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REVIEW PAPER

A Systematic Review of the Assessment and Treatment of Posttraumatic Stress Disorder in Individuals with Autism Spectrum Disorders

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Abstract

Individual differences are known to influence the risk of trauma exposure and development of posttraumatic stress disorder (PTSD). It has been suggested that features of autism spectrum disorder (ASD) may confer such risk. This article provides a systematic review of the assessment and treatment of PTSD in individuals with ASD, in addition to summarising the rates and presentation of PTSD within this population. Twenty-four studies met eligibility criteria. PTSD in children and adolescents was found to co-occur at a similar or greater rate compared to general population estimates, although current estimates come predominantly from treatment-seeking samples. Preliminary findings from case reports suggest traditional assessments and treatments for PTSD can be effective, although there is a shortage of well-controlled research.

Keywords Posttraumatic stress disorder · Autism spectrum disorder · Trauma · Assessment · Prevalence · Treatment

Autism spectrum disorders (ASD) are a group of neurodevelopmental conditions characterised by impairment in reciprocal social interaction, communication and repetitive and stereotyped behaviours (American Psychiatric Association 2013). Prevalence of co-occurring anxiety disorders for children and adolescents with ASD has been estimated to be around 40% (van Steensel et al. 2011), with rates in adults ranging from 34% to 50% (Bakken et al. 2010; Hofvander et al. 2009). Anxiety in ASD presents an increased symptom burden over and above that associated with ASD, with the potential to exacerbate core ASD features and to increase social withdrawal and behavioural problems (for a review see Wood and Gadow 2010). Preliminary evidence suggests that anxiety in ASD presents itself in both "traditional" and "atypical" forms (Kerns et al. 2014). Models of anxiety development in ASD posit that cognitive, genetic and neurobiological features of ASD presentation, together with socio-environmental stressors, act to predispose individuals to the development of clinical anxiety. This risk is influenced by both mediating factors which are intrinsic to ASD and moderating effects of individual differences (Wood and Gadow 2010; White et al. 2014; South and Rodgers 2017). These models hold ASD-related stressful events as key in the vulnerability towards clinical anxiety, with reviews highlighting the high rates of peer victimisation within this population (Humphrey and Hebron 2015; Sreckovic et al. 2014).

Whilst peer victimisation in ASD has been studied in great detail, research examining the prevalence of other traumatic or stressful life experience is lacking. It has been proposed that certain features of ASD symptomatology may predispose this population to an increased risk of trauma exposure and subsequent development of posttraumatic stress disorder (PTSD) (Kerns et al. 2015; Hoover 2015; Haruvi-Lamdan et al. 2017). The experience of traumatic life events for children and adolescents with ASD has been found to increase ASD-related deficits in communication, daily living motor skills and socialisation, measured at 6 and 12 months post-trauma (Valenti et al. 2012). Following trauma exposure, it is clear that PTSD can and does develop in certain individuals with ASD (Mehtar and Mukaddes 2011), with PTSD diagnosis found to be associated with suicidal thoughts and actions within this population (Storch et al. 2013).

The current DSM-5 classification of PTSD resides within a new category of "trauma- and stressor- related disorders",

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highlighting the importance of the prerequisite trigger as exposure to "death, threatened death, actual or threatened serious injury, or actual or threatened sexual violence" (Criterion A; American Psychiatric Association 2013). However, the previous conceptualisation of PTSD within DSM-IV was nested within the "anxiety disorders" category—emphasising the close links between PTSD and anxiety symptomatology. A large body of literature has now explored the co-occurrence of anxiety and other mental health difficulties in ASD (Kerns and Kendall 2012), and modified treatments for anxiety have been developed (Vasa et al. 2014). Despite the symptomatology of PTSD being characterised by altered arousal, in addition to trauma re-experiencing, avoidance and negative alterations in cognition and mood (American Psychiatric Association 2013), this disorder has been noticeably neglected in studies exploring mental health difficulties in individuals with ASD. The omission of PTSD assessment and diagnosis within the bulk of ASD literature is particularly surprising in light of the abundance of literature, outlined above, detailing the association between ASD and anxiety.

