fifty-six studies reported depression prevalence. A random effects meta-analysis suggested that 24.2% [95% CI 20.6 – 28.0] of children and adolescents exposed to a traumatic event met criteria for depression. Our second meta-analysis across 30 studies found that the effect of trauma exposure (relative to unexposed or less exposed children and adolescents) on depression scores was medium in size (d = 0.51, 95% CI

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0.41 – 0.61). The odds of a diagnosis of depression were 2.6 times greater [95% CI 2.0 – 3.3] for children and adolescents exposed to trauma as compared to those unexposed or less exposed. Participants exposed to interpersonal violence (IPV) had a higher prevalence and level of depression compared with those exposed to non-IPV trauma.

Limitations

Results should be interpreted with caution due to high levels of heterogeneity.

Conclusion

Depression in trauma-exposed children and adolescents is a common response to trauma that is not solely reflective of pre-traumatic difficulties. Post-traumatic depression merits serious consideration in trauma-exposed children and adolescents.

Keywords:

Posttraumatic stress disorder; Depression; Trauma-exposure; Children; Adolescents; Review.

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Introduction

It is well established (Smith, Dalgleish, & Meiser-Stedman) that each year, millions of children and adolescents are exposed to traumatic events worldwide. Exposure to trauma can adversely influence children's long-term social, emotional, and physical development and well-being (Fairbank & Fairbank, 2009; Pynoos et al., 2009). The majority of mental health research for trauma-exposed child populations, to date, has focused on the development and treatment of post-traumatic stress disorder (PTSD). However, several researchers have also identified elevated rates of depression in trauma-exposed child populations (e.g., Cénat, 2015; Fan, 2011; Lai, 2013; Ying, 2013).

Depression in trauma-exposed children and adolescents is a critical area for further study for several reasons. First, depression in children and adolescents is one of the leading causes of disability globally (Gore et al., 2011). Second, depression in child populations often has a recurring course frequently persisting into adulthood (Costello, Egger, & Angold, 2005; Patel, Flisher, Hetrick, & McGorry, 2007; Thapar, Collishaw, Pine, & Thapar, 2012). Third, depression in children and adolescents increases the risk of long-term adverse outcomes (Bardone, Moffitt, Caspi, Dickson, & Silva, 1996; Weissman, Wolk, Goldstein, & et al., 1999). For example, in a longitudinal follow-up study which compared adult mental health outcomes between depressed adolescents and non-depressed controls, Weissman et al. (1999) found that depressed adolescents had a five-fold increase of first suicide attempts 10-15 years later. They were also at high risk for additional episodes of major depressive disorders throughout their lifetime and reported more psychiatric and medical hospitalisations at follow-up than controls.

Despite the substantive disease burden that depression poses globally, there are no reliable estimates of the extent to which depression affects trauma-exposed children and adolescents. The research published to date has shown wide variations in point prevalence rates ranging from 3.7%

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after a motor vehicle accident (Tierens, 2012) to 79.7% (Dass-Brailsford, 2015) after the 2010 Haitian earthquake. However, the extent to which these rates are a result of depressive disorders present *prior to* or exacerbated by the traumatic event is unclear. Furthermore, the heterogeneous nature of these estimates suggest that moderating factors may exert a considerable influence on these rates. For example, prior research on post-traumatic stress disorder has demonstrated that event characteristics (Alisic et al., 2014), pre and post exposure individual level variables (Lack & Sullivan, 2008; McDermott, Berry, & Cobham, 2012), as well as measurement methods (Carrion, Weems, Ray, & Reiss, 2002; Copeland, Keeler, Angold, & Costello, 2007) may moderate the incidence of PTSD. The variables that may moderate the prevalence of depression after trauma-exposure, however, are currently unknown.

To the best of our knowledge, a systematic review on the prevalence of depression in trauma-exposed child populations has not been published. A precise estimate on the prevalence of depression and the extent to which it is influenced by trauma exposure has the potential to yield important clinical benefits for trauma-exposed children and adolescents. First, it will help us to ascertain the extent of the clinical problem. Second, identifying the degree to which depression impacts children and adolescents after trauma-exposure can highlight the magnitude and type of resources which may need to be mobilised to address this issue (e.g., depression screening, depression-specific interventions) and lead to the earlier identification of children in need of intervention. It is well established that the early identification and treatment of mental health disorders is a critical factor in maintaining a normal developmental trajectory and facilitating recovery for children and adolescents (Kieling et al., 2011). Third, improving our understanding in this area can spur the development of intervention strategies to specifically target post-traumatic depression (e.g., behavioural activation) which may be distinct from treating PTSD.

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The present systematic review was based around two meta-analyses. The first meta-analysis sought to answer the following research question:

1. What is the prevalence of depression (based on either a structured interview assessment or cut-off on a validated questionnaire measure) in children and adolescents after exposure to trauma? (hereafter RQ1)

In order to explore whether our prevalence rate primarily reflected depression that existed prior to trauma exposure or as a result of trauma-exposure, the second meta-analysis using surrogate methods, indirectly examined the following research question:

2. Does trauma exposure increase the rates of depression comparative to another comparison group of children and adolescents who had milder exposure or no exposure to trauma? (hereafter RQ2)

We also examined potential moderators: type of trauma, self-report vs diagnostic report, individual vs collective trauma, high income (HIC) vs low or middle-income country (LMIC), and gender which could influence the prevalence rate and level of depression.

Method

We conducted systematic searches in three electronic databases: Medline, PsycINFO, and Published International Literature on Traumatic Stress (PILOTS), and examined a reference list from Montgomery (2011).

Electronic searches used variants of the following search terms with syntax adapted to each database:

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"Depressive Disorders" OR dysphoria OR "dysphoric disorder" OR "depressive symptom" OR dysthymia OR "dysthymic disorder" AND child* OR teen* OR youth* OR youngster* OR "young person" OR adolescent* OR adolescence AND hurricane* OR flood* OR tsunami* OR earthquake* OR disaster* OR abuse OR violence OR maltreatment OR "trauma exposure" OR "post-traumatic stress disorder" OR PTSD OR "psychological trauma". Please see Supplementary Information for the exact search strings.

We restricted searches to papers in either English or French with at least 50 participants in each group, published in peer-reviewed journals between 1994 (when DSM-IV was first published) and 15 June 2016.

