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## Review Article

## Acute stress disorder in children and adolescents: A systematic review and meta-analysis of prevalence following exposure to a traumatic event

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## ABSTRACT

**Background:** Acute stress disorder (ASD) was proposed to encapsulate traumatic stress reactions within the first few months of exposure to trauma. The present systematic review and meta-analysis aimed to estimate the prevalence of ASD in children and adolescents, and the extent to which assessment, demographic and trauma variables moderate this.

**Method:** Searches of EMBASE, MEDLINE (PubMed), PsycINFO, PsycARTICLES and PILOTS were conducted to identify studies published between 1<sup>st</sup> January 1994 and 1<sup>st</sup> January 2018. Seventeen studies were identified as meeting inclusion criteria (N=2918 participants).

**Results:** The pooled prevalence estimate for ASD was 16.5% (95% CI 10.6–23.4%), with considerable heterogeneity between studies ( $Q[16]=261.12, p < .001, I^2=95.3\%$ ). Risk of bias was unrelated to prevalence estimates. Studies that used a clinical interview ( $k=8$ ) yielded a higher estimate (24.0%, 95% CI 13.8–36.0%) than those that used a questionnaire which adhered to the diagnostic algorithm for DSM-IV ASD ( $k=6$ ; 6.8%, 95% CI 3.6–10.9%). Studies comprising older participants yielded greater prevalence estimates. Prevalence was significantly greater in studies where the majority of participants had been exposed to interpersonal trauma (27.9%, 95% CI 15.1–42.8%;  $k=5$ ) compared to non-interpersonal trauma (12.8%, 95% CI 7.2–19.7%;  $k=12$ ).

**Conclusions:** This review suggests that a significant minority of trauma-exposed children and adolescents meet criteria for ASD (in particular youth exposed to interpersonal trauma), but the findings are limited by a large degree of heterogeneity. DSM-IV ASD-specific self-report questionnaire measures may be too insensitive for identifying youth with this disorder.

## 1. Introduction

The diagnosis of Acute Stress Disorder (ASD) is intended to identify those who experience significant traumatic stress symptoms in the first month following exposure to a traumatic event (Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition [DSM-IV]; American Psychiatric Association, 1994). The original version of ASD in the DSM-IV required specified clusters of symptoms to be present during this acute stage to reach a diagnosis. This consisted of three from five dissociative symptoms, one from four re-experiencing symptoms, one from two avoidance symptoms, and one from six arousal symptoms, in addition to distress or impairment in functioning. However, the release of Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5; American Psychiatric Association, 2013) has seen a change in the way in which ASD is diagnosed, with the cluster-based algorithm now replaced by a threshold of nine or more acute symptoms from a possible 14. Previous research had suggested that the requirement of three

or more dissociative symptoms in DSM-IV led to many distressed children and adolescents not meeting the threshold for diagnosis (Kassam-Adams and Winston, 2004; Meiser-Stedman, Yule, Smith, Glucksman, and Dalgleish, 2005).

Initially intended as a way of predicting later post-traumatic stress disorder (PTSD; Bryant, 2017), in recent years there has been less emphasis placed on this function of ASD (Bryant, Salmon, Sinclair, and Davidson, 2007; Dalgleish et al., 2008). Although the use of DSM-5 criteria has demonstrated an improvement in predictive power (Bryant et al., 2015; Meiser-Stedman et al., 2017), the diagnosis of ASD is currently best used to identify individuals with severe stress reactions post-trauma who may benefit from additional support or intervention in the acute stage Bryant (2017).

## 1.1. Demographics and acute stress symptoms

Previous studies involving child and adolescent participants have found mixed evidence as to the impact of age on prevalence of acute

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stress symptoms. Whereas some have found that younger children are more at risk of experiencing prominent acute stress symptoms (Doron-LaMarca, Vogt, King, King, and Saxe, 2010; Le Brocque, Hendrikz, and Kenardy, 2010), others have not (Bryant, Mayou, Wiggs, Ehlers, and Stores, 2004; Haag, Zehnder, and Landolt, 2015). Studies of post-traumatic stress in youth have demonstrated that girls are at greater risk of developing both acute (Holbrook et al., 2005; Liu et al., 2010) and persistent symptoms (Trickey, Siddaway, Meiser-Stedman, Serpell, and Field, 2012) when compared to boys. It has been suggested that symptoms of post-traumatic stress are more likely in females following interpersonal trauma (Alisic et al., 2014) and through coping via rumination (Hampel & Petermann, 2005). Ethnicity has not been shown to be predictive of ASD (Winston et al., 2002; Kassam-Adams & Winston, 2004; Ostrowski et al., 2011).

### 1.2. Trauma characteristics and acute stress symptoms

Studies suggest that youth are more likely to have severe symptoms of acute stress following exposure to a violent interpersonal trauma when compared to accidental injury or illness (Hamrin, Jonker, and Scahill, 2004; Holbrook et al., 2005), with this also found in youth with PTSD (Alisic et al., 2014). It has been posited that exposure to interpersonal trauma results in self-blame and other maladaptive cognitive strategies Tolin and Foa (2006) that may result in decreased coping in the aftermath when compared to non-interpersonal trauma Gunaratnam and Alisic (2017). Acute stress symptoms may also be more prevalent following collective traumas such as natural disasters (Liu et al., 2010) when compared to individual traumas Kassam-Adams (2006).