Associations between known risk factors for PTSD development in the general population and features inherent to ASD suggest that individuals with ASD may be at increased risk of PTSD development. Cognitive models of PTSD in the general population (e.g. Brewin et al. 1996; Brewin 2001; Ehlers and Clark 2000) hold that deficits in trauma processing and memory are key to the aetiology of the disorder. Sensory-based ("visuospatial") processing of the traumatic event results in the formation of poorly contextualised and disjointed trauma memories, leading to the development of intrusive trauma memories and subsequent PTSD symptomatology (Halligan et al. 2002). Maladaptive emotion regulation strategies, such as suppression and behavioural avoidance, then act to maintain PTSD symptomatology by blocking opportunities to consolidate and adaptively process the trauma memories (Davis and Clark 1998). Theoretical papers exploring the association between ASD and PTSD suggest that the socio-cognitive features of ASD, including deficits in theory of mind, executive functioning, global processing, emotional insight and cognitive flexibility, may impact peri-traumatic and post-traumatic processing, and appraisals of traumatic memories and their sequelae, thus increasing risk of PTSD development (King 2010; Kerns et al. 2015). Although theoretical articles have outlined the possible links between ASD, trauma exposure and post-trauma outcomes (Kerns et al. 2015; Hoover 2015; Haruvi-Lamdan et al. 2017), to date no systematic review of the literature has been conducted to collate current knowledge regarding the assessment or treatment of PTSD in individuals with ASD. This paper seeks to extend the literature by providing a comprehensive and systematic review of published original studies investigating PTSD in individuals with ASD. In this review, the following research questions are addressed:

1. How is PTSD being assessed in individuals with ASD?
2. What is the presentation of PTSD in populations with ASD?
3. What are the rates of PTSD in individuals with ASD?
4. What psychological and psychosocial treatments have been implemented, and what outcomes have been reported, for individuals with PTSD and ASD?

The objective of this review was to outline the current state of the field of research into PTSD in ASD, highlighting limitations and gaps in the literature and providing recommendations regarding future research directions. Studies of all designs across any age group were considered relevant, given the scarcity of literature on PTSD in ASD. Whilst it has been posited that a broader or differential range of experiences may be perceived as traumatic by individuals with ASD (Kerns et al. 2015; Haruvi-Lamdan et al. 2017), this review focuses on "traditional" traumatic events as defined within criterion A of the DSM-5 criteria for PTSD (American Psychiatric Association 2013).

Methods

Protocol and Reporting

A systematic review protocol was developed and registered with Prospero (https://www.crd.york.ac.uk/PROSPERO; registration number: CRD42017071131) prior to data extraction. The systematic review was conducted and reported in accordance with the preferred reporting guidelines for systematic reviews and meta-analysis (Moher et al. 2009).

Search Strategy

A systematic search of databases including: Web of Science, Medline, Psychinfo, Pubmed, Embase and PILOTS (a database of PTSD literature) was completed. Two search groupings were created and used across all database searches, the first covered terms pertaining to ASD including: autis* OR Asperger* OR "Pervasive developmental disorder" OR PDD-NOS OR "childhood disintegrative disorder", the second covered terms pertaining to PTSD including: "Posttraumatic stress disorder" OR "post-traumatic stress disorder" OR "post traumatic stress disorder" OR PTSD OR "acute stress disorder" OR "acute stress reaction" OR traum*. The reference lists of all included papers and all prior reviews of anxiety disorders, PTSD or trauma in populations with ASD, developmental disabilities or intellectual disability were also reviewed.

Selection of Articles

A systematic search was completed for English language publications, published between 1980 (the year PTSD formally entered the psychiatric nosology) and May 2017, which reported data pertaining to PTSD within individuals of any age with a confirmed diagnosis of an autism spectrum disorder (ASD), including Asperger's syndrome, high functioning autism, childhood autism, atypical autism, Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS) and childhood disintegrative disorder. Any studies employing a randomised control trial, quasi-experimental, cross-sectional, longitudinal, case series or case study were considered for inclusion if they reported data pertaining to either:

- The assessment of PTSD in one or more individuals with ASD
- The rates of PTSD in ASD
- The treatment of PTSD in one or more individuals with ASD.

Grey literature (e.g. thesis, conference abstracts, conference proceedings, book chapters), letters to the editor and theoretical/opinion papers which did not report any relevant case studies were excluded. Studies were excluded if they did not explicitly specify either (I) the assessment of PTSD, (II) the rate of PTSD within a sample of ≥ 30 individuals with ASD or (III) treatment aimed at addressing PTSD, in individuals or groups. In addition, for publications outlining either (II) the rates or (III) treatment of PTSD in ASD, papers were excluded if participants did not have a diagnosis of PTSD confirmed by a psychiatrist, psychologist or other trained clinician, or clinically significant scores on a standardised diagnostic measure of PTSD symptomatology.