RQ 1 Study Selection Criteria

RQ 1 studies were required to meet the following criteria:

a) All study participants were exposed to trauma as defined by the A1 Criteria for PTSD in either DSM-IV or DSM-5, or separate data for the trauma-exposed group was available; (exposure to trauma was determined by study authors typically by a demographic survey assessing exposure, or living in an area affected by a disaster)
b) The study participants were between the ages of 5-18 years old at the time of the first assessment of depression, or the mean age was between 5-18 years (for studies that included participants outside this age range);
c) The study participants did not represent a clinic-referred sample (i.e. people were screened in or out of the study based on their symptoms);

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d) The study assessed depression at least 1 month after trauma exposure using a structured interview or validated self-report questionnaire measure, in order to avoid natural and transient distress responses in the first 4 weeks after trauma exposure;
e) The study provided adequate information to derive the prevalence rate of depression solely for those children exposed to trauma;
f) The study sample was not a clinical sample with regards to mental health (e.g., psychiatric in-patients, or selected as they were treatment seeking or receiving treatment). For those studies that were evaluating a universal clinical intervention, only the baseline prevalence rate was used).

RQ 2 Study Selection Criteria

RQ 2 studies were required to meet the following criteria:

a) All study participants were exposed to trauma as defined by the A1 Criteria for PTSD in either DSM-IV or DSM-5, or separate data for the trauma-exposed group was available;
b) The study participants were between the ages of 5-18 years old at the time of the first assessment of depression, or the mean age was between 5-18 years (for studies that included participants outside this age range);
c) The study participants did not represent a clinic-referred sample (i.e. people were screened in or out of the study based on their symptoms);
d) The study assessed depression at least 1 month after trauma exposure using a structured interview or validated self-report questionnaire measure, in order to avoid natural and transient distress responses in the first 4 weeks after trauma exposure;

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e) The study reported adequate information to compare the rates of depression between

   i. a trauma-exposed group and a suitable non-trauma exposed comparison group or;

   ii. between two or more groups with varied levels of trauma exposure. (We used each the definition of greater or lesser trauma-exposure provided by each study author. The majority of study authors defined levels of trauma exposure as closer or farther proximity to a major disaster (e.g., Goenjian, 1995).

   iii. Alternatively, they compared a trauma-exposed group (i.e. every participant had been exposed to a given trauma) to a community group, where the precise level of trauma-exposure was not formally ascertained but was considered to be at the normal population level.

Details of the protocol for this systematic review were registered on PROSPERO and can be accessed at http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42016042065. See Figure 1 for PRISMA flow diagram.

Coding of studies

The title/abstract screening of studies was completed by researcher VV. Two researchers independently completed full-text reviews for all studies that were potentially relevant (n = 650) and coded which research questions each study addressed. Any differences in opinion were resolved through consultation with the senior researcher on the team (RMS).

Researchers VV and BG primarily completed the data extraction for RQ1 and RQ2, respectively. Researcher LA checked a sample of the extracted data for errors. In addition to the publication details of each study, we also extracted information on sample characteristics, the type of

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trauma exposure, the measurement instrument, and outcomes. For RQ2 we also extracted the mean and standard deviation of depression scores on each sample or other statistical data that could be converted into an effect size. (The coding sheet is available from VV).

Sample and exposure characteristics

We recorded the country of data collection, the number of children and adolescents who participated in the depression assessment, age of the sample (range, mean and standard deviation), the population type (i.e. social service referred, refugees, incarcerated juveniles, other), gender composition, and the response rate.

We extracted a description of the index event and the type of exposure. The pre-designated exposure categories were accidental injury, domestic violence, physical abuse, sexual abuse, disaster, war, mixed exposure, community violence, earthquake, flood, tsunami, hurricane, tornado, motor vehicle accident, varied trauma types including interpersonal violence (IPV), varied trauma types without IPV, emergency room (which may also include previously mentioned exposure types. We then grouped the different trauma exposures into two broad categories, IPV and non-IPV. We defined IPV as witnessing or experiencing violence (e.g., child maltreatment, domestic violence, war, homicide, refugee trauma) If samples contained some participants only exposed to non-IPV traumas, we categorised them as non-IPV. We chose to do this in order to distinguish definite IPV studies from non-IPV or mixed samples, and thereby facilitate a clear analysis of whether IPV conferred greater risk of depression.

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Depression measurement

We included both self-report and diagnostic (i.e. interview) measures. We recorded the informant, the type of measure, cut-off score used, the period for which depression was assessed (1-6 months, <1year, >1 year, unknown) and how long after the trauma the depression measurement was administered.

Outcomes of the assessment

For RQ1, we extracted the number of children and adolescents who scored above the self-report cut-off score used by the study team, or the number of children and adolescents who met criteria for depression according to diagnostic interview assessments. In the case of measurements at multiple time points, we extracted the first measurement for which information was available a minimum of 4 weeks after the index event. In the rare circumstance that both a self-report measure and a diagnostic measure for depression was administered, we extracted the results of the diagnostic measure.

For RQ2, we extracted the mean and SD of depression scores for each exposure group or other statistical data provided which could be converted to an effect size.

Statistical analysis.

All analyses for RQ1 were performed using Open MetaAnalyst (Wallace et al., 2012) which utilises the *metafor* package in R (Viechtbauer, 2010). We decided *a priori* to test the following variables as potential moderators for each research question: interpersonal

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violence (IPV) vs non-interpersonal violence (non-IPV), high vs LMIC country (LMIC), self-report vs diagnostic measure of depression, collective vs individual trauma. If the study participants were exposed to the same index trauma (e.g., natural disaster, war), we considered it a collective trauma. We used a binary random effects model to calculate prevalence rates based on the assumption that that the studies would contain substantial heterogeneity that was not due to chance alone. Proportion estimates were subjected to a Freeman-Tukey arcsine transformation (Freeman & Tukey, 1950; Miller, 1978) to stabilise variances before the meta-analysis. The results were reverse transformed before being reported here.

Results

RQ1: Prevalence of depression in trauma-exposed children and adolescents

The first stage of our data analysis involved determining an overall pooled incidence estimate of depression in children and adolescents who were trauma-exposed, based on all included studies for RQ1 (k = 56). We retrieved 56 articles for RQ1, describing 56 independent samples. In total, studies for RQ1 reported assessments for depression on 37,756 children and adolescents exposed to trauma as defined by Criteria A1 of DSM-IV or DSM 5. The ages of children varied from 5-18 years and approximately 47% of the overall sample were boys (not reported for 10/56 samples). Only 22/56 studied specified the timeframe for the assessment of depression symptoms. Almost all of the studies reporting this information used a timeframe of 1 month or less for the assessment of depression symptoms. Therefore, we have treated the prevalence rate as point-prevalence rate for current depression. Most samples originated from the USA (k = 18) and China (k = 8). An overview of the samples and their characteristics are given in Table 1.

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For the RQ1 overall sample (k = 56) we found that 24.2% (95% CI 20.6 – 28.0) of the children exposed to a traumatic event met criteria for depression (for forest plot, see Figure 2). The Q-test for pooled estimates was significant (Q = 3654.019, d.f. = 55; $p < 0.001$; $I^2 = 98.495$) indicating substantial between study heterogeneity.

Sensitivity Analysis

For RQ1 we conducted two different sensitivity analyses according to both liberal and conservative outlier criteria. Using liberal criteria, we considered as outliers studies whose 95% confidence intervals did not overlap with the 95% CI for the overall pooled prevalence estimate (Cuijpers, 2016). Thirty-three of the 56 studies used in the meta-analysis for RQ1 met criteria for outliers. Using the liberal criteria provided a similar overall pooled prevalence rate of 24.1% [95% CI 22.2 – 26.1, $p < .001$]. The Q-test for pooled estimates remained significant (Q = 101.865, d.f. = 22; $p < 0.001$; $I^2 = 78.4\%$) indicating a high degree of between study heterogeneity. Given the extreme proportion (59%) of studies which were considered outliers using the liberal criteria and that the prevalence estimates for depression did not substantially change even once these studies were removed, we concluded that these studies reflected the inherent variability in the data.

Using conservative criteria, we made a box plot and considered as outliers all observations more than 1.5 times more extreme than the inter-quartile range (Tukey, 1977). Only one study (Dass-Brailsford, 2015) was excluded according to this criterion. We found a similar pooled prevalence rate of 23.4% (95% CI 19.9 – 27.1, $p < .001$). The Q-test for pooled estimates was significant (Q = 3564.277, d.f. = 54; $p < 0.001$; $I^2 = 98.485$) indicating substantial between study heterogeneity.

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In summary, sensitivity analyses that removed outliers according to either method did not substantially change our prevalence estimates and heterogeneity remained high.

Moderator analyses

We conducted a series of meta-regressions to test differences in the pooled incidence estimate based on the following covariates that were established *a priori*: Type of trauma (IPV vs non-IPV), whether the trauma exposure was collective or individual, assessment type, and country type (high income vs LMIC). We selected these covariates due to previous research suggesting that they may moderate the incidence of PTSD (event characteristics (e.g., Alisic et al., 2014), measurement methods (e.g., Carrion, Weems, Ray, & Reiss, 2002; Copeland, Keeler, Angold, & Costello, 2007) and due to the limited research on potential differences in prevalence rates between LMIC and high-income countries. We also conducted a *post-hoc* meta-regression on the covariate of maltreatment vs other types of trauma. None of these variables significantly moderated the prevalence of depression when all studies were included. When the conservative approach to outliers was used, IPV resulted in a significantly higher prevalence rate of depression than non-IPV trauma exposure ($p < .037$). When we re-ran the meta-regressions, applying the liberal approach to outliers, none of the variables were found to have a significant effect on the prevalence of depression.

The moderator analyses showed a high level of heterogeneity with Q-test scores above 90% for every moderator. This suggests that there are additional unexplored moderators exerting an influence on the prevalence of depression in children and adolescents.

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We examined gender differences by calculating odds ratios on the subset of studies where this data was available (k = 9). Girls had 1.8 times greater odds of a diagnosis of depression or clinically significant depressive symptoms than boys (95% CI 1.3 – 2.4, $p < .001$)

RQ2: The effect of trauma-exposure on depression

We identified 32 articles meeting the inclusion criteria for RQ2 which reported data from 30 independent samples once all duplicates were removed. Ten of the studies included for RQ1 were also used for RQ2. RQ2 analyses were performed using OpenMeta[Analyst] software (Wallace et al., 2012). We decided *a priori* to test the following variables as potential moderators for effect size: interpersonal violence (IPV) vs non-interpersonal violence (non-IPV), HIC vs LMIC, self-report vs diagnostic measure of depression, collective vs individual trauma. If the study participants were exposed to the same index trauma (e.g., natural disaster, war), we considered it a collective trauma. For RQ2, standardised mean difference (Cohen's *d*) effect sizes were calculated based on differences between low-exposure or no-exposure and higher-exposure groups. Calculations were based on the first time point where depression was assessed which was at least 4 weeks post exposure (k = 30 studies). We selected a random effects maximum likelihood (REML) model as this method allowed the results to be generalised to a wider population of studies (Hedges & Vevea, 1998). We then re-ran this meta-analysis using only the subset of 11 studies that reported on cases of depression, where odds ratios were aggregated) (Wallace et al., 2012).

Differences in depression severity between trauma-exposed and non-exposed children and adolescent samples

In total, 32 studies with 30 independent samples for RQ2 reported assessments for depression on 17,186 children and adolescents exposed to trauma. The ages of children varied from 5-18 years and approximately 49.7% of the overall sample were boys (not reported for 4/32

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samples). Only 9/32 studies specified the timeframe for the assessment of depression symptoms. Almost all of the studies reporting this information used a timeframe of 1 month or less for the assessment of depression symptoms. Therefore, we have treated the prevalence rate as point-prevalence rate for current depression. Most studies reported on samples of children and adolescents living in HIC countries (k = 21). The majority of included studies (k = 19) investigated the impact of exposure to individual as opposed to collective trauma. Most of the trauma exposures investigated involved interpersonal violence (k = 21). An overview of the samples and their characteristics are given in Table 2.

The random effects meta-analysis found that the effect of trauma exposure on depression scores was medium in size (d = 0.51, 95% CI 0.41 – 0.61; for forest plot see Figure 3). The Q-test for pooled estimates was significant (Q = 387.39, $p < .001$) and the corresponding I^2 value was high (92.5%) indicating a high degree of between study heterogeneity.

The random effects meta-analysis using the subset of studies reporting on *cases* of depression demonstrated that the odds of having a diagnosis of or clinically significant symptoms of depression were 2.6 times greater [95% CI 2.0 – 3.3] for children and adolescents more exposed to trauma as compared to those who were unexposed or less exposed to trauma. (See Table 3 for included studies). The Q-test for pooled estimates was 54.654 (df = 10, $p < .001$) and the corresponding I^2 value was high (81.7%) indicating a high degree of between study heterogeneity.

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RQ 2 Sensitivity Analysis

We made a box plot and considered as outliers all observations more than 1.5 times more extreme than the inter-quartile range. Two studies were excluded according to this criterion (Goenjian, 1995; Lynch, 1998). We found a similar medium effect size of trauma exposure on depression scores (d = .46, 95% CI .37 - .56). The Q-test for pooled estimates was significant (Q = 319.255, df = 27, p < .001) indicating substantial between study heterogeneity. In summary, sensitivity analyses that removed outliers did not substantially change the effect of trauma-exposure on depression scores, and heterogeneity remained high.

RQ 2 Moderator Analysis

We conducted meta-regression analyses to explore potential moderators of the pooled effect of trauma exposure on depression. The potential moderating variables were the same as for a priori variables investigated in RQ1 (IPV vs non-IPV, HIC vs LMIC, self-report vs diagnostic measure of depression, collective vs individual trauma). Of these variables, only type of trauma was a significant moderator of the effect of trauma exposure on depression: IPV exposure (d = 0.59) had a larger effect on depression than did non-IPV (d = 0.32, p = .04). Other moderators analysed were LMIC vs HIC (d = 0.50, d = 0.51 respectively, p > .99), collective vs individual exposure (d = 0.41, d = 0.56 respectively, p > .24), diagnostic interview vs self-report (d = 0.58, d = 0.49 respectively, p > .52).

Publication Bias

We assessed publication bias (e.g., the selective publication of significant results) by inspecting funnel plots for each analysis. For RQ1, the funnel plot (see Figure 4) underscores how heterogenous the effect sizes of the included studies are. There was evidence of asymmetry, with

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larger studies appearing to yield smaller prevalence rates, i.e. our aggregated prevalence rate may be slightly exaggerated. For RQ2a, funnel plot (see Figure 5)**Error! Reference source not found.** also showed some asymmetry, with few small studies showing weaker effect sizes. Our estimate for RQ2 may therefore also be slightly exaggerated.

Discussion

Although it has been widely acknowledged that depression is a disorder that emerges in trauma-exposed children and adolescents, until now there has not been an estimate of the prevalence rate of depression for this population. To the authors' best knowledge, this meta-analysis was the first to examine the extent of this problem in children and adolescents. Our results demonstrated that almost one in four (24.2%) trauma-exposed children and adolescents met threshold for clinically significant depression or diagnosis. There was no evidence that prevalence rate differed according to country (HIC vs LMIC), whether the trauma was individual or collective, or whether depression was assessed via self-report or diagnostic instrument. Our findings did demonstrate that girls had greater odds of a diagnosis of depression or clinically significant depression symptoms than boys.

Although it could be argued that this high prevalence rate, in and of itself, may simply reflect pre-existing cases of depression, the results of our second meta-analysis indicated otherwise. When we compared depression scores between trauma-exposed and unexposed or less exposed groups, the effect of trauma-exposure on depression scores was medium in size, providing strong evidence that a significant number of new depression cases arose as a result of trauma exposure. This effect remained robust across gender, how depression was assessed, whether the participant came from a HIC or LMIC country, or if the trauma was individual or collective.

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It is important to note that the 24.2% prevalence rate for depression in trauma-exposed children and adolescents identified in our first meta-analysis is remarkably higher than what has been reported in community samples in this age-group. For example, in a meta-analysis conducted by Polanczyk, Salum, Sugaya, Caye, and Rohde (2015) which examined global prevalence rates for mental health disorders in children and adolescents, the prevalence rate for depression was 2.6% [95% CI 1.7 – 3.9]. In a US national survey using community samples of adolescents aged 12-18 years, Mojtabai, Olfson, and Han (2016) found a prevalence rate of 11.3% for depression.

Although our results demonstrate that exposure to trauma contributed to elevated depression scores in children and adolescents, the importance of these elevated depression scores required further clarification. For example, if trauma-exposure only contributed to an increase in depression scores which remained far below diagnostic cut-off, it could be argued that a medium effect size of trauma-exposure on depression scores was not clinically meaningful. To further explore the significance of these results, we conducted an additional meta-analysis using the subset of studies which compared prevalence of depression cases between trauma-exposed and unexposed or less exposed groups. Our results established that not only did trauma-exposed children and adolescents have significantly higher depression scores, but they were also at 2.6 times greater odds of receiving a diagnosis of depression [95% CI 2.0 – 3.3] compared to those who were unexposed or less exposed to trauma.

In addition to demonstrating the significance of depression as a response to trauma-exposure, our results have also shown that the type of trauma, notably IPV, may have been an important factor influencing the development of depression in children and adolescents. Participants exposed to interpersonal violence had a higher incidence rate of depression (e.g. 28.7% versus 22.9%, $p < .001$, respectively), and higher levels

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of depression as compared to children exposed to other types of trauma. These results were consistent with prior PTSD research showing that children and adolescents exposed to IPV had higher PTSD incidence rates than participants exposed to other types of trauma (Alisic et al., 2014).

A note of caution is warranted in the overall interpretation of these results, however. The overall pooled prevalence rate should be considered in light of the very high levels of heterogeneity present in each of the analyses that we conducted. Although we attempted to identify several possible sources of heterogeneity via moderator analyses, only IPV was identified to be a potential moderator of depression. This suggests there were additional unidentified factors moderating the prevalence and levels of depression in children and adolescents in this meta-analysis. It should be noted that the high level of heterogeneity we have observed is consistent with the heterogeneity in the meta-analysis conducted by Alisic et al. (2014) on the incidence of PTSD in children and adolescents.

Limitations

This study has several limitations which should be considered. First, our meta-analysis included a wide range of assessment time-frames (e.g. from four weeks to 1-year post-trauma). We were unable to examine how "time since trauma" may have influenced the prevalence rate because not enough studies reported this information. Therefore, it was possible that some youth may have experienced significant improvement in their mood with the passage of time which could contribute to an under-estimation of the prevalence rate. On the other hand, not all studies consistently required the endorsement of functional impairment to meet criteria for depression which may have over-estimated the prevalence of depression (Polanczyk et al., 2015).

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Furthermore, there was evidence of asymmetry and publication bias which may have also resulted in an over-estimation of the pooled prevalence rate of depression and the effect of trauma-exposure on the level of depression. In addition, although this meta-analysis included studies with children aged 5-18 years, the majority of participants were aged 12 years and older. Additional research focusing on pre-adolescent trauma-exposed children is needed to confirm these results in a younger age-group. It is also important to note that systematic differences between studies (e.g., study design, how trauma was assessed, the nature of the comparison group, the culture in which the data was collected) may be influencing our results. In addition, between subject variability may account for some of our findings given that moderators were assessed between studies and not between individuals. Lastly, and perhaps most importantly, the high level of heterogeneity in this study has demonstrated that there are additional unexplained factors moderating the prevalence of depression in trauma-exposed children and adolescents. Therefore, the overall 24.2% pooled prevalence rate of depression needs to be considered with caution.

Future Research

These findings raise intriguing questions and highlight important avenues for research. First, it would be important to explore if depression experienced after exposure to trauma is qualitatively different from depression arising out of other factors, e.g., with respect to symptom presentation or course of disorder. If there are qualitative differences, implications for treatment would also merit further examination. Second, although it was beyond the scope of this meta-analysis to examine the rate of co-morbidity, we know from previous research (Eksi, 2009; Lai, 2013) that a significant percentage of children and adolescents experience both PTSD and depression. An important clinical question would be to determine which comorbid disorder should be considered primary and therefore treated first. Lastly, given the high level of

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heterogeneity suggests the presence of unaccounted for moderators, it would be important to explore risk and protective factors for depression in this population, in addition to methodological variables which also may influence the prevalence and level of depression in children and adolescents. Furthermore, given that this meta-analysis included studies from around the world, it would be important to explore how the prevalence of and moderators of depression may vary according to culture.

Clinical Implications

The current study has established that depression is a common response to trauma in children and adolescents. This finding carries several important implications. First, to ensure early identification and treatment, it is important for clinicians to assess for depression in addition to PTSD after trauma exposure. Second, additional resources should be targeted towards the improvement of treatments for depression in trauma-exposed children. Effective treatments for depression in children and adolescents have yielded, at best, only medium effect sizes, lagging behind treatments for other mental health disorders in both trauma-exposed (Cary & McMillen, 2012; Gutermann et al., 2016) and in broader clinical samples (Weisz, McCarty, & Valeri, 2006). For example, in a large meta-analysis examining the effectiveness of trauma-focused cognitive behavioural treatment (TF-CBT) in children, adolescents, and young people; Gutermann et al. (2016) found that TF-CBT yielded large effect sizes for treating PTSD but only medium effect sizes for treating depression. Furthermore, given that our results demonstrated that girls were at greater odds for depression than boys, it is imperative to ensure that evidence-based treatments are tested with girls. Third, the emergence of IPV as a potentially significant moderator for both depression and PTSD (Alisic et al., 2014) suggests that additional mental health resources should be focused on children who have experienced IPV relative to other types of trauma. Furthermore,

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these findings call attention to the need to focus additional societal resources on preventing and reducing the incidence of IPV which could lead to a reduced incidence of depression in children and adolescents.

Conclusion

This study has demonstrated that depression in trauma-exposed children and adolescents is a substantial problem that merits serious clinical and research attention.

Acknowledgments

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Figure 1 PRISMA Flow Diagram

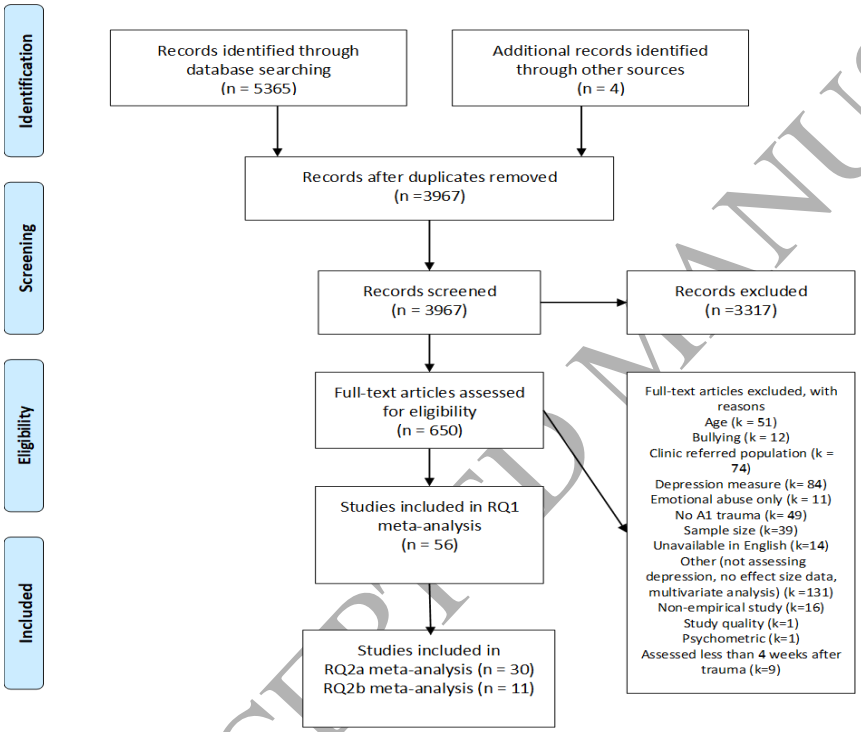

Figure 2: RQ1 Forest Plot for Overall Prevalence Rate

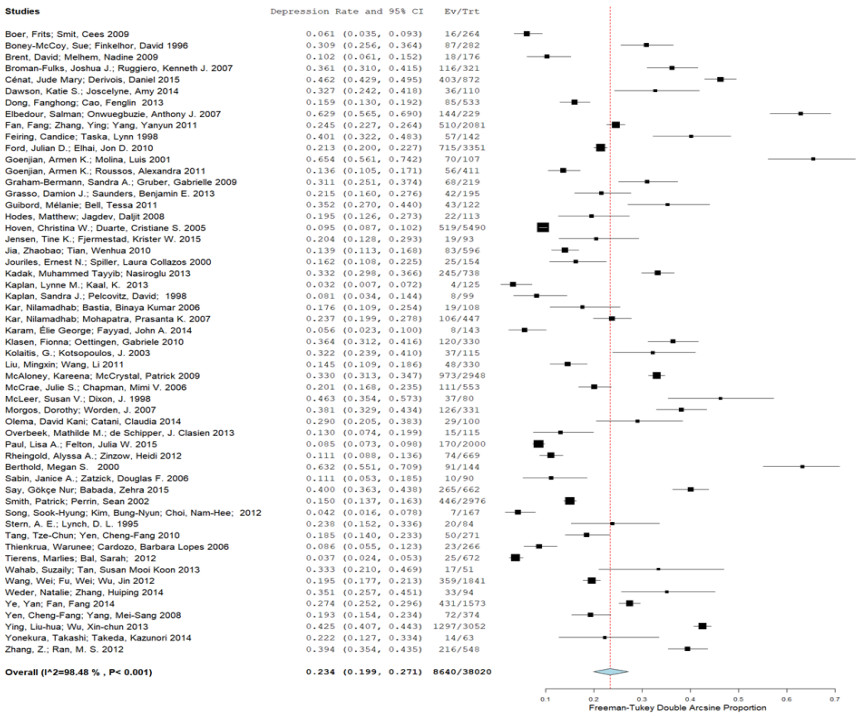

Figure 3 RQ2b Forest Plot of Odds Ratios for Diagnosis of Depression

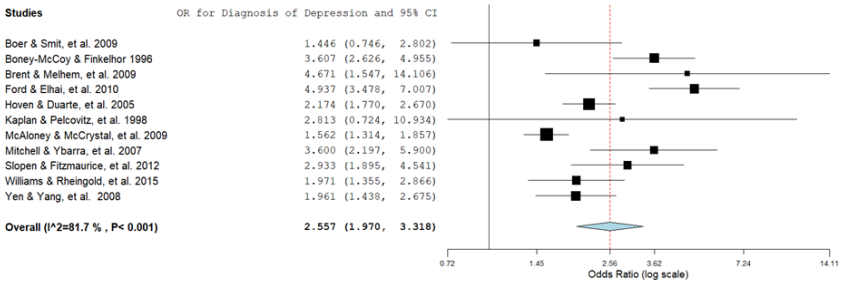

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Figure 4 RQ1 Funnel Plot

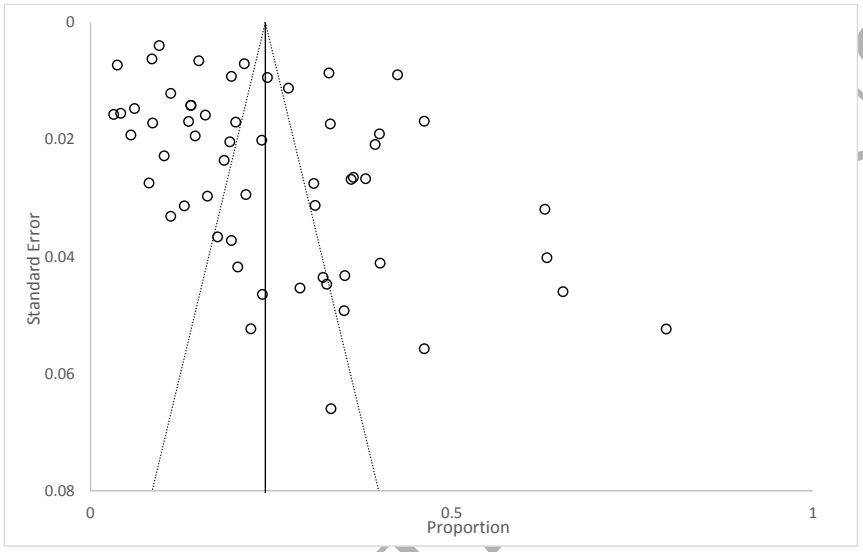

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Figure 5 RQ2a Funnel Plot

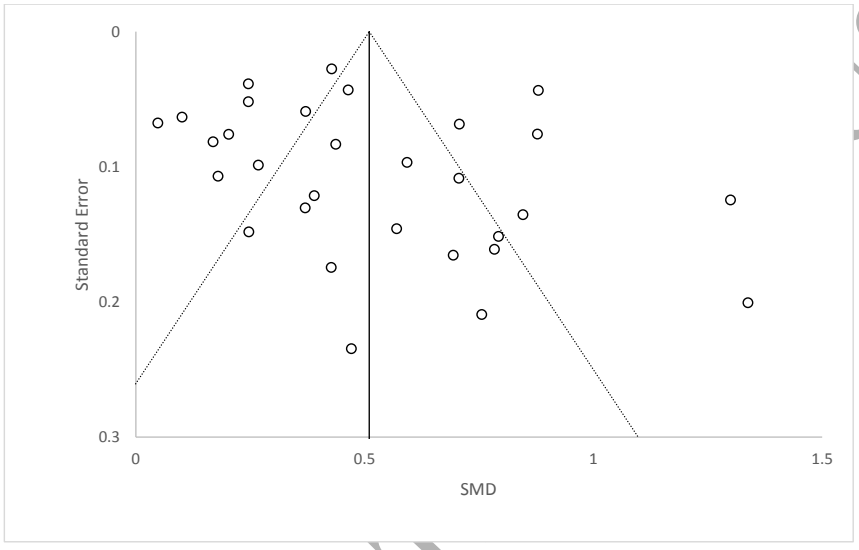

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Table 1 Included Studies RQ1

Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
Berthold (2000)	144	14-20	0.5	War	USA	IPV	Collective	Self-report	CES-D
Boer & Smit, et al. (2009)	779	9-14	Unreported	Technological disaster	Netherlands	Non-IPV	Collective	Self-report	Short Depression Inventory for Children
Boney-McCoy & Finkelhor (1996)	1457	10-16	0.51	Youth victimisation	USA	IPV	Individual	Diagnostic interview	NIMH Diagnostic Interview Schedule DISIII

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
Brent & Melhem et al. (2009)	176	7-25	0.48	Sudden death of parent	USA	Non-IPV	Individual	Self-report	MFQ
Broman-Fulks & Ruggiero et al. (2007)	3906	13-17	0.78	Sexual abuse	USA	IPV	Individual	Diagnostic interview	The National Women's Study Depression Module

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
Cénat & Derivois	872	7-17	0.56	Earthquake	Haiiti	Non-IPV	Collective	Self-report	CDI
Dass-Brailsford & Thomley et al. (2015)	59	9-10	0.71	Earthquake	Haiiti	Non-IPV	Collective	Self-report	CES-D
Dawson & Joscelyne et al. (2014)	110	7-13	0.59	Tsunami	Indonesia	Non-IPV	Collective	Self-report	Short MFQ
Dong & Fenglin et al.	3155	12-18	0.126	Varied	China	Non-IPV	Individual	Self-report	DSRS

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
Elbedour & Onwuegbuzie et al. (2007)	229	15-19	0.47	War	Gaza	IPV	Collective	Self-report	BDI
Fan & Zhang, et al.	2081	12-14	0.54	Earthquake	China	Non-IPV	Collective	Self-report	DSRS
Feiring & Taska, et al. (1998)	142	8-15	0.76	Sexual abuse	USA	IPV	Individual	Self-report	CDI
Ford & Elhai,		12-		Poly-		Non-		Diagnostic	

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
et al. (2010)	4023	17	Unreported	victimisation	USA	IPV	Individual	interview	The National Women's Study Depression Module
Goenjian & Molina, et al. (2001)	158	12-13	0.32	Hurricane	Nicaragua	Non-IPV	Collective	Self-report	DSRS
Goenjian & Roussos, et al. (2011)	411	13-18	0.72	Earthquake	Greece	Non-IPV	Collective	Self-report	DSRS
Graham-									

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
Bermann & Gruber et al. (2009)	219	6-12	0.5	IPV	USA	IPV	Individual	Self-report	CDI
Grasso & Saunders, et al. (2013)	195	7-17	0.64	Family violence	USA	IPV	Individual	Diagnostic interview	Diagnostic interviews
Guibord & Bell, et al.	122	12-15	0.46	Maltreatment	Canada	IPV	Individual	Self-report	Assessment and Action Record
Hodes & Jagdev, et al.	78	13-18	0.33	Unaccompanied asylum seekers	UK	IPV	Collective	Self-report	DSRS

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
(2008)									
Hoven & Duarte, et al. (2005)	8236	9-21	0.52	Terrorism	USA	Non-IPV	Collective	Diagnostic interview	DISC IV
Jensen & Fjermestad, et al. (2015)	93	10-16	0.19	Unaccompanied asylum seekers	Norway	IPV	Collective	Self-report	Hopkins Symptom Checklist-37 for Adolescents Depression subscale

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
Jia & Tian, et al.(2010)	596	8-16	0.5	Earthquake	China	Non-IPV	Collective	Self-report	CDI
Jouriles & Spiller, et al. (2000)	154	8-12	0.46	Family violence	USA	IPV	Individual	Self-report	CDI
Kadak & Nasiroglu, et al. (2013)	738	13-17	0.45	Earthquake	Turkey	Non-IPV	Collective	Self-report	CDI
				Siblings with		Non-			

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
Kaplan & Kaal, et al. (2013)	125	8-17	0.5	cancer	USA	IPV	Individual	Self-report	CDI
Kaplan & Pelcovitz, et al. (1998)	99	12-18	50%	Physical abuse	USA	IPV	Individual	Diagnostic interview	CDI
Kar & Bastia (2006)	108	13-16	0.56	Cyclone	India	Non-IPV	Collective	Diagnostic interview	MINI-KID
Kar & Mohapatra, et al. (2007)	447	7-17	0.5	Cyclone	India	Non-IPV	Collective	Diagnostic interview	Psychiatric interview
Karam & Fayyad, et al.		8 -						Diagnostic	

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
(2014)	386	14	Unreported	War	Lebanon	IPV	Collective	interview	DICA-R
Klasen & Oettingen, et al. (2010)	330	11-17	0.49	Former child soldiers	Uganda	IPV	Collective	Diagnostic interview	MINI
Kolaitis & Kotsopoulos, et al. (2003)	115	9-11	0.52	Earthquake	Greece	Non-IPV	Collective	Self-report	CDI
Liu & Wang, et al. (2011)	330	8-11	0.5	Earthquake	China	Non-IPV	Collective	Self-report	TSCC A depression subscale

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
McAloney & McCrystal, et al. (2009)	3828	15-16	Unreported	Community violence	Ireland	IPV	Individual	Self-report	Short MFQ
McCrae & Chapman, et al.	553	3-14	0.74	Sexual abuse	USA	IPV	Individual	Self-report	CDI
McLeer & Dixon, et al. (1998)	230	6-16	0.81	Sexual abuse	USA	IPV	Individual	Self-report	CDI

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
Morgos & Worden, et al. (2007)	331	6-17	0.44	War	Sudan	IPV	Collective	Self-report	CDI
Olema & Catani, et al. (2014)	100	12-17	Unreported	War	Uganda	IPV	Collective	Self-report	HSC-25 depression subscale
Overbeek & de Schipper, et al. (2013)	155	6-12	0.45	Family violence	Netherlands	IPV	Individual	Self-report	CDI

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
Paul & Felton, et al (2015).	2000	12-17	0.49	Tornado	USA	Non-IPV	Collective	Diagnostic interview	NSA Depression module.
Rheingold & Zinzow, et al.	3614	12-17	0.57	Homicide of loved one	USA	IPV	Individual	Diagnostic interview	Depression Module of the NWS survey
Sabin & Zatzick, et al. (2006)	90	12-18	0.34	Physical injury	USA	Non-IPV	Individual	Diagnostic interview	CES-D

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
Say & Nur, et al.	662	4-18	0.81	Sexual abuse	Turkey	IPV	Individual	Diagnostic interview	Psychiatric interview
Smith & Perrin, et al. (2002)	2976	9-14	0.51	War	Bosnia	IPV	Collective	Self-report	DSRS
Song, & Kim, et al. (2012)	167	9-10	0.42	Witness of accidental death	South Korea	Non-IPV	Collective	Self-report	CDI
Stern & Lynch, et al. (1995)	84	5-15	0.74	Sexual abuse	Australia	IVP	Individual	Self-report	CDI
Tang & Yen,	271	12-15	0.54	Earthquake	Taiwan	Non-IPV	Collective	Diagnostic interview	TSCC Depression

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
et al. (2010)									Sub-scale
Thienkrua & Cardozo et al.	266	7-14	0.5	Tsunami	Thailand	Non-IPV	Collective	Self-report	DSRS
Tierens & Bal, et al. (2012)	3007	11-18	0.36	MVA	Belgium	Non-IPV	Individual	Self-report	TSCC Depression subscale
Wahab & Tan, et al. (2013)	51	12-20	1	Sexual abuse	Malaysia	IPV	Individual	Diagnostic interview	K-SADS

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
Wang & Fu, et al. (2012)	1841	11-20	0.51	Earthquake	China	Non-IPV	Collective	Self-report	DSRS
Weder & Zhang, et al. (2014)	94	5-14	0.58	Maltreatment	USA	IPV	Individual	Diagnostic interview	K-SADS
Ye & Fan, et al. (2014)	1573	12-14	0.54	Earthquake	China	Non-IPV	Collective	Self-report	DSRS
Yen & Yang, et al. (2008)	1684	13-18	0.51	Physical abuse	Taiwan	IPV	Individual	Self-report	Zung Depression Scale
Ying & Wu, et al. (2013)	3052	8-19	0.54	Earthquake	China	Non-IPV	Collective	Self-report	CES-D

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Authors	N	Age	Proportion Female	Trauma Type	Country	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression measure
Yonekura & Takeda, et al. (2014)	63	12-13	0.41	Earthquake	Japan	Non-IPV	Collective	Self-report	GHQ depression subscale
Zhang & Ran, et al. (2012)	548	15-18	0.57	Earthquake	China	Non-IPV	Collective	Self-report	BDI

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Table 2 RQ2a Included Studies

Authors	N	Age	Proportion Female	Trauma Type	Nature of Control Group	Country	Year	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression Measure
Allwood et al. (2002)	791	6-16	0.51	War	No violence exposure	Europe	2002	IPV	Collective	Self-report	Childhood Depression Inventory
Avanci et al. (2012)	464	6-10	0.48	IPV	No IPV exposure	Brazil	2012	IPV	Individual	Diagnostic interview	CBCL depression subscale
Bergen et al. (2003)	2603	13	0.44	Sexual abuse	Non-sexually abused	Australia	2003	IPV	Individual	Self-report	Childhood Depression Inventory
Boer et al. (2009)	779	9-14	0.52	Technological disaster	Non-exposed to technological disaster	Netherlands	2009	Non-IPV	Collective	Self-report	Short Depression Inventory for Children
Boney-McCoy et al. (1996)	1345	10-16	0.51	Assault	Non-assaulted	USA	1996	IPV	Individual	Diagnostic interview	NIMH Diagnostic Interview Schedule DISIII

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Authors	N	Age	Proportion Female	Trauma Type	Nature of Control Group	Country	Year	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression Measure
Brensilver et al. (2011)	454	9-12	0.45	Maltreatment	Non-maltreated	USA	2011	IPV	Individual	Self-report	Childhood Depression Inventory
Chen et al. (2004)	2300	16-24	0.5	Sexual abuse	Non-sexually abused	China	2004	IPV	Individual	Self-report	Center for Epidemiological Studies Depression Scale
Chen et al. (2006)	351	16-19	1	Sexual abuse	Non-sexually abused	China	2006	IPV	Individual	Self-report	Center for Epidemiological Studies Depression Scale
Ford et al. (2010)	4023	12–17	0.49	Poly-victimisation	Non-exposed	USA	2010	Non-IPV	Individual	Diagnostic interview	NSA MDD module

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Authors	N	Age	Proportion Female	Trauma Type	Nature of Control Group	Country	Year	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression Measure
Giannopoulou et al. (2006)	2037	9-17	0.52	Earthquake	Non-exposed to earthquake	Greece	2006	Non-IPV	Collective	Self-report	Depression Self Rating Scale
Goenjian et al. (1995)	218	12-14	0.62	Earthquake	Greater distance from epicentre	Armenia	1995	Non-IPV	Collective	Self-report	Depression Self Rating Scale
Goenjian et al. (2005)	125	15-17	0.59	Earthquake	Greater distance from epicentre	Armenia	2005	Non-IPV	Collective	Self-report	Depression Self Rating Scale
Hoven & Duarte et al. (2005)	5396	9-21	0.52	Terrorism	Non-direct exposure to terrorism	USA	2005	Non-IPV	Collective	Diagnostic interview	DISC Predictive Scales
Jabbar et al. (2014)	360	7-12	0.51	War	Living farther distance from war zone	Syria	2014	Non-IPV	Collective	Self-report	Hopkins Symptom Checklist-25

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Authors	N	Age	Proportion Female	Trauma Type	Nature of Control Group	Country	Year	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression Measure
Kaplan et al. (1998)	198	12-18	0.75	Physical abuse	Non-physically abused	USA	1998	IPV	Individual	Diagnostic interview	K-SADS-E
Kolaitis et al. (2003)	115	9-11	0.52	Earthquake	Non-exposed to earthquake	Greece	2003	Non-IPV	Collective	Self-report	Childhood Depression Inventory
Lynch et al. (1998)	322	7-12	0.27	Maltreatment & Community violence	Non-maltreated	USA	1998	IPV	Individual	Self-report	Childhood Depression Inventory
McAloney et al. (2009)	3828	14-17	Unreported	Community violence	No violence exposure	N Ireland	2009	IPV	Individual	Self-report	Short Mood and Feelings Questionnaire
McLeer et al. (1998)	230	6-16	0.81	Sexual abuse	Non-sexually abused	USA	1998	IPV	Individual	Self-report	Childhood Depression Inventory
Mitchell et al. (2007)	1501	10-17	0.47	Assault	Witnessed assault	USA	2007	IPV	Individual	Self-report	Questionnaire based on DSM IV TR MDD diagnosis

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Authors	N	Age	Proportion Female	Trauma Type	Nature of Control Group	Country	Year	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression Measure
Olema et al. (2014)	100	12-17	Unreported	Abducted during war	War exposed and non-abducted	Uganda	2014	IPV	Individual	Self-report	Hopkins Symptom Checklist-25
Rheingold et al. (2012)	3614	12-17	0.57	Homicide survivor	Non-exposed to homicide	USA	2012	IPV	Individual	Diagnostic interview	Depression module of NWS survey
Rollocks et al. (2013)	420	10-15	0.46	Varied	0-1 traumas experienced	Trinidad	2013	Non-IPV	Individual	Self-report	Trauma Symptoms Checklist for Children depression module
Slopen et al. (2012)	1594	9-15	0.5	Violence	Low-violence exposure	USA	2012	IPV	Individual	Diagnostic interview	DISC IV Youth

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Authors	N	Age	Proportion Female	Trauma Type	Nature of Control Group	Country	Year	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression Measure
Stern et al. (1995)	84	5-15	0.74	Sexual abuse	Non-sexually abused	Australia	1995	IPV	Individual	Self-report	Childhood Depression Inventory
Tierens et al. (2012)	3007	11-18	0.47	Motor vehicle accident	MVA with no injury	Belgium	2012	Non-IPV	Individual	Self-report	Trauma Symptoms Checklist for Children depression module
Vigil et al. (2008)	81	12-17	0.73	Hurricane	Non-exposed to hurricane	USA	2008	Non-IPV	Collective	Self-report	Center for Epidemiological Studies Depression Scale
Wang et al. (2012)	1841	11-20	0.51	Earthquake	Less objective earthquake exposure	China	2012	Non-IPV	Collective	Self-report	Depression Self Rating Scale

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Authors	N	Age	Proportion Female	Trauma Type	Nature of Control Group	Country	Year	IPV or non-IPV	Collective or Individual Trauma	Type of Report	Depression Measure
Weder et al. (2014)	190	5-14	0.58	Maltreatment	Non-maltreated	USA	2014	IPV	Individual	Diagnostic interview	K-SADS PL
Yen et al. (2008)	1684	13-18	0.51	Physical abuse	Non-physically abused	Taiwan	2008	IPV	Individual	Self-report	Zung Depression Scale

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Table 3: RQ2b Included Studies

Authors	Year	Age	*n,* Trauma-Exposed Group	*n,* Non-trauma or Less Exposed Comparison Group	% Female	Trauma Type	Country
Boer & Smit, et al.	2009	9-14	264	515	52%	Technological disaster	Netherlands
Boney-McCoy & Finkelhor	1996	10-16	282	1063	51%	Assault	USA
Brent & Melhem, et al.	2009	7-25	176	168	48%	Sudden death of parent	USA
Ford & Elhai, et al.	2010	12–17	3350	672	49%	Poly-victimisation	USA
Hoven & Duarte et al.	2005	9-21	2650	2746	73%	Hurricane	USA
Kaplan & Pelcovitz, et al.	1998	12-18	99	99	50%	Physical abuse	USA
McAloney & McCrystal, et al.	2009	14-17	2948	880	Unreported	Community violence	N Ireland
Mitchell & Ybarra, et al.	2007	10-17	unreported	unreported	47%	Assault	USA

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Authors	Year	Age	*n,* Trauma-Exposed Group	*n,* Non-trauma or Less Exposed Comparison Group	% Female	Trauma Type	Country
Slopen & Fitzmaurice, et al.	2012	9-15	117	1477	50%	Violence	USA
Williams & Rheingold, et al.	2015	12-17	207	1643	50%	Motor vehicle accidents	USA
Yen & Yang, et al.	2008	13-18	374	1310	51%	Physical abuse	Taiwan

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