### 1.3. Assessment of acute stress symptoms

The assessment of acute stress following exposure to a traumatic event in children and adolescents has been conducted in various ways. Many studies have used measures designed to capture PTSD to identify youth who present with symptoms of acute stress in the first month post-trauma (e.g. Le Brocque et al., 2010). While previous studies of PTSD in adults have suggested that the use of questionnaires may have led to more individuals being classified as experiencing symptoms akin to PTSD than using clinical interview (Shalev, Freedman, Peri, Brandes, and Sahar, 1997), recent evidence suggests that there is no difference in prevalence of PTSD when measured using either questionnaire or interview (Hiller et al., 2016). The heterogeneity in assessment method is largely attributable to a lack of reliable, validated tools by which to capture ASD in youth until recently, e.g. measures which capture the DSM-IV ASD symptom algorithm (CASQ, Kassam-Adams and Winston, 2004; ASC-Kids, Kassam-Adams, 2006). In addition, 'gold standard' measures of assessment for ASD are relatively new and untested (Kassam-Adams et al., 2013). Kassam-Adams et al. (2013) reported the stark contrast in prevalence of ASD dependent upon whether assessed by interview (25.5%) or questionnaire (6.5%), which was attributed to the greater coverage of dissociative symptoms for a DSM-IV ASD diagnosis conducted via clinical interview.

### 1.4. Purpose of the current review

With a renewed focus on ASD following the publication of DSM-5, a reliable estimate of its prevalence would better inform the allocation of support and resources in the one month following trauma. In studies of acute stress symptoms in children and adolescents, prevalence rates have been reported to range from 1% (Kassam-Adams, 2006) to over 50% (Liu et al., 2010). Studies that have combined data from several sites have found prevalence rates ranging from 9% to 13.6% using criteria for either DSM-IV or DSM-5 ASD (Dalglish et al., 2008; Kassam-Adams et al., 2012; McKinnon et al., 2016). However, diagnoses of ASD in these studies were derived through different methods of assessment

which may have impacted upon the prevalence rate obtained. Further, the majority of youth included in these studies were exposed to road traffic collisions, which limits how these findings can be generalized to youth who experience other types of trauma. This meta-analytic review will focus upon reaching a reliable estimate of prevalence of ASD in children and adolescents following exposure to a traumatic event, whilst exploring whether prevalence is moderated by method of assessment, demographic and trauma variables.

## 2. Method

The protocol for this systematic review was pre-registered on the Prospective Register of Systematic Reviews (PROSPERO; CRD42017083980).

### 2.1. Eligibility criteria

The review inclusion criteria were that studies i) included an assessment of ASD within one month of a traumatic event and adhered to criteria as classified in DSM-IV or DSM-5; ii) the mean age of participants was below the age of 18; iii) ASD was assessed via a self-report questionnaire or diagnostic clinical interview; and iv) data was available to derive the prevalence of ASD. Data from the preliminary stages of randomized trials were also included where a reliable measure of ASD had been used in a screening phase prior to intervention taking place. Exclusion criteria applied to studies included those that administered interventions immediately post-trauma; those which did not report sample characteristics such as age or time elapsed since the traumatic event; those which did not measure ASD as defined by DSM criteria; those which recruited only participants with ASD and thus prevalence could not be estimated; and those which represented a clinical sample with respect to mental health. Additionally, studies that reported duplicate data, solely reviewed past research, were purely qualitative, reported lifetime prevalence of ASD, or were single case studies were also excluded. Studies published in a language other than English were not included in the analysis but were recorded in accordance with guidance from the Centre for Reviews and Dissemination Guidelines CRD (2008). Studies which used only a parent report of ASD were also excluded.

### 2.2. Information sources and search terms

Relevant studies were identified through following a search of several leading psychological and medical literature databases: EMBASE, MEDLINE (PubMed), PsycINFO, PsycARTICLES and PILOTS (Published International Literature on Traumatic Stress). Further, reference sections of full texts, prior to the final number of studies being decided, were screened for relevant papers. Databases were searched for studies published between 1994 (when ASD was first defined by the DSM) and 1<sup>st</sup> January 2018. Where full texts of studies could not be accessed, efforts were made to contact the authors directly, which resulted in some full texts being retrieved. Dissertations identified through searches were retrieved via electronic depositories. The following search terms were used to identify relevant studies: (Acute Stress Disorder OR Acute Stress Symptoms OR Acute Stress Reaction OR Acute Stress Response) AND (Child\* OR Adolescen\* OR Juvenil\* OR Teen\* OR Youth OR Young Person OR Young People); these terms were used to search title and abstracts.

### 2.3. Study selection and data collection

All abstracts of papers from initial searches were screened by the first author. At the full-text stage of screening papers, the first reason encountered as to why a study did not meet inclusion criteria was recorded. A data extraction spreadsheet was developed which contained items of interest for inclusion in the meta-analysis. Data was collected for the following study variables: author, year of publication, country

and World Bank classification of national income, design, setting, recruitment method, number of those eligible to take part, sample size, number of ASD cases and inclusion and exclusion criteria. For participants in each study, data was collected regarding ethnicity, age (mean, standard deviation and range), sex, trauma type (interpersonal, non-interpersonal, individual, collective), injury severity and hospital admission. Regarding how ASD was assessed in each study, extracted data pertained to the method of data collection (e.g. in person), timing of ASD assessment post-trauma, self-report measure (with clinical cut-off) or diagnostic interview used (with measure of reliability and validity), and the diagnostic criteria used. Where studies used both self-report questionnaires and structured diagnostic interviews to assess ASD, data was collected on both. However, in the meta-analysis the data from the interview was used as this is generally seen as the gold standard and has been done in previous research (Hiller et al., 2016).

#### 2.4. Risk of bias

To assess the risk of bias in the final included studies, a tool was developed based on those which have previously been used for prevalence studies (Hoy et al., 2012; Munn, Moola, Riitano, and Lisy, 2014). Questions concerned the participation rate, reasons for non-response, representativeness of the sample, recruitment, sample size and measurement (Supplementary Material 1). The risk of bias tool included 10 questions (maximum score 20. Higher scores indicated lower risk of bias).

#### 2.5. Data synthesis

Data analysis was conducted using the metafor package (Viechtbauer, 2010) in R 3.6.2 (R Core Team, 2014). The prevalence of ASD from each study was computed, with these then pooled to produce a weighted estimate of prevalence of ASD using a random effects model. Heterogeneity was assessed via Cochran's Q test and the  $I^2$  statistic (Higgins and Thompson, 2002). Estimates of prevalence of ASD were arcsine transformed to prevent the confidence intervals of studies with low prevalence falling below zero (Barendregt, Doi, Lee, Norman, and Vos, 2013).

Moderator analyses that were planned *a priori* included the method by which ASD was assessed, age, sex, ethnicity and trauma characteristics. Sensitivity analysis was conducted for the risk of bias score of each study. Due to a lack of information reported in studies, data regarding injury severity and hospital admission could not be meta-analysed. Therefore, the moderator analysis concerning trauma type was limited to interpersonal trauma and non-interpersonal trauma. We categorised interpersonal trauma studies as those in which participants had experienced assaults and attacks by others. Non-interpersonal trauma studies included exposure to events such as road traffic collisions, animal attacks, natural disasters, significant falls, serious recreational/sporting injuries and physical illness such as allergic reactions. Categorising studies in this way was based upon the method of Alisic et al's. (2014) meta-analytic review of the prevalence of PTSD in youth, although we recorded studies with mixed samples as either interpersonal or non-interpersonal based upon the trauma type of the highest percentage of participants. Moderator analysis on country income, as defined by the World Bank classification, was not achievable as all studies were from high or upper-middle income countries. Similarly, comparing studies of collective traumas (e.g. natural disasters) to studies of individual traumas was not possible as only one final study related to collective trauma, and too few studies reported ethnicity data to consider if this was a moderator. Meta-regression was used to assess the differences between subgroups. Forest plots were created as a means of graphically summarising the results. The 95% confidence interval around the prevalence of ASD in each study is presented, as well as the pooled prevalence at the bottom of each figure in the form of a diamond. The length of the line for the 95% confidence interval indicates the precision of the effect size estimate of each study; the larger the study, the more narrow the 95%

confidence interval will be, reflecting a more precise effect size estimate. Therefore, wide 95% confidence intervals reflect smaller studies and narrow 95% confidence intervals reflect larger studies. Potential publication bias was assessed via visual inspection of funnel plots.

### 3. Results

#### 3.1. Search Results

The process of study selection for inclusion in the meta-analysis can be seen in the PRISMA diagram (Fig. 1). Following a systematic search, 2393 results were obtained after duplicates had been removed. Of these, 205 full-text articles were assessed for eligibility for inclusion in the meta-analysis. This resulted in 17 studies that met inclusion criteria, comprising 2918 participants, the details of which can be seen in Table 1 (see Supplementary Material 2 for list of the included studies). Studies ranged in size from 16 to 479 participants.

#### 3.2. Risk of bias assessment

Fig. 2 displays the proportion of studies that were rated as low, moderate or high risk of bias for each of the 10 criteria, whilst Table 1 provides the overall risk of bias score for each individual study. Scores between 15–20 indicate a low risk of bias, 9–14 a moderate risk of bias, and less than eight a high risk of bias. Details of the risk of bias assessment for each study can be seen in Supplementary Material 3. When independently assessed by another researcher, inter-rater reliability for a subsample of four of the included studies was good (Cohen's kappa = 0.76).

#### 3.3. Prevalence of ASD

With all 17 studies included, the pooled prevalence of ASD was 16.5% (95% CI 10.6–23.4%) with considerable heterogeneity found between studies ( $Q[16]=261.12, p < .001, I^2=95.3\%$ ).

#### 3.4. Sensitivity analysis

Due to high heterogeneity between studies, sensitivity analysis was conducted by removing each study in turn to identify any significant impact upon the overall prevalence of ASD reported. This resulted in prevalence estimates ranging from 15.1% (95% CI 9.8–21.4%) to 18.0% (95% CI 12.2–24.7%) indicating that no one study greatly impacted upon the estimate of pooled prevalence obtained. This was also conducted for the eight studies that used a clinical interview for assessment, resulting in prevalence estimates ranging from 21.1% (95% CI 12.0–31.9) to 27.7% (95% CI 19.4–36.8).

Further sensitivity analysis was conducted through using meta-regression for the continuous measure of risk of bias. This proved to be insignificant ( $p=0.97$ ) when considering all 17 studies, i.e. risk of bias had little impact on prevalence estimates. When the two studies that were deemed to have a high risk of bias (were excluded from analysis, the estimated prevalence of ASD was not dissimilar (17.3%, CI 11.4–24.3), with heterogeneity unaffected ( $Q[14]=178.86, p < .001, I^2=94.4\%$ ).

#### 3.5. Moderator analysis

Subgroup and moderator analysis were conducted using all 17 studies. The method by which ASD was assessed had a significant impact upon the estimated prevalence obtained (see Fig. 3 for forest plot). For studies that assessed ASD using a clinical interview adhering to DSM-IV or DSM-5 criteria ( $k=8, n=1210$ , range of sample sizes 16–479) the estimated prevalence was 24.0% (95% CI 13.8–36.0%), with considerable heterogeneity present ( $Q[7]=86.59, p < .001, I^2=94.5\%$ ). For studies assessing ASD using a questionnaire which adhered to the diagnostic algorithm for DSM-IV ASD ( $k=6, n=1036$ , range of sample

**Table 1**  
Included studies, sample characteristics, methods of assessment, quality ratings and prevalence of ASD.

Study	Country	Recruitment site	Age		Timing of ASD assessment	Measure of ASD	Method of ASD assessment	Majority trauma type	Risk of bias score	Risk of bias category	Sample size	ASD prevalence	
			Range	<i>M</i> ( <i>SD</i> )								<i>N</i>	%
Brown et al. (2016)	USA	Burn Centre & ED	7-18	13.5 (3.5)	<i>M</i> =5.5 days	DICA-ASD	Int, DSM-IV	Non-interper	12	Moderate	197	71	36.0
Bryant et al. (2004)	UK	ED	5-16	12.3 (2.9)	2 weeks	IESR-8 plus questions for DSM-IV ASD	Ques, DSM-IV	Non-interper	9	Moderate	86	10	11.6
Ellis et al. (2009)	Australia	ED & Inpatient	7-17	12.0 (2.8)	<i>M</i> =20.4 days	ASC-Kids	Ques, DSM-IV	Non-interper	16	Low	97	5	5.2
Fein et al. (2001)	USA	ED	8-24	14.4 (3.4)	Within 24 hrs of admission	ISRC	Subthreshold Ques, DSM-IV	Interpers	17	Low	81	24	29.6
Haag et al. (2015)	Switzerland	ED	7-16	11.6 (2.7)	10 days	IBS-A-KJ	Int, DSM-IV	Non-interper	17	Low	101	3	3.0
Hamrin (1998)	USA	ED	11-15	13.9	24 hrs post-admission	DSM-IV Clinical interview	Int, DSM-IV	Interpers	13	Moderate	16	9	56.2
Kassam-Adams & Winston (2004)	USA	ED	8-17	11.3 (2.5)	2 days-1 month	CASQ	Ques, DSM-IV	Non-interper	17	Low	243	19	7.8
Kassam-Adams (2006)	USA	ED & Intensive Care Unit	8-17	11.8	2 days-1 month	ASC-Kids	Ques, DSM-IV	Non-interper	8	High	176	2	1.1
Kassam-Adams et al. (2013)	USA	Health & Community Social Services	8-17	13 (2.6)	2 days-1 month	DICA-ASD	Int, DSM-IV	Non-interper	10	Moderate	479	122	25.5
Li et al. (2010)	China	ED	5-17	9.4 (2.8)	1 week	CASQ	Ques, DSM-IV	Non-interper	12	Moderate	358	38	10.6
Meiser-Stedman et al. (2007)	UK	ED	10-16	13.8 (1.9)	2-4 weeks	ADIS-C+	Int, DSM-IV	Interpers	15	Low	93	18	19.4
Meiser-Stedman et al. (2008)	UK	ED	7-10		2-4 weeks	CAPS-CA+	Int, DSM-IV	Non-interper	15	Low	48	11	22.9
Meiser-Stedman et al. (2017)	UK	ED	8-17	14.1 (2.9)	<i>M</i> =22.0 days	CPTSDI+	Int, DSM-5	Non-interper	14	Moderate	226	32	14.2
Pailler et al. (2007)	USA	ED	12-17	14.3	Within 72 hours	IRSC	Subthreshold Ques, DSM-IV	Interpers	11	Moderate	394	46	11.7
Salmon et al. (2007)	Australia	ED	7-13	9.9 (2.6)	<i>M</i> =25.6 days	CASQ	Ques, DSM-IV	Non-interper	12	Moderate	76	6	7.9
Salmond et al. (2011)	UK	ED	8-17	13.5 (2.5)	2-4 weeks	ADIS-C+	Int, DSM-IV	Interpers	15	Low	50	19	38.0
Zhou et al. (2016)	China	Middle School	9-15	13.2 (1.6)	2 weeks	ASDS	Subthreshold Ques, DSM-IV	Non-interper	8	High	197	56	28.4

Note. + = with extra questions for dissociation; ADIS-C = Anxiety Disorders Interview Schedule for Children; ASC-Kids = Acute Stress Checklist for Children; CAPS-CA = Clinician-Administered Posttraumatic Stress Disorder (PTSD) Scale for Children and Adolescents; CASQ = Child Acute Stress Questionnaire; ED = Emergency Department; IESR-8 = Impact of Event Scale-Revised - 8 items; IBS-A-KJ = Interview zur Erfassung der Akuten Belastungsstörungen bei Kindern und Jugendlichen; ISRC = Immediate Stress Reaction Questionnaire; ASDS = Acute Stress Disorder Scale; CPTSDI = Children's Posttraumatic Stress Disorder (PTSD) Inventory; DICA-ASD = Diagnostic Interview for Children and Adolescents for Acute Stress Disorder

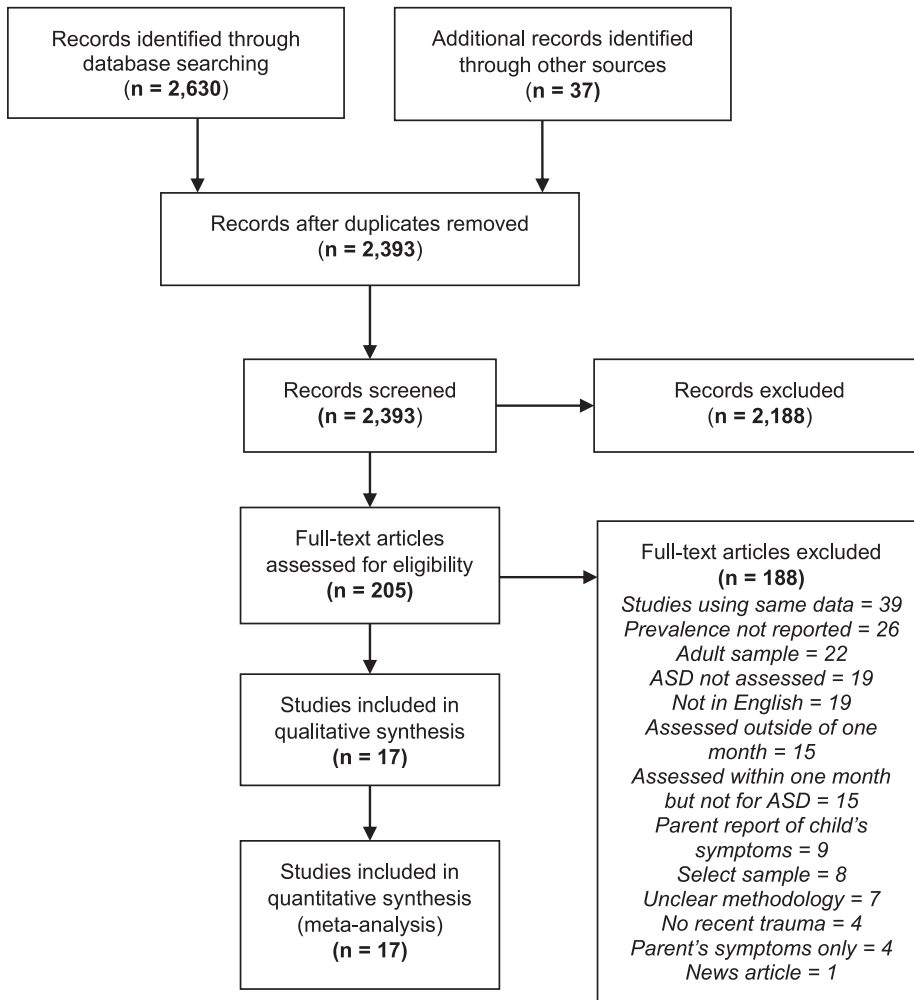


Fig. 1. PRISMA Diagram demonstrating process of study selection.

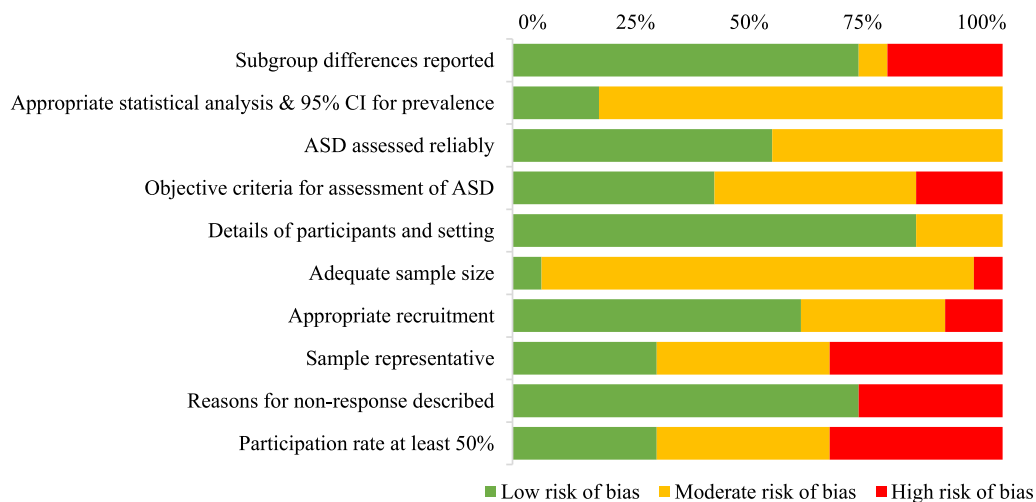


Fig. 2. The proportion of studies that were rated as low, moderate or high risk of bias for each risk of bias question assessed.

sizes 76–358) the prevalence estimate was 6.8% (95% CI 3.6–10.9%), with high levels of heterogeneity ( $Q[5]=27.21, p < .001, I^2=80.5\%$ ). For the studies assessing ASD using a questionnaire that addressed DSM-IV ASD symptoms but did not conform to the precise diagnostic criteria in how they determined caseness ( $k=3, n=672$ , range of sample sizes 81-394) the prevalence estimate was 22.2% (95% CI 11.3–35.6%), with

considerable heterogeneity present ( $Q(2)=30.88, p < .001, I^2=92.0\%$ ). Meta-regression analyses confirmed that a statistically significant difference existed between the estimated prevalence when assessed via an ASD specific questionnaire compared to clinical interview ( $B=-0.243, p < .003$ ).



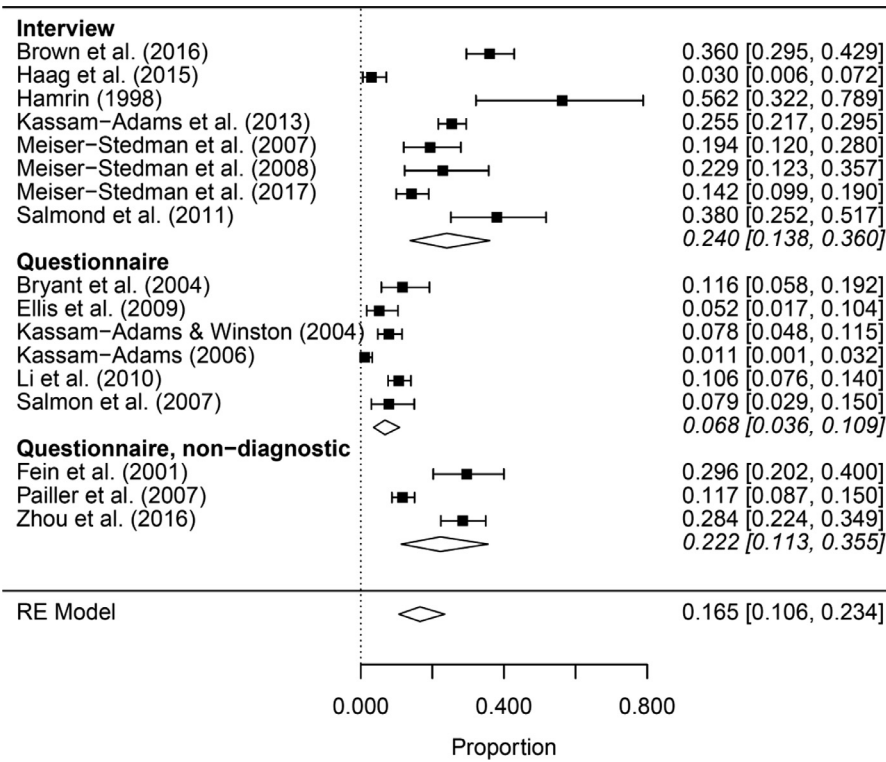


Fig. 3. Pooled prevalence of ASD, grouped by assessment type.

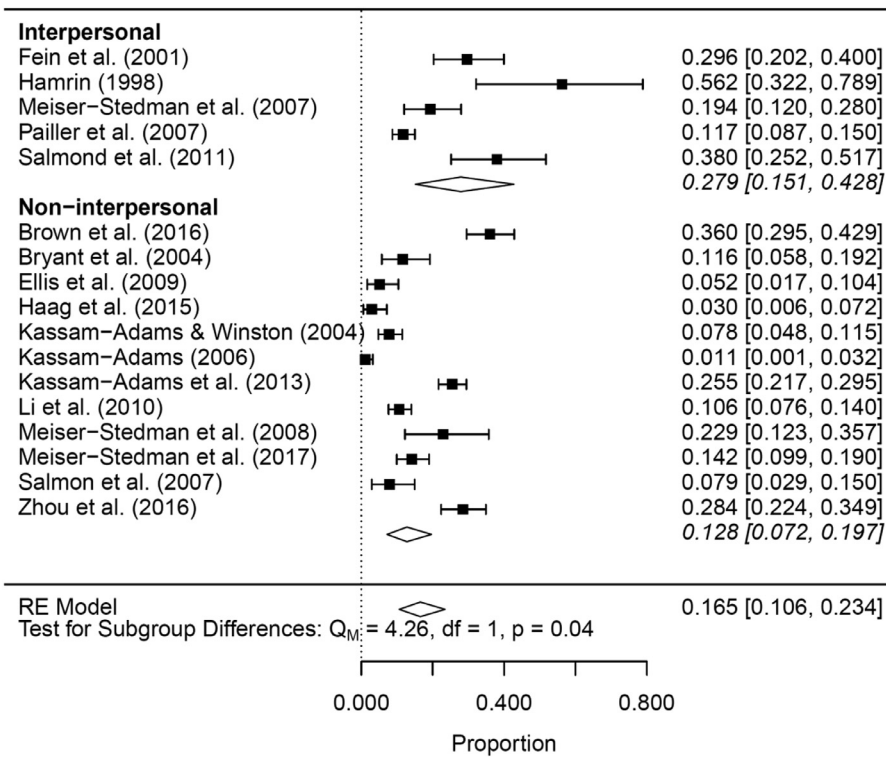


Fig. 4. Pooled prevalence of ASD, grouped by trauma type (interpersonal vs non-interpersonal).

For studies in which the majority of participants had been exposed to interpersonal trauma, the prevalence of ASD was higher ( $k = 5$ ,  $n = 634$ , range of sample sizes 16-394; pooled estimate 27.9%, 95% CI 15.1-42.8%) than those where the majority had been exposed to non-interpersonal trauma ( $k = 12$ ,  $n = 2284$ , range of sample sizes 48-479; pooled estimate 12.8%, 95% CI 7.2-19.7%). This finding was confirmed via meta-regression ( $B = 0.190, p < 0.04$ ; see Fig. 4). Even when restricted

to those studies which *entirely* comprised youth exposed to interpersonal trauma or non-interpersonal trauma ( $k = 11$ ), the same pattern of results remained. None of the interpersonal trauma studies utilised a questionnaire measure focused on diagnostic criteria, suggesting that trauma type and assessment type were confounded.

The mean age of participants in studies was found to significantly moderate prevalence ( $B = 0.071, p = .004$ ), i.e. studies with older partic-

ipants reported higher prevalence of ASD. No significant association was found between prevalence of ASD and sample characteristics regarding sex ( $p = 0.65$ ).

To examine whether the association between older age and increased prevalence was a product of trauma type (since it might be expected that older children are more exposed to interpersonal trauma such as community violence), a further meta-regression of age was conducted omitting the interpersonal trauma studies. Data on average age was available for 11 of the 12 non-interpersonal trauma studies, with the significant association of older age and increased prevalence of ASD no longer observed ( $B=0.062$ ,  $p = 0.058$ ).

### 3.6. Publication bias

Publication bias was assessed via visual inspection of a funnel plot (see Supplementary Material 4). Observed asymmetry may be attributable to heterogeneity, in the way that ASD was assessed and the trauma event to which participants in different studies were exposed, rather than publication bias Cuijpers (2016). The funnel plot could be interpreted as indicating that smaller studies reporting low prevalence of ASD are less likely to be published. However, smaller studies may focus on specific groups of individuals. The study by Hamrin (1998) included in this review recruited youth who had experienced extreme violence as they had all been victims of gunshots. This can lead to the funnel plot displaying a small sample bias, rather than a publication bias Cuijpers (2016).

## 4. Discussion

This systematic review and meta-analysis sought to estimate the prevalence of ASD in youth in the first month following exposure to a traumatic event, with consideration of moderators such as method of assessment, demographic and trauma variables. Conducting a meta-analysis allowed us to pool 17 studies comprising 2918 participants, which provided an estimated prevalence of 16.5%, a figure higher than previous reports of prevalence of ASD from large samples of trauma exposed youth (Dagleish et al., 2008; Kassam-Adams et al., 2012; McKinnon et al., 2016).

### 4.1. Impact of moderators on prevalence of ASD

#### 4.1.1. Method of assessment

The significant difference between prevalence of ASD obtained through using clinical interview (24.0%) when compared to an ASD specific questionnaire (6.8%) was striking. The low prevalence of ASD obtained through using ASD-specific questionnaires has implications for the way in which youth are assessed in the acute aftermath of a traumatic event. There will be instances where administering a questionnaire is preferable to an interview in order to make more efficient use of available resources. However, the findings here suggest that many children and adolescents who might meet diagnostic criteria through a clinical interview may not be identified using a questionnaire oriented to DSM-IV ASD criteria. This has been attributed to the lack of coverage of dissociative symptoms on questionnaire measures of DSM-IV ASD when compared to interview, resulting in many youth not meeting diagnostic criteria (Kassam-Adams et al., 2013). Questionnaires for use with the updated DSM-5 criteria will no longer include the cluster-based algorithm, although will require the presence of at least nine of fourteen symptoms. This may facilitate more sensitive assessment of ASD in child populations using questionnaires. Only one study in this meta-analysis utilised DSM-5 criteria (Meiser-Stedman et al., 2017), which prevented subgroup analysis of the two diagnostic classifications. Clinical interviews may allow for more time for acute symptoms to be explored with the young person when compared to a brief questionnaire measure, which may result in the identification of symptoms that might have otherwise been missed.

### 4.1.2. Interpersonal trauma

Studies in which youth were exposed to interpersonal trauma reported higher prevalence of ASD than those in which participants had experienced a non-interpersonal trauma. This finding is consistent with PTSD research in youth (Alisic et al., 2014). Future research should focus on delineating this relationship further. Screening youth exposed to such trauma may represent a clinical priority. The prevalence of ASD in trauma exposed youth reported in the current study may be higher than that from previous pooled samples due to the majority of youth in those studies having been assessed via questionnaire (Dagleish et al., 2008; Kassam-Adams et al., 2012); moreover, most (Kassam-Adams et al., 2012; McKinnon et al., 2016), if not all (Dagleish et al., 2008), comprised youth exposed to non-interpersonal trauma. It is important to note, however, the potential confounding effect of interpersonal trauma in the current study as there were no interpersonal trauma samples which utilised an ASD specific questionnaire.

### 4.1.3. Demographic characteristics

Where age has been found to increase the likelihood of ASD, this has often been in studies of younger children (e.g. Le Brocq et al., 2010). Contrary to this literature, this review found that studies with older participants showed increased prevalence of ASD. It has been reported that older children might be more likely to be exposed to interpersonal violence (Stein, Jaycox, Kataoka, Rhodes, and Vestal, 2003) which could explain this effect. However, this result was no longer present when the interpersonal trauma studies were removed to account for the higher prevalence of ASD in those studies. Moreover, whilst our result regarding age and ASD differs from that of Trickey et al. (2012) who found no relationship between younger age and PTSD, their methodology was more robust as it took correlation coefficients from each study. The current study on the other hand considered demographic factors at the sample rather than the individual level.

While several studies have reported girls to be at higher risk of developing ASD than boys, no association was detected between prevalence of ASD and gender when using the proportion of females across studies as the independent variable. Recent meta-analytic studies in youth have reported conflicting findings regarding female gender and risk of developing PTSD (Trickey et al., 2012). It has been suggested that being female may interact or be confounded with other trauma variables (interpersonal trauma; see Alisic et al., 2014) and coping styles (e.g. higher rates of internalising disorders when compared to males pre- and post-trauma, Hankin et al., 1998; rumination, Hampel and Petermann, 2005) to increase the likelihood of post-trauma symptoms.

### 4.2. Clinical implications

This review suggests that ASD is experienced by a significant minority of children and adolescents exposed to trauma. Moreover, it was found that studies in which children and adolescents were assessed via interview reported higher prevalence than in those which utilised a questionnaire, and that youth exposed to interpersonal trauma are at greater risk of developing ASD.

Most of the available data has focused on the DSM-IV algorithm for ASD. Despite the de-emphasis on dissociative symptoms and the move away from a cluster-based algorithm, the updated DSM-5 ASD criteria may result in individuals being missed due to the sheer number of symptoms required to meet diagnosis. The limited available research has suggested that a reduced symptom count of four or more symptoms may aid in identifying youth with severe acute stress reactions post-trauma (Kassam-Adams et al., 2012; Meiser-Stedman et al., 2017).

The weaknesses associated with questionnaire assessment of ASD may not be a major issue in those situations where the utility of this diagnosis may be to facilitate early treatment in health systems that rely on diagnostic assessment. In such situations, an interview assessment may be feasible. However, it is possible that ASD does not lend itself easily to the sort of mass screening that may be required following

a large-scale incident, or if a service routinely receives a large number of referrals in the acute phase post-trauma. In such instances the use of a brief screening questionnaire (e.g. the Child Trauma Screening Questionnaire, the Child Trauma Screen, the Children's Revised Impact of Event Scale) (Dyregrov and Yule, 1995; Kenardy, Spence, and Macleod, 2006; Lang and Connell, 2017) may be more appropriate. Further research exploring the utility of DSM-5 ASD self-report questionnaires is warranted, but may need to be precise about their function of such tools, e.g. are any cut-off scores to be used for identifying youth who require immediate treatment, youth who require further monitoring or "screening out" youth who are highly unlikely to require treatment.

While the ASD diagnosis may facilitate the take-up of treatment, the fact that it appears to be a relatively common response to trauma does represent a potential challenge for mental health services. The possible impact of ASD on a child or adolescent's well-being and development may need to be weighed against the widespread natural recovery for PTSD (Hiller et al., 2016) and the treatment resources that are available.

#### 4.3. Limitations

This review has several limitations. First, heterogeneity across studies was high, with sensitivity analysis failing to significantly decrease this, limiting the generalisability of our findings. Second, planned moderator analyses, including income of country and whether the trauma was collective or individual, could not be conducted due to a lack of identified studies. There is still much we do not know about ASD in developing countries, perhaps attributable to the difficulties in allocating resources to investigate this in the acute post-trauma period. Third, moderator analyses considering demographic factors had to consider characteristics at the sample and not individual level. This may have masked effects. Fourth, questions within each study were asked in relation to a clear, one-off trauma; with only one study reporting the percentage of the sample who had been exposed to prior trauma. It is therefore unclear as to what impact prior trauma or historical post-trauma symptoms may have upon prevalence of ASD following exposure to a further traumatic event. Fifth, although a strength of this study is in demonstrating the difference in prevalence of ASD when measured via interview compared to questionnaire, heterogeneity may have been lower if all studies had utilised a gold standard interview. Sixth, the moderator analysis conducted in this review would have lacked power had the additional ASD and subthreshold ASD questionnaire studies not been included. ASD is a relatively new diagnosis and therefore the number of studies that met inclusion criteria for this review are relatively low when compared to more established diagnoses such as PTSD. The findings presented in this article should be interpreted in the context of a small number of studies being used for moderator analysis. Confounding may also have played a role; none of the interpersonal trauma studies used a questionnaire measure, for example, which may have yielded a lower prevalence rate.

#### 5. Conclusion

Prevalence of ASD in children and adolescents in the first month following exposure to a traumatic event was estimated to be 16.5% (95% CI 10.6-23.4%), but characterised by considerable heterogeneity. When studies were limited to those which used a clinical interview to assess ASD, prevalence increased to 24.0%. Prevalence was also higher for youth exposed to interpersonal trauma. Given the much lower prevalence obtained through using questionnaires adopting the DSM-IV cluster-based algorithm, the interview rate may be more reliable. Findings from the current review suggest that questionnaires which utilise the DSM-IV cluster-based algorithm for ASD may be too strict when intended to identify those youth with severe acute symptoms post-trauma.

#### Contributors

Jack Walker conceived and designed the analysis, extracted the data, performed the analysis and wrote the paper.

Bonnie Teague conceived and designed the analysis and helped to write the paper.

Jessica Memarzia extracted the data, performed the analysis and wrote the paper.

Richard Meiser-Stedman conceived and designed the analysis, performed the analysis and helped to write the paper.

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#### 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.2020.100041](https://doi.org/10.1016/j.jadr.2020.100041).

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