An initial screening of all titles and abstracts was completed, with full text screening carried out for any hits which did not obviously fit within the exclusion criteria. Any ambiguous papers were discussed with a second reviewer to reach consensus. In addition, a second reviewer reviewed all the articles that were judged to meet the review eligibility criteria and 10% of all abstracts, chosen at random. Inter-rater agreement was very good (Kappa = .092; SE = .045; CI = .083–1) and any discrepancies were discussed between the coders until a consensus was reached.

Data Extraction and Quality Assessment

Details regarding the study characteristics, design, outcomes and quality were extracted. Personalised data extraction forms were used to collate data pertaining to characteristics, design and outcomes. Data relating to the quality of the studies was extracted using an adapted quality assessment tool for quantitative study designs (The EPHPP quality assessment tool for quantitative studies, Effective Public Health Practice Project; available at www.ephpp.ca/tools.html) and another for case study or case report designs (Checklist for Case Reports, The Joanna Briggs Institute 2016; available at joannabriggs.org/research/critical-appraisal-tools.html).

Data were extracted regarding (I) study and sample characteristics (e.g. sample size, study design, recruitment process, sample source, demographics, IQ, ASD diagnosis, comorbidities, trauma types), (II) the rates of PTSD reported in samples of individuals with ASD, PTSD assessment measures, details of PTSD presentation (i.e. symptomatology), details of intervention(s) for PTSD and outcomes of interventions addressing PTSD and (III) aspects relating to the quality of the study, based on the tools listed above. Data were summarised using a narrative synthesis approach, due to the heterogeneity of the literature and study designs. Rates of PTSD were calculated based on studies with a sample size of ≥ 30.

Results

Study Selection

The titles and abstracts of all returns from the search strategy were reviewed, 1198 were excluded as not meeting the criteria. Reasons for exclusion included the returns being grey literature (book chapters, book reviews, conference proceedings, commentaries, editorials and thesis) or letters to the editor, papers not including new data (reviews and theoretical papers), studies being in populations other than humans with clinically diagnosed ASD (animal models, ADHD, psychosis, depression, traumatic brain injury, epilepsy, Parkinson's, mental health of parents of children with ASD, neurotypicals with no mental health difficulties), papers not written in English language and studies not reporting the assessment or treatment of PTSD in ASD or psychodynamic papers reporting trauma as a primary cause of ASD development. In total, 130 full text articles were retrieved and assessed for eligibility, with 24 meeting the criteria for inclusion in this systematic review. Reasons for exclusion at the full-text screening stage included the returns being grey literature (conference proceedings; thesis), studies being in populations other than humans with clinically diagnosed ASD (investigating mixed developmental disorders, ASD-traits or mental health of the parents of children with ASD), papers not written in English language, and studies not reporting assessment or treatment of PTSD in ASD (psychodynamic papers reporting trauma as cause of ASD development, no clinical diagnosis or standardised measure of PTSD reported or data on anxiety disorders not sub-divided by PTSD). The full study selection process is depicted in Fig. 1.

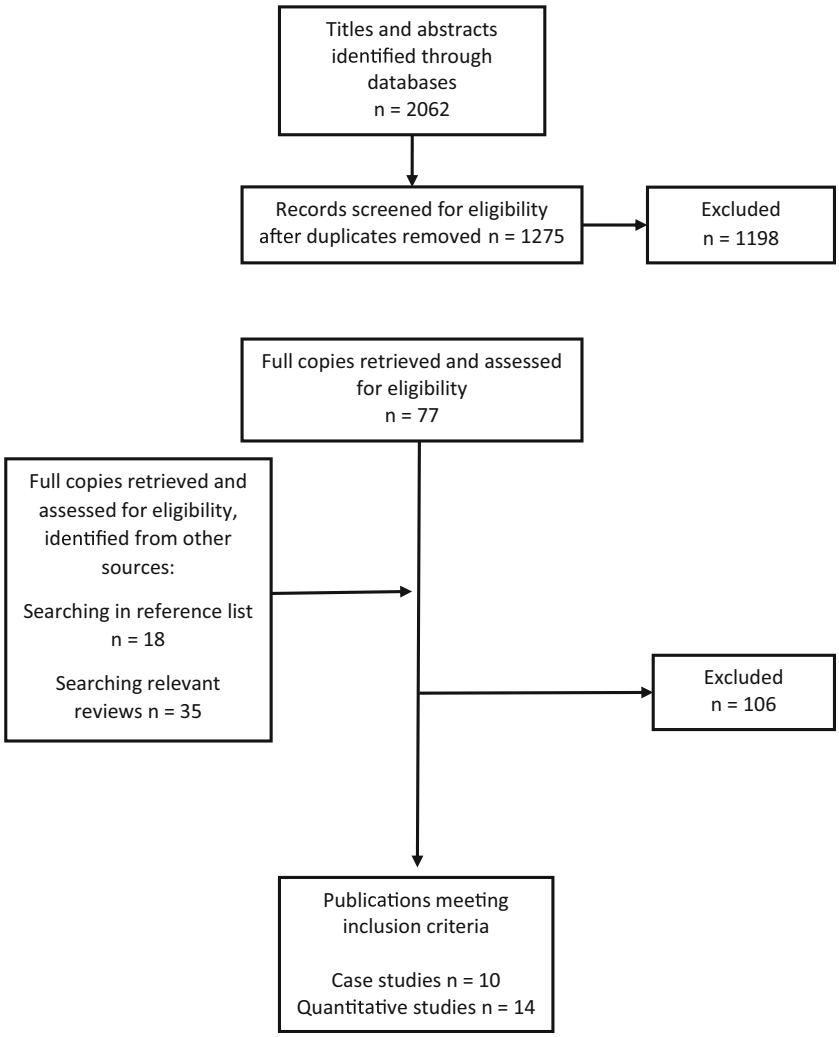

Fig. 1 PRISMA flow diagram of study selection process

Assessment of PTSD in People with ASD

All of the 24 papers which met the eligibility criteria reported information regarding the assessment of PTSD in individuals with ASD. The following section provides an expanded overview of the results regarding assessment of PTSD in individuals with ASD, to supplement the information presented in Tables 1, 2 ,3, and 4.

Case Studies

Ten papers reported case studies and case series outlining the assessment of PTSD in individuals with ASD, across a total sample of seven females and 15 males. The age range of the patients was between 6 and 45 years of age, with four papers reporting data in children (Cook et al. 1993; Trelles Thorne et al. 2015; Harley et al. 2014; Mevissen et al. 2011) and six in adults (Ryan 1994; Carvill and Marston 2002; Weiss and Lunsky 2010; Kosatka and Ona 2014; Carrigan and Allez 2017; Barol and Seubert 2010). All but one case report (Weiss and Lunsky 2010) detailed clients who had been referred to clinical services for specialist assessment and/or treatment. For a full summary of demographic characteristics, see Table 1.

The most common traumatic event was experiencing abuse or assault, which occurred in 8 cases (Table 1). PTSD was most often assessed via information gathered from multiple informants and sources including self-report and/or parent report, standardised questionnaire measures or semi-structured interview, clinical observation, information from staff and reports regarding historical diagnosis (Table 2). PTSD symptom presentation was detailed in all studies where PTSD was formally diagnosed (Table 2). Five of the studies explicitly specified that diagnosis of PTSD according to DSM or ICD criteria was possible (Ryan 1994; Cook et al. 1993; Weiss and Lunsky 2010; Carrigan and Allez 2017; Mevissen et al. 2011). Clients were able to report events, symptoms and emotional states and expressed a comparable symptom profile to that seen in the typical developing population. However, for two cases presented

Table 1 Sample characteristics of the studies included in the review

First author (year)	Study type	Reason for referral (Case reports) or sampling technique (Group studies)	ASD participants	Comparison group	Mean age in years (range)	Female % or gender	ASD method of diagnosis	Level of functioning	Trauma types
Barol and Seubert (2010)[1]	*Case Series*	*Recruited* via *purposive sampling of individuals with PTSD symptoms from a residential facility and snowball sampling* via *referrals from clinical advertisement*	*N = 4 (Autism)*	None	*25 (20)*	*50% (2/4)*	*ASD diagnosis prior to study*	*2/4 mild ID; 1/4 moderate ID; 1/4 severe ID*	*Bullying at school and home (n = 1); death of mother aged 12 (n = 1); serious illness (n = 1); homicide of brother and suicide of father(n = 1)*
Carrigan and Allez (2017)[1,3]	*Case report*	*Referral by his GP to the Community Learning Disabilities Team.*	*N = 1 (ASD, PTSD)*	None	*26*	*Male*	*Childhood diagnosis of ASD*	*Mild learning disability; IQ not specified*	*Sexual assault*
Carvill and Marston (2002)[1]	*Case series*	*Referrals to South Birmingham Psychiatry of ID service between 1996 and 1999*	*N* = 8 (atypical ASD, sensory impairments)	None	30.5	12.5% (1/8)	*Clinical assessment using ICD-10 criteria, using information systematically gathered from staff, families and medical records. Behaviour monitored for 4–6 weeks.*	2/8 Moderate ID; 6/8 Severe ID; IQ not specified	Past recurrent abuse *(n = 1)*; Several moves *(n = 1)*
Cook et al. (1993)[1,3]	*Case report*	*Referred psychiatric clinic because of persistent, severe delays in language, poor social relatedness, and stereotypes behaviours* (e.g. *spinning and hand flapping)*	*N* = 1 (autistic disorder, PTSD)	None	12	Male	*Psychiatrists evaluation using DSM-III-R criteria, Autistic Diagnostic Interview* [b] (ADI; Le Couteur et al. 1989*) algorithm, and Childhood Autism Rating Scale* [c] *(CARS; Schopler* et al. 2002*)*	Severe delays in language and marked limitations in ability to communicate—although verbal; IQ not specified	Physical abuse
de Bruin et al. (2007)[1,2]	Cross sectional	All consecutive referrals to an outpatient treatment clinic between July 2002 and September 2004, screened for PDD-NOS and asked to participate via opt-in.	PDD-NOS (*N* = 94)	None	8.5 (6–12)	11.7%	Multidisciplinary team obtained consensus for final DSM-IV classification, using semi-structured interviews with parents, psychiatric observation of child and review of school and medical records. ADOS-G [c] completed in 93.6% of the sample, but 42.1% did not meet criteria on this. Rated according to the PDD-NOS research criteria (Buitelaar et al. 1999).	IQ, M = 91.22 (range = 55– 120)	Not reported
Harley et al. (2014)[1,3]	*Case report*	*Referred to a clinical service because of*		None	*6*	*Male*	*Diagnosed at age of 2 years old and*	*Not specified*	*Exposure to domestic*

Table 1 (continued)

First author (year)	Study type	Reason for referral (Case reports) or sampling technique (Group studies)	ASD participants	Comparison group	Mean age in years (range)	Female % or gender	ASD method of diagnosis	Level of functioning	Trauma types
		trauma history and difficulties with cognitive, behavioural and social functioning	*N = 1 (Autism, DBD-NOS, PTSD)*				*confirmed* via *a psychological assessment during treatment.*		*violence and experiencing physical and emotional abuse.*
Hofvander et al. (2009)[1,2]	Cross sectional	Consecutively referred adults with normal intellectual functioning, with possible childhood-onset neuro-psychiatric disabilities a hospital in Paris and a hospital in Gothenburg, who sub-sequently met criteria for ASD.	Autism ($N = 5$) AS ($N = 67$) PDD NOS ($N = 50$)	None	Median = 29 (16–60)	33%	Clinical diagnosis of ASD (DSM-IV), confirmed by clinicians in the study. 87% of the sample completed the Asperger Syndrome Diagnostic Interview [b] (ASDI; Gillberg et al. 2001). Diagnosis assigned according to DSM-IV and the Gillberg & Gillberg (1989) criteria	Specified as having "normal intelligence"	Not reported
Hollocks et al. (2016)[1,2]	Cross sectional	ASD: Recruited from NHS treatment clinics Controls: recruited from local schools and public advertisement, no history of psychiatric or neurological problems	ASD ($n = 55$)	Typically developing controls ($n = 28$)	(10–16)	0%	Diagnosis by local clinicians. Confirmed for 30/55 cases using ADOS-G [c] and/or ADI-R [b], remaining participants confirmed using score of > 15 on the Social Communication Questionnaire [a] (SCQ; Rutter et al. 2003).	IQ and reading level ≥ 70	Not reported
Kosatka and Ona (2014)[1,3]	*Case report*	Referred *to a clinical service* for psychiatric evaluation because of impairing symptoms.	*N = 1 (AS, PTSD)*	None	*21*	*Female*	Diagnosed by psychological testing at 18 years of age	*Average IQ, spelling 1SD below average*	*Abuse by peers in school.*
Mattila et al. (2010) [1]	Cross-sectional	Recruited from both a community based sample ($n = 18$) and a clinic sample ($n = 32$)	AS/HFA ($n = 50$)	No TD group; compared clinic and community based samples with ASD	12 (9–16)	*24%*	Clinical diagnosis prior to the study. Confirmed by Finnish versions of the Autism Spectrum Screening Questionnaire [a] (ASSQ; Ehlers et al. 1999), the Autism Diagnostic Interview-Revised [b] (ADI-R; Lord et al. 1994), and the Autism Diagnostic Observation Schedule (ADOS-G; Lord et al. 2000).	IQ > 75	Not reported
McConachie et al.	RCT	Recruited via clinician approach to parents	ASD ($n = 32$)	No TD group; compared	11 (9–13)	12.5%	Clinical diagnosis prior to the study. Confirmed	IQ, M = 100	Not reported

Table 1 (continued)

First author (year)	Study type	Reason for referral (Case reports) or sampling technique (Group studies)	ASD participants	Comparison group	Mean age in years (range)	Female % or gender	ASD method of diagnosis	Level of functioning	Trauma types
(2014)[1,2]		using CAMHS services, via opt-in. Excluded children with untreated ADHD or oppositional behaviour. Treatment-seeking sample. Recruited to have at least one anxiety disorder.		immediate treatment and delayed treatment groups with ASD			using score of > 15 on the Social Communication Questionnaire [a] (94%) (SCQ; Rutter et al. 2003) and/or over threshold on the ADOS [d] (84%).		
Mehtar and Mukaddes (2011)[1,2]	Cross-sectional	All regular attendants of the Autism Clinic at Istanbul School of Medicine. Recruited during follow up appointment, via opt-in. Followed up over a period of 1–12 years.	Autism ($n = 59$) AS (n = 5) PDD-NOS ($n = 5$)	No TD comparison group; data compared between individuals with and without trauma histories	11.7 (6–18)	23%	Diagnosis according to DSM-IV criteria. Re-confirmed by study team.	Borderline – normal range ($n = 19$; 27.5%); Mild LD ($n = 5$; 7.2%); Moderate LD ($n = 27$; 39.1%); Severe LD ($n = 18$; 26.1%)	Witnessing or being victim of an accident or disaster ($n = 9$); Witnessing or being victim of violence, physical or sexual abuse ($n = 9$); multiple traumas ($n = 3$)
Mevissen et al. (2011) [1,3]	*Case series*	*Referred for specialist assessment and treatment.*	*N = 1 (Autism, OCD, PTSD)*	None	*7*	*Female*	*Diagnosed with childhood disorder NOS age 6; diagnosed with multiple complex developmental disorder age 7 due to disturbing thoughts; post-therapy diagnosis changed to autistic disorder, as traumas had been identified which explained disturbing thoughts.*	*Borderline (IQ = 71)*	*Witnessed sudden death of family member, learned about father's best friend being found with stab wounds and seeing pictures of classmate in hospital with life threatening illness.*
Reinvall et al. (2016)[1,2]	Cross sectional	Unclear whether self-referral permitted. ASD: recruited from a hospital in Helsinki and a private medical centre, via opt-in. TD: recruited from mainstream school in same borough as hospital, via opt-in.	AS and no major genetic or neurological disorders ($N = 60$)	No neurological disorders, learning difficulties, psychiatric disorders or ASD based on parent report ($N = 60$)	ASD: 11.6 (6.5–16.7) TD: 11.1 (6.9–16.2)	ASD: 20% TD: 22%	Clinical diagnosis (ICD-10) prior to study; confirmed via ADI-R [b] in the study	ASD: No learning disability (M = 105.5) Comparison: IQ not tested but attending mainstream school.	Not reported
Ryan (1994)[1,3]	*Case Example*	*Referral to developmental disorders service for consultation and evaluation of abrupt shrieking, drawing up of legs and scratching legs and abdomen.*	*N* = 1 (autism, PTSD)	None	21	Female	*Diagnosis was present since childhood and author states it was "correctly diagnosed"*	Profound intellectual disability and no spoken language; IQ not specified	Physical and sexual abuse

Table 1 (continued)

First author (year)	Study type	Reason for referral (Case reports) or sampling technique (Group studies)	ASD participants	Comparison group	Mean age in years (range)	Female % or gender	ASD method of diagnosis	Level of functioning	Trauma types
Storch et al. (2013)[1,2]	Cross-sectional	Treatment-seeking sample. Recruited to have an anxiety disorder. Recruitment strategy not specified.	Autism ($n = 28$) AS ($n = 39$) PDD-NOS ($n = 35$)	No TD comparison group; data compared between individuals with and without suicidal thoