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Review Article

Risk factors for depression in trauma-exposed children and adolescents: A systematic review and meta-analysis

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ABSTRACT

Background: While Post Traumatic Stress Disorder (PTSD) has been the most frequently studied sequela in the aftermath of trauma, post-traumatic depression is at least as prevalent, if not more so. The impacts of depression are wide-ranging, deleterious and potentially long-term. Understanding the risk factors for post-traumatic depression in children and adolescents is therefore critical. The present systematic review and meta-analysis considered this question.

Method: Three databases (Medline, PsycINFO, and Published International Literature on Traumatic Stress [PILOTS]) were searched for pertinent studies.

Results: Fifty-seven studies ($N = 45{,}981$) allowed for the derivation of pooled effect sizes for 12 risk factors, contributing 145 effect sizes. All effect sizes were statistically significant. Negligible to small effect sizes were largely found for pre-trauma variables (age [r=0.09], gender [r=0.16], low family income [r=0.16] and prior trauma exposure [r=0.16) and trauma-related risk factors (trauma severity [r=0.20], peri-traumatic distress [r=0.24] and direct exposure [r=0.07]). Small to large effect sizes were found for post-trauma variables (comorbid PTSD symptoms [r=0.58], avoidant coping [r=0.26], low social support [r=0.29] and maternal depression [r=0.20]) and bereavement (r=0.29).

Limitations: Risk factor effect size estimates were characterised by significant heterogeneity, and several effect sizes were based on only a few studies (e.g. income, maternal depression).

Conclusions: These findings suggest that the post-traumatic responses and environments of children and adolescents may be prominent risk factors for the emergence or maintenance of post-traumatic depression in children and adolescents. This highlights potential targets for assessment and monitoring those most at risk and may also inform treatment.

1. Introduction

The association between childhood exposure to traumatic events and wide-ranging impairments is widely acknowledged in the literature (e.g. Fairbank and Fairbank, 2009). Indeed, research suggests that the developmental timing of trauma exposure identifies childhood and adolescence as particularly vulnerable to chronic biopsychosocial impairments (Ogle et al., 2013; Lupien et al., 2009). For example, Copeland et al. (2007) found that children exposed to trauma had twice the likelihood of having a psychiatric diagnosis compared to non-exposed children. The most studied post-trauma condition has been post-traumatic stress disorder (PTSD). However, a meta-analysis conducted by Rytwinski et al. (N.K. 2013) found the rate of comorbid depression in adults to be 52%. Indeed, findings in children show post-traumatic depression (PTD) to be as prevalent as PTSD, if not more so (e.g. Karam et al., 2014; Ying et al., 2013). A recent systematic review of trauma-exposed children and young people (CYP) estimated the prevalence of depression to be 24.2% (95% CI 20.6–28.0), with the odds of trauma-exposed CYP having depression relative to non-exposed or less exposed CYP estimated to be 2.6 (95% CI 2.0–3.3; Vibhakar et al., 2019).

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1.1. Post-traumatic depression in children and adolescents

The World Health Organization (WHO, 2014) found depression to be the most prevalent cause of illness and disability in CYP. While the symptoms of depression are debilitating in themselves, they are also linked to a range of poorer outcomes that can persist into adulthood. These include substance misuse (Siennick et al., 2017), cognitive deficits (Wagner et al., 2015), academic and social functioning, mental and physical health problems, and suicidality (Maughan et al., 2013). These outcomes highlight the public health concern of depression in CYP, and the necessity of effective identification and early-intervention (Avenevoli et al., 2015; Lawrence et al., 2016). Additionally, consideration must be made of the impact of comorbid depression symptoms on treatment, which has been related to non-response and dropout in interventions for PTSD (Zayfert et al., 2005; Kar, 2011).

Prevalence rates of depression following trauma appear heterogeneous. For example, a meta-analysis by Tang et al. (2014) found a prevalence range of 7.5–44.8% in children exposed to natural disasters. Rates may vary according to the type and severity of trauma experienced as well as methodological issues. Nevertheless, these prevalence rates highlight that not everyone exposed to traumatic events develops depression. A recent, worldwide adult population study in 24 countries ($N = 68,984$) found a 70% reported lifetime exposure to at least one traumatic event (Benjet et al., 2016). Similar rates of trauma exposure (67.5%) were found in a longitudinal study of children (Copeland et al., 2007). Together these findings demonstrate that although exposure to traumatic events is a common part of childhood and adolescence, many CYP do not develop depressive disorders. Therefore, ascertaining the risk factors for the development of depression following traumatic exposure is important to enable identification of those most at risk. Understanding these risk factors could inform the development of suitable interventions for post-traumatic depression. This is of importance when existing trauma-focused therapies primarily address symptoms of PTSD, with only modest effects on depression symptoms (Morina et al., 2016, 2017).

1.2. Risk factors

In an effort to conceptualise risk factors for post-traumatic psychopathology, Sayed et al. (2015) identified three categories related to traumatic exposure: pre-trauma, peri-trauma and post-trauma risk factors. Pre-trauma risk factors are those that predate the traumatic event, e.g. demographic factors such as age, gender, socio-economic status, or predisposing factors such as prior exposure. Peri-trauma risk factors refer to the objective and subjective characteristics related to the trauma itself, such as trauma severity, whether the trauma was direct or indirect (witnessed/occurred to a close family member or friend) and perceived threat. Post-trauma risk factors encompass the biological, psychological and environmental aspects following the traumatic event. This may include coping skills, the environment around the child (e.g. parental distress, family functioning and social support) and the experience of other mental health difficulties (e.g. PTSD). The risk factors for depression in the present meta-analysis will be explored in line with this conceptualisation. This is consistent with other meta-analyses examining risk factors for post-traumatic psychopathology in CYP (e.g. Trickey et al., 2012).

1.3. Rationale for the present study

The identification of risk factors for the development of depression in CYP following traumatic exposure will help to improve the monitoring and treatment necessary to prevent potential long-term impairment. The only meta-analysis, to our knowledge, that has attempted to synthesise the literature around risk factors for post-traumatic depression in CYP focused exclusively on those exposed to natural disasters (Tang et al., 2014), identifying relatively few studies (11 studies investigating risk factors for depression in trauma-exposed children). Therefore the present study will attempt to further our understanding of the risk factors across the full range of trauma types. This review was undertaken as a part of a wider project that addressed aspects of post-traumatic depression in children and young people; an earlier paper from the same project considered the prevalence of post-traumatic depression (Vibhakar et al., 2019). Within the PTSD literature, a similar meta-analysis was undertaken by Trickey et al. (2012), looking at the risk factors for PTSD in trauma-exposed CYPs. In consideration of the high level of comorbidity highlighted between PTSD and depression, it may be of further interest to compare our findings.

2. Method

2.1. Pre-registration

The protocol for this review was pre-registered on PROSPERO (CRD42016042065; date of registration, 29th June 2016).

2.2. Selection of studies

This meta-analysis was undertaken as part of a wider research project addressing research questions relating to post-traumatic depression in CYP; the first review stemming from this project addressed prevalence (Vibhakar et al., 2019), while the present review focused on risk factors for depression in trauma-exposed CYP. Broad database searches of Medline, PsycINFO and PILOTS (Published International Literature on Traumatic Stress) were undertaken to identify relevant English and French language (researchers spoken languages) peer-reviewed articles between 1994 (with the introduction of DSM-IV) and 15th June 2016 for all research questions. Articles were selected where the search terms (depress* OR dysthym* OR dysphor*) AND (child* OR teen* OR adolescen* OR youth* or young person*) AND (trauma* OR post-trauma* OR Stress*) OR (disaster OR hurricane OR flood OR tsunami OR earthquake OR violence OR abuse OR maltreatment) was identified in the title, abstract or keywords. The reference section of a key review paper (Montgomery, 2011), yielded through the keyword search, was also reviewed. This literature search identified 3967 articles after duplicates (1398) were removed. Article titles and abstracts were then screened against defined inclusion and exclusion criteria by two researchers, resulting in a shortlist of 647 articles for full text review and coding to each research question. Two researchers undertook the full text reviews for inter-rater agreement and consensus was reached with a third researcher where necessary. A shortlist of 83 articles was then subject to a further full text review by the primary researcher of the present study in line with the inclusion and exclusion criteria resulting in 59 articles for inclusion (see Fig. 1 for PRISMA diagram). A full list of the included articles is presented in Supplementary Material 1.

2.3. Inclusion and exclusion criteria

To be included for review the main (trauma-exposed) sample must have been exposed to a stressor that meets A1 criteria for PTSD, (DSM-IV or DSM-5). Therefore other experiences that did not meet A1 criteria, such as bullying/peer victimization (unless explicit physical assault), emotional/verbal abuse only and neglect only, were excluded.

Included samples were required to be within the age range of 5–18 years. This age range was selected to promote maximum inclusion for school-aged children. Where the upper limit of this range was breached, a consensus was reached to include the study if the average age fell within the age range; eight studies breaching the upper limit were included in the present study.

Studies must have assessed depression using a standardized and validated measure. Reliability was demonstrated through peer-reviewed publication of adequate psychometric properties (minimum Cronbach's alpha ≥ 0.70); where established measures were minimally adapted for a study (e.g. translation), the minimum internal consistency must have been reported within the paper. Finally, studies must have investigated

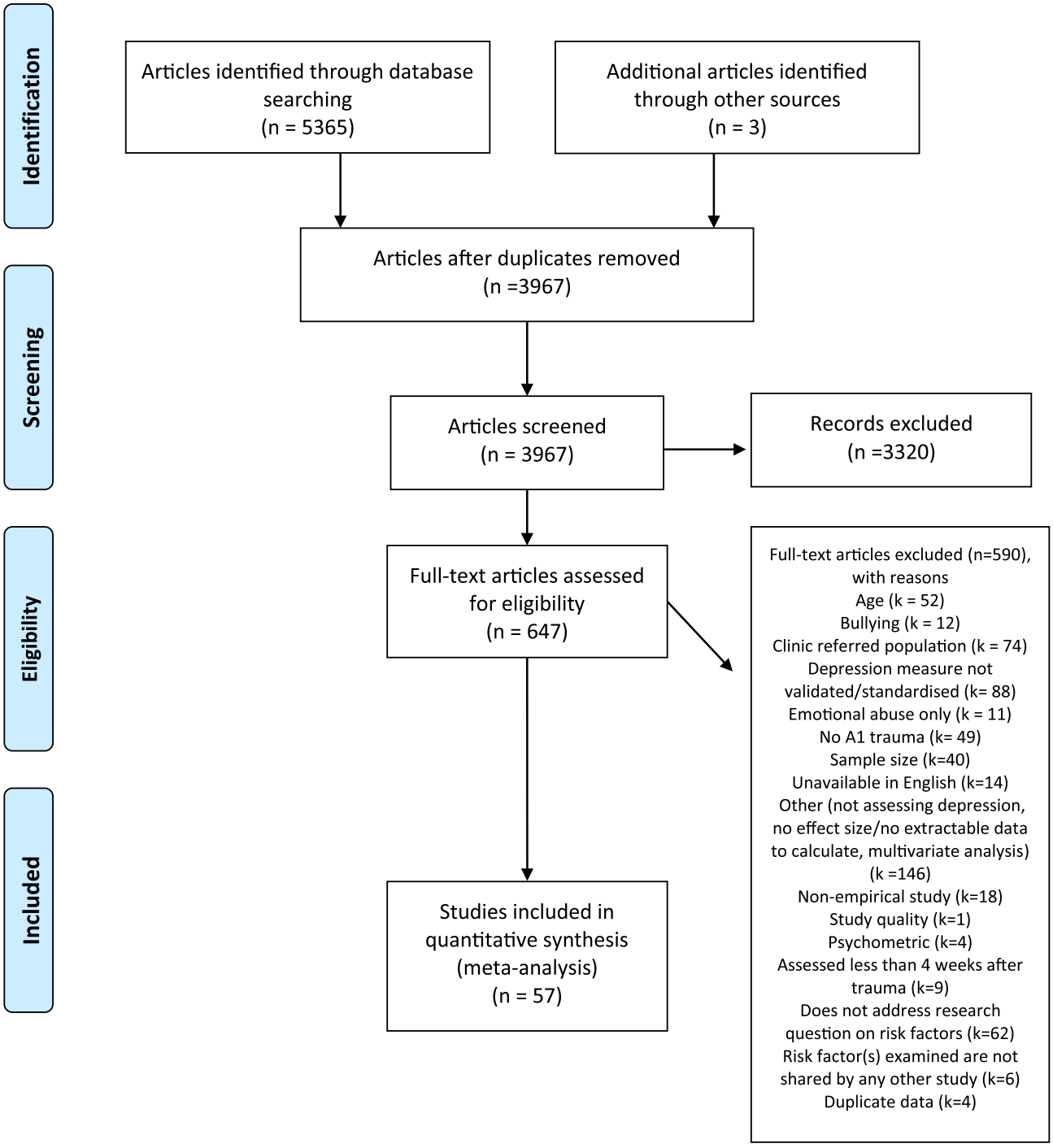

Fig. 1. PRISMA Flow Diagram of included and excluded studies.

at least one risk factor for depression in the trauma-exposed sample (any variable potentially contributing to the severity of depression symptoms or the presence of depression as defined by DSM IV or DSM 5 diagnostic criteria).

Studies were excluded on the following criteria:

1) Sample size of $N<50$. Caution is advised in the risk of biased estimates from small sample studies in meta-analysis (Harrison, 2011), particularly in random effects models (Morris, 2000). Furthermore, Cohen's (1988) guidelines also suggest a minimum sample size of 50 in a single study to obtain a moderate effect size.
2) The study measured an acute trauma response (i.e. < 1 month post-trauma.).
3) The study had insufficient data to allow for the calculation of an effect size.
4) The study was primarily psychometric in nature.
5) The sample was a treated population OR the sample had been screened based on inclusion for mental health disorders (e.g. intervention studies).
6) Insufficient data was provided to ascertain group membership (exposed vs not-exposed) where risk correlations were not based on a 100% exposed sample.

7) The study reported a single risk factor, which was not also investigated by another article.

2.4. Coding of studies

Data was extracted and imputed into a standardised form and checked by a second researcher. Extracted data included effect sizes for all reported study risk factors and additional information on study characteristics. This included sample demographics, response rates, country of study, trauma type, depression measure, and duration between traumatic event and measurement of depression. Key study characteristics on the included articles can be found in Table 1.

Where an article reported a finding as non-significant but provided no effect size, this was recorded as 0. While conservative, this approach is recommended over exclusion, which can result in the over-estimation of effect size (Rosenthal, 1995). Where an article reported multiple effect sizes for a risk factor, the mean was calculated using Fisher transformed values then back-transformed. Only effect sizes with single degrees of freedom were deemed suitable for extraction e.g. results from multiple regression models were excluded. Duplicate samples were included as long as the same risk factor was not studied. Where this did occur, to avoid the risk of bias in the analysis, we used the effect size from a) the largest sample, or if samples were similar b) the study with the most risk factors investigated. Finally, where a study was longitudinal in nature, data from the first time point was extracted (but no earlier than four weeks post-trauma).

2.5. Deriving effect sizes

The common effect size mode of *r* was selected for several reasons. First, many of the studies included in the meta-analysis had undertaken risk factor correlations already reported in *r*, thus reducing the amount of computation required. Second, *r* can be derived from d, t, F, odds ratio, and chi-square statistics, allowing computation of a wide range of raw data. Calculations were based on Borenstein et al. (2009), Rosenthal (1994) and Cohen (1988). Finally, *r* is widely recognised and easily interpretable as an effect size. For categorical data, effect sizes were computed so that the theoretical risk group was a positive coefficient i.e. female gender, diagnosis of PTSD. Where an article had included a control group or mixed groups in the effect size, we derived an effect size from the raw, unmixed data. Where this was not possible, the effect size was excluded.

2.6. Meta-analysis

Quantitative syntheses were carried out using MAVIS Version 1.1.3 (http://kylehamilton.net/shiny/MAVIS/) which uses the metafor package in R (Viechtbauer, 2010). A random effects model was used for each meta-analysis. Meta-analyses were carried out for each risk factor separately, with any risk factor that had a single effect size excluded, resulting in 14 excluded risk factors (e.g. community acceptance, shame, only child, parenting effectiveness, emotional regulation difficulties, time of disclosure, post-traumatic change, attributions, negative appraisals).

The potential moderating influences of different factors on effect sizes were considered. Moderator analyses are tests of interaction and as such have lower power than main analyses in detecting effects. Therefore, consideration of factors pertaining to the power of moderator analyses including participant numbers, expected effect sizes, variability and particularly for random effects models, study numbers, is important (see e.g. Hedges and Pigott, 2004; Thompson and Higgins, 2002; Borenstein et al., 2009). Consequently, in a bid to increase detection power of putative moderating variables, in line with Hempel et al. (S. 2013) we limited our moderator analysis to risk factor meta-analyses with 20 or more studies. The following variables were considered as possible moderators of overall effect sizes: i) continuous vs categorical measurement of PTSD (shown to be a moderator in previous meta-analyses; Brewin et al., 2000, Ozer et al., 2003); and ii) trauma type, i.e. collective vs individual, and intended vs unintended (based on the findings from Trickey et al., 2012).

Heterogeneity was examined using Cochrane's Q and I^2 statistics (Higgins et al., 2003).

2.7. Quality assessment

The quality of included studies was assessed. A brief four-item checklist, feasible and relevant to our study design, was created. Items were derived from the Agency for Healthcare Research and Quality (AHRQ) Methodology Checklist suitable for cross-sectional studies and the NICE Quality Appraisal Checklist for quantitative studies reporting correlations and associations (National Institute for Clinical Excellence, 2012).

Four criterion items were created from the two checklists in line with the Sanderson et al. (2007) recommendations of key criteria around participant selection, measurement of variables and control of confounding variables (see Supplementary Material 2). A score of 0, 1 or 2 points could be awarded to each item. One researcher carried out the quality assessment and a sample of 15% of the total studies was checked for rating reliability (94.4% inter-rater agreement, $\varkappa$=88.97%). An overall score of five or greater (out of eight) was agreed upon as a standard for studies that met the NICE checklist's overall rating of *"All or most of the checklist criteria have been fulfilled, where they have not been fulfilled the conclusions are very unlikely to alter"*. A sensitivity analysis was undertaken to see if removing low quality studies affected the pattern of results.

2.8. Publication bias

In line with guidance on assessing publication bias (Borenstein et al., 2009), funnel plots were investigated for risk factors with 10 studies or more to ensure adequate detection power (Macaskill et al., 2001). We also calculated funnel plot asymmetry statistics for each plot (Egger et al., 1997).

3. Results

3.1. Main analyses of risk factors

Fifty-nine articles were included in the meta-analysis, generating a comprised sample size of 45,981, comprising 145 effect sizes across 12 risk factors. Meta-analyses were undertaken for each examined risk factor. The risk factors that could extracted from each study are presented in Supplementary Material 3. Meta-analyses included between 3 and 34 studies, with study sample sizes ranging from 53 to 8236. Table 2 summarises the main results for each risk factor, including effect sizes, number of studies, combined sample size, and 95% confidence intervals. A forest plot of the overall effect sizes for each risk factor can be seen in Fig. 2. Negligible (i.e. $r<0.1$) or small but significant effects were found for pre-trauma demographic factors: female gender ($r = 0.16$), low family income ($r = 0.16$) and older age ($r = 0.09$). A small effect size was also found for prior trauma exposure ($r = 0.16$). Peri-traumatic risk factors showed small but significant effect sizes for trauma severity ($r = 0.20$) and peri-traumatic distress ($r = 0.24$). A significant small effect size was found for bereavement ($r = 0.29$) although this meta-analysis comprised just five studies. The effect size found for direct (over indirect) exposure was trivial ($r = 0.07$).

Meta-analyses on post-trauma risk factors revealed significant, small effect sizes for maternal depression ($r = 0.20$), avoidant coping ($r = 0.26$), and low social support ($r = 0.29$). A significant and large ef-

Table 1
Characteristics of studies included in the meta-analysis.

Article	Trauma type	Sample size	Depression measure	Age range	Mean Age (SD)	Female (%)	Country
Banks et al., 2014	Hurricane	1098	RCADS	7–18	13.51 (2.44)	53	USA
Berthold, 2000	War	144	CES-DC	14–20	16.35 (1.31)	50	Cambodia
Betancourt et al., 2011	War	273	HSCL-25	NR	16.55 (2.61)	29	Sierra Leone
Bokszczanin, 2002	Flood	335	CES-DC	11–20	NR	72	Poland
Brensilver et al., 2011	Maltreatment	454	CDI	9–12	10.48(1.15)	50	USA
Brent et al., 2009	Sudden death of parent	344	MFQ	7–25	9.0	42	USA
Brown & Goodman, 2005	Terrorist attack	83	BASC	8–18	M-12.8 (2.9)	41	USA
Cénat & Derivois, 2015	Earthquake	872	CDI	7–17	14.91 (1.94)	56	Haiti
Collin-Vézina, 2011	Maltreatment	53	TSCC	14–17	15.5 (1.1)	45	Canada
Dass-Brailsford et al., 2015	Earthquake	59	CES-DC	9–10	10.7 (NR)	71	Haiti
Elbedour et al., 2007	War	229	BDI	15–19	17.13 (1.51)	48	Gaza
Fan et al., 2011	Earthquake	2081	DSRS	Grades 7–10	14.6 (1.3)	54	China
Feiring et al., 1999	Sexual abuse	169	CDI	8–15	NR	72	USA
Flett et al., 2012	Sexual abuse	58	CES-D	NR	15.3	43	Canada
Giannopoulou et al., 2006	Earthquake	2037	DSRS	9–17	12.85 (2.4)	52	Greece
Goenjian et al., 1995	Earthquake	218	DSRS	NR	12.99	62	Europe
Goenjian et al., 2011	Earthquake	511	DSRS	13–18	15.6 (1.7)	58	Greece
Graham-Bermann et al., 2009	IPV	219	CDI	6–12	8.49 (2.16)	50	USA
Guibord et al., 2011	Maltreatment	122	AAR-C2	12–15	13.75 (1.15)	46	Canada
Hanson et al., 2008	IPV	3906	NSW-DM	12–17	14.49 (1.70)	49	USA
Henrich & Shahar, 2013	War	362	CES-D	12–16	14 (median)	54	Israel
Hodes et al., 2008	Refugee	112	DSRS	13–18	17 (median)	33	UK
Hoven et al. 2005	Terrorist attack	8236	DISC-IV	9–21	NR	52	USA
Jensen et al., 2015	Refugee	93	HSCL-37	10–16	13.8 (1.4)	19	Norway
Jia et al., 2013	Earthquake	596	CDI	8–16	11.5 (2.1)	50	China
Jouriles et al., 2000	IPV	154	CDI	8–12	9.44 (1.39)	46	USA
Kadak et al., 2013	Earthquake	738	CDI	13–17	16.22 (0.88)	45	Turkey
Kaplan et al., 2013	Serious illness	125	CDI	8–17	12.4 (2.9)	50	USA
Kar & Bastia, 2006	Cyclone	108	MINI-KID	NR	14.3 (0.7)	56	India
Karakaya et al., 2006	Terrorist attack	113	CDI	12–14	12.8 (7.06)	41	Turkey
Khamis, 2008	War	179	BDI	12–18	16.3 (1.64)	0	Palestine
Kiliç et al., 2011	Earthquake	104	TSCC	8–15	12.1 (2.1)	59	Turkey
Kolaitis et al., 2003	Earthquake	163	CDI	NR	11.03 (1.03)	52	Greece
Lai et al., 2014	War exposure	151	CDI	9–12	10.62	51	Kuwait
Lehmann, 1997	IPV	84	CDI	9–15	11.0	43	USA
Morgos et al., 2007	War	331	CDI	6–17	12.0 (2.3)	44	Sudan
Nugent et al., 2006	Injury	82	RCADS/RADS	8–18	13.21 (2.94)	32	USA
Olema et al., 2014	War	100	HSCL-25	12–17	14.6 (1.5)	NR	Uganda
Papageorgiou et al., 2000	War	95	DSRS	8–13	9.6	57	Bosnia
Paul et al., 2015	Tornado	2000	NSA-DM	NR	14.56 (1.75)	49	USA
Rollocks et al., 2013	Mixed	420	TSCC	10–15	NR	46	Trinidad
Runyon & Kenny, 2002	Maltreatment	98	CDI	8–17	12.09 (2.84)	60	USA
Salloum et al. 2011	Hurricane	122	MFQ	7–12	9.48 (1.51)	43	USA
Simon et al., 2015	Sexual abuse	160	CDI	8–16	11.36 (2.23)	73	USA
Smith et al. 2001	War	339	DRSR	9–14	NR	NR	Bosnia
Smith et al., 2002	War	2976	DSRS	9–14	12.11 (1.69)	51	Bosnia
Tebbutt et al., 1997	Sexual abuse	68	CDI	9–21	15.1 (3.2)	77	Australia
Thabet et al., 2004	War	403	MFQ	9–15	9–15	53	Palestine
Tierens et al., 2012	MVA	3007	YSR	11–18	14.62 (1.83)	47	Belgium
Udwin et al., 2000	Shipping disaster	217	DSRS	11–18	14.7 (1.14)	74	UK
Wang et al., 2012	Earthquake	1841	DSRS	11–20	14.26 (1.2)	51	China
Warheit et al., 1996	Hurricane	4978	CES-DC	NR	NR	10	USA
Wolfe et al., 1994	Sexual abuse	90	CDI	6–16	12.4	77	Canada
Yang et al., 2011	Earthquake	271	DASS-21	12–15	13.4 (1.0)	54	Taiwan
Ying et al., 2012	Earthquake	200	CES-DC	13–16	15.0	62	China
Ying et al., 2013	Earthquake	3052	CES-DC	8–19	13.31 (2.27)	54	China
Zhang et al., 2012	Earthquake	548	BDI	15–18	16.86 (0.58)	57	China

Note: AAR = Assessment and Actions Records, BASC= behaviour Assessment System for Children (depression subscale) BDI = Beck Depression Inventory, CDI = Child Depression Inventory (depression subscale), CES-*D* = The centre for Epidemiological Studies Depression Scale, CES-DC = The centre for Epidemiological Studies Depression Scale for Children, DASS-21 = Depression and Anxiety Stress Scale (depression subscale), DISC-IV = The Diagnostic Interview Schedule for Children, DSRS = Depression Self Report Scale, HSCL= Hopkins Symptom Checklist IPV= Interpersonal Violence, MINI-KID = Mini International Neuropsychiatric Interview for Children and Adolescents, MFQ= Mood and Feeling Questionnaire, MVA = Motor Vehicle Accident, NSA-DM = NSA Depression Module, NSW-DM= National Study of Women Depression Module, RCADS = The Revised Child Anxiety and Depression Scale, RCDS = Reynold's Child Depression Scale, RADS = Reynold's Adolescent Depression Scale, TSCC = Trauma Symptom Checklist for Children (depression subscale), YSR = Youth Self Report (depression subscale). NR = Not reported.

fect size was found for the presence of PTSD symptoms ($r = 0.58$), which appears robust with 25 studies. It is important to note that several of our meta-analyses were based on small study numbers, however the comprised sample sizes for each meta-analysis were generally noteworthy, with a range of 703 to 37,394.

3.2. Heterogeneity

Cochrane's Q statistics were significant (i.e. no evidence for heterogeneity) for all risk factors except low family income and maternal depression. I^2 statistics showed a medium to large degree of heterogeneity

Table 2
Summarised individual meta-analyses of risk factors.

Risk factor	k	*N*	Pooled effect (*r*)	95% confidence intervals		τ^2	z	I^2(%)
				Lower	Upper			
Pre-trauma factors								
Female gender	34	37,394	.16	.12	.21	0.015	7.10*	93.8
Older age	28	27,452	.09	.04	.13	0.012	3.68*	91.2
Low family income	3	2398	.16	.12	.20	0.000	7.72*	0.0
Prior trauma exposure	11	7047	.16	.10	.21	0.004	6.21*	66.9
Peri-trauma factors								
Direct exposure	4	7399	.07	.01	.12	0.002	2.45*	78.2
Trauma severity	12	10,313	.20	.17	.24	0.002	10.52*	64.3
Bereavement	5	3484	.29	.15	.43	0.027	3.84*	93.8
Peri-traumatic distress	5	5189	.24	.17	.30	0.005	6.68*	80.6
Post-trauma factors								
PTSD symptoms	25	18,009	.58	.50	.66	0.081	11.40*	98.2
Avoidant coping	5	3710	.26	.12	.39	0.023	3.55*	86.8
Low social support	9	12,220	.29	.22	.36	0.011	7.72*	92.3
Maternal depression	4	703	.20	.13	.27	0.000	5.26*	0.0

Note. *k*= number of studies, *N*= sample size, *z*= test of effect size. * $p<.001$.

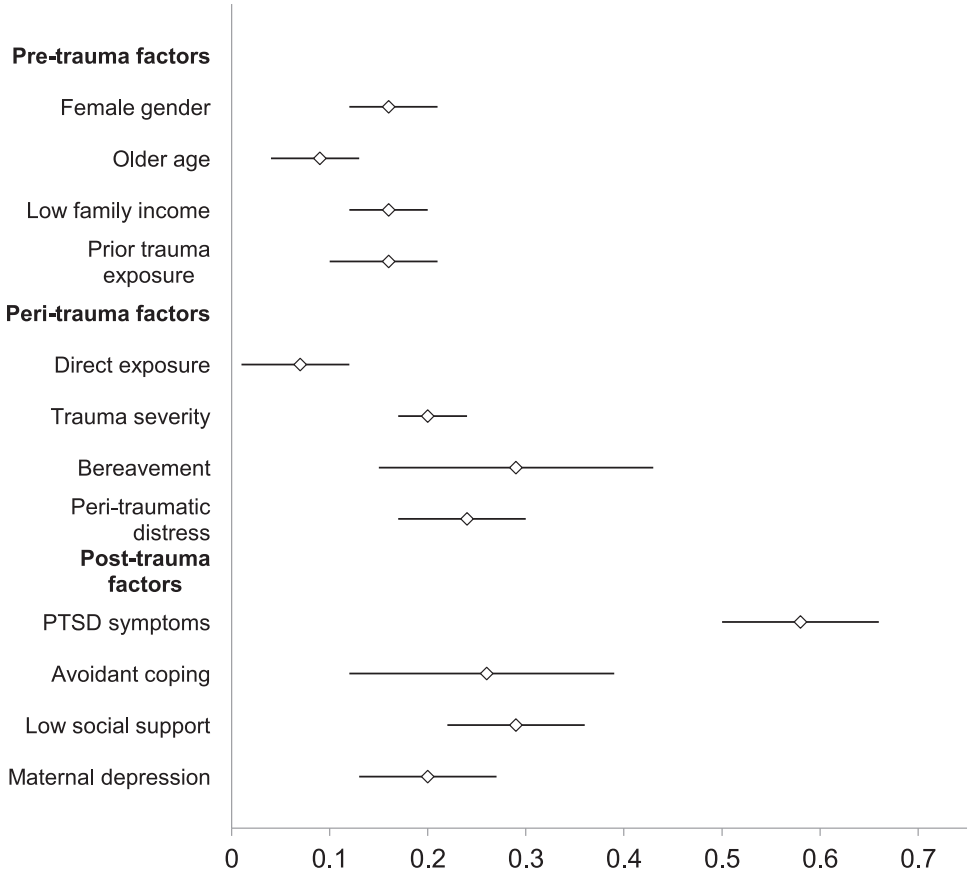

Fig. 2. Forest plot of all risk factors with overall effect size and 95% confidence intervals.

for all meta-analyses apart from low family income and maternal depression.

3.3. Publication bias

Inspection of funnel plots and their corresponding asymmetry tests, revealed only one instance (age) where there may be some evidence of publication bias. However, in this case the plot suggested that there were missing studies with larger effect sizes, rather than smaller studies, i.e. if anything our observed estimate may be an underestimate of the true effect.

3.4. Moderator analyses

Moderator analyses were run for being female, being older and PTSD symptoms (i.e. the only variables to be considered in at least 20 studies); the putative moderator variables weretrauma type (collective vs individual, intended vs unintended) and continuous vs categorical measurement of PTSD. The only significant moderating effect found was for continuous vs categorical measurement of PTSD, where a significantly lower effect size for measures of categorical PTSD ($r = 0.36$, 95% CI 0.09, 0.58; $k = 3$) compared to continuous measures ($r = 0.58$, 95% CI 0.51, 0.65; $k = 21$; moderation effect, $p<.04$).

3.5. Quality assessment and sensitivity analysis

Our study quality assessment found that five studies had low quality, i.e. high risk of bias (see Supplementary Table 1). In order to see whether low quality studies had a disproportionate effect on our results, sensitivity analyses were run where all effect sizes were recalculated, excluding the five low quality studies. No effect size changed more than 0.0073.

3.6. Post-hoc analyses of gender and age

Given the significant, albeit small, effects detected for gender and age, and the relative frequency with which these variables were considered, we undertook further analysis of these factors. In particular, we considered whether these variables were also associated with different prevalence rates for depression (i.e. either a diagnosis derived from a structured interview or scoring above cut-off on a questionnaire).

We reported overall prevalence findings in our included studies in our previous article from this review (Vibhakar et al., 2019). We considered the issue of whether there were differences between boys and girls in those studies where data for groups were available; we previously reported that there was a significantly greater risk of having post-traumatic depression in girls. For those studies where prevalence data for girls was reported, the pooled prevalence estimate was 30.1% (k = 11; 95% CI 20.9–40.3%), while for boys the estimate was 20.8% (k = 10; 95% CI 14.7–27.6%).

With respect to age, individual participant data was not available to produce prevalence estimates for different age ranges, e.g. by quartile. However, it was possible to identify two groups of studies such that prevalence estimates for younger versus older studies could be derived. For the seven with age range less than 13, an estimate of 24.9% (95% CI 9.5–44.8%) was derived; for the 10 studies with an age range that included youth aged 13 or older, an estimate of 32.9% (95% CI 22.5–44.3%) was derived.

4. Discussion

This paper presents a meta-analysis of 12 risk factors for depression in trauma-exposed children and adolescents from 59 studies published between 1994 and 2016. Our findings revealed all 12 risk factors investigated to be significant predictors for depression, with effect sizes ranging from negligible (r = 0.07) to large (r = 0.58). Pre and peri-trauma risk factors tended to negligible/small effect sizes, whereas post-trauma risk factors were generally small to large. The most notable effect sizes were found for the presence of PTSD symptoms (r = 0.58), low social support (r = 0.29), trauma-related bereavement (r = 0.29) and avoidant coping (r = 0.26). It is important to note that most effect sizes were characterised by a medium to large degree of heterogeneity.

4.1. Pre-trauma factors

A consistent and substantial rise in the prevalence of depression in adolescence is recognised (for reviews see Hankin, 2015; Costello et al., 2011). Across 28 studies we found older age to be a consistent and significant, albeit weak, predictor of depression following trauma-exposure. This association was supported when we considered a subset of studies that could be clearly demarcated as older or younger studies, where we found a slightly higher prevalence estimate in the older youth. Similarly, our finding across 34 studies of a small effect size for being female is in line with the wider depression literature (e.g. Cyranowski et al., 2000; Hankin and Abramson, 2001). When considering absolute prevalence estimates for the subset of studies where data were reported by gender, being female was associated with a greater risk than of having depression; if anything the effect was more marked than that suggested by the pooled correlation coefficient estimate.

Our finding of a small effect size for low family income is consistent with earlier findings which posited that low income may be linked to depression through increased trauma-exposure (Finkelhor et al., 2005). However, with only three studies addressing this variable in our review, this finding warrants further investigation.

We found a small effect size for prior trauma exposure in the 11 included studies, consistent with Tang and colleagues (2014). Whilst much research attention has been paid to specific single traumatic events, epidemiological studies have linked multiple traumas to increased mental health symptoms (e.g. Copeland et al., 2007), which is in line with our findings, although the effect size we detected was only small. Much of the literature we reviewed used categorical measurement of prior trauma exposure rather than the frequency of prior trauma exposure, which may mean our results underestimate the true effect.

4.2. Peri-traumatic factors

Whilst the effect for direct exposure was significant, it was very weak and based on only four studies. However, this finding may suggest that both direct and indirect trauma exposure is linked to depression, widening the range of youth that warrant attention post-trauma. The assessment of trauma severity widely differs depending on what can be considered measurable aspects of the trauma; this is particularly variable across (and even within) trauma types. Due to the extensive variation of what constitutes trauma severity, between and even within trauma types, it is difficult to know whether trauma severity represents a common construct between studies.

Cognitive models of PTSD relay the importance of peri-traumatic distress (fear and threat) in the development of PTSD (Ehlers and Clarke, 2000). This has been largely based on adult responses to trauma although similar conclusions have been made in children and adolescents (Stallard & Smith, 2007; Trickey et al., 2012). Few studies have addressed peri-traumatic distress and bereavement in terms of post-traumatic depression. Our findings revealed a small effect for each variable as a risk factor for depression. These findings replicate Tang and colleagues (2014) in their meta-analysis of children exposed to natural disasters. Bereavement was the strongest peri-traumatic risk factor we identified; given the lasting impact and significance of bereavement this may be expected.

4.3. Post-trauma factors

In an effort to quantify the impact of maternal depression on child mental health, a large meta-analysis of 121 studies (Goodman et al., 2011) found a small effect size for maternal depression on children's internalising disorders, including depression; this relationship is similar to our findings for post-traumatic depression. Our findings are also comparable to the existing literature concerning the relationship between maternal depression and child PTSD (Morris et al., 2012), albeit yielding a slightly smaller effect.

Although adaptive in the short-term (Compas et al., 2001), avoidant coping has been linked to more severe and chronic depression in longitudinal studies of adolescents (Seiffge-Krenke and Klessinger, 2000). In the context of trauma, avoidance has mainly been considered in relation to PTSD rather than depression. Our finding of a robust if small relationship between avoidant coping and post-traumatic depression suggests that avoidant coping may be a risk factor common to both PTSD and depression, and that its relationship to post-traumatic depression warrants further research.

Aside from PTSD, low social support was the largest correlate of post-traumatic depression. This is again consistent with the broader depression literature in CYP (Gariépy et al., 2016; Rueger et al., 2016).

PTSD was the largest correlate of post-traumatic depression, yielding a large and consistent effect size. Disentangling PTSD-depression comorbidity has become a more recent focus in the adult literature, particularly due to the associated increased negative outcomes (Campbell et al., 2007). Given the strength of this relationship and the potential theoretical and clinical implications, further research is needed to understand

Table 3
Comparison of effect sizes with Trickey et al.'s (2012) PTSD meta-analysis.

	Effect size found in meta-analysis (95% CI)	
Risk Factor	Present study: Depression	Trickey et al. (2012): PTSD
Pre-trauma		
Age	0.09 (0.04 - 0.13)[a]	0.03 (−0.04 - 0.10)[b]
Female gender	0.16 (0.12 - 0.21)	0.15 (0.13 - 0.18)
Low family income	0.16 (0.12 - 0.20)	0.17 (0.05 - 0.28)
Prior Trauma	0.16 (0.10 - 0.21)	0.21 (0.11 - 0.31)[c]
Peri-trauma		
Trauma severity	0.20 (0.17 - 0.24)	0.29 (0.24 - 0.35)
Peri-traumatic distress (fear/threat)	0.24 (0.17 - 0.30)	0.36 (0.13 - 0.59)
Bereavement	0.29 (0.15 - 0.43)	0.22 (0.12 - 0.32)
Post-trauma		
Comorbid psychological problems	0.58 (0.50 - 0.66)[d]	0.40 (0.34 - 0.47)[e]
Low social support	0.29 (0.22 - 0.36)	0.33 (0.13 - 0.53)
Maternal depression	0.20 (0.13 - 0.27)	0.29 (0.22 - 0.36)[f]

Note. [a]Older; [b]Younger; [c]Life events; [d]PTSD; [e]Any comorbidity; [f]Any parental psychological problem.

the nature and the mechanisms underlying this relationship, particularly in CYP populations, e.g. can this be attributable to symptom overlap, common risk factors, or other mechanisms?

4.4. Comparison to previous meta-analysis of risk factors for PTSD

Similar risk factors have been explored in a recent meta-analysis examining the risk factors for PTSD following wide-ranging trauma-exposure in CYP (Trickey et al., 2012). In view of this and the level of comorbidity between PTSD and depression, we compared our findings. A summary of these comparisons is presented in Table 3.

Small effect sizes were found for demographic risk factors of gender, low family income/socio-economic status and prior trauma exposure in each review. While Trickey and colleagues (2012) found no significant overall relationship between PTSD and being younger, the present review found being older was a small risk factor for post-traumatic depression.

In comparing risk factors related to the trauma itself we highlight some contrasts. Our meta-analysis generally found small effect sizes for peri-trauma risk factors for depression, whereas Trickey and colleagues (2012) found moderate effect sizes for trauma severity and peri-traumatic fear in PTSD; the reverse was found for bereavement. Thus, whilst this suggests that some risk factors are shared and may be of some clinical relevance in both disorders, some evidence of specificity is also apparent.

In comparing post-trauma risk factors, similar magnitudes of effect sizes for social support and comorbid psychological problems were found in both reviews. We found a particularly strong relationship between comorbid PTSD symptoms and depression. Trickey and colleagues (2012) looked at any comorbid disorder rather than PTSD symptoms specifically, and found a moderately strong relationship.

4.5. Moderators

We considered whether several more commonly investigated risk factors (being female, being older, PTSD symptoms) for post-traumatic depression were moderated by other variables. The only moderating effect on the relationship between PTSD symptoms and depression severity was for PTSD measure type (i.e. continuous vs. categorical). In this case substantially greater effect sizes when PTSD was indexed using continuous measures compared to categorial measures. This is likely the result of the greater sensitivity that continuous measures possess. Notably, we only ran moderator analyses on those with 20 or more studies, meaning many risk factors were not explored.

4.6. Limitations

To our knowledge this is the first synthesis of the literature and effect sizes on risk factors for depression in trauma-exposed children across all trauma types. The strengths of the present meta-analysis include a large number of studies that were assessed for risk of bias, a large overall sample size, and a comprehensive examination of different pre-trauma, peri-trauma, and post-trauma risk factors for depression. However, this review also has several limitations.

A primary limitation is the small number of studies included in several of the analyses. Only around half of the risk factors investigated were based on 10 or more studies. This clearly limits the inferences that can be made from these particular analyses. Moreover, most effect sizes were highly heterogeneous.

The cross-sectional nature of the included studies prevents drawing any conclusions about the direction of relationships. A greater focus on the longitudinal relationships of these risk factors would be highly informative. Moreover, the effect of pre-trauma depression was not controlled for.

4.7. Implications and further research

Notwithstanding the identified limitations, the present paper delineates clinically and theoretically important findings, in relation to depression in trauma-exposed children and adolescents. We found small effects for pre-trauma variables (including demographic variables and prior trauma) as risk factors for depression. Children's post-trauma reactions (notably PTSD) and environment (e.g. social support) following trauma may play a larger role in depression compared to pre-trauma risk factors. Peri-traumatic risk factors were still only small risk factors (albeit larger than pre-trauma risk factors). While we grouped bereavement with peri-trauma risk factors, its effect on risk of post-traumatic depression may be sustained and complex (e.g. through the loss of social support, subsequent loss of resources and economic hardship), and so may also be viewed as a post-trauma risk factor. However, there is still much to be understood. The range of variables that could be considered for quantitative synthesis was quite limited, emphasizing the need to consider other putative risk factors (e.g. coping and appraisal factors, nature of the family environment).

Notably, in comparing our findings to Trickey et al. (2012) and the trauma literature more widely, several risk factors appeared shared in both PTSD and depression, with similar effect sizes. However, differences also emerge in the degree of effect for some risk factors, particularly around the higher effect sizes of peri-traumatic factors for PTSD and trauma-related bereavement for depression. Although tentative, these findings may help further our understanding of potentially

shared risk factors and relative importance of some risk factors for post-traumatic depression and PTSD. This may have theoretical implications in terms of models of post-traumatic depression (and potentially PTSD) in children and adolescents and seems a promising avenue of further research.

The presence of PTSD was the most prominent risk factor found for post-traumatic depression. This finding underscores the need for further understanding of the depression-PTSD relationship. Research investigating the mechanisms underlying this relationship would be of great value, both theoretically, and also clinically in helping to develop effective interventions.

5. Conclusion

Overall our findings suggest that comorbid PTSD, trauma-related bereavement, low social support and avoidant coping are particularly relevant risk factors for depression in trauma-exposed children and adolescents. Factors related to post-traumatic environment and responses may be particular targets for monitoring, support, and treatment to reduce post-traumatic depression symptoms in children and adolescents. Further research that increase our understanding of these factors and the development of depression-targeted interventions after exposure to trauma is necessary.

Declaration of Competing Interest

None.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jadr.2021.100150.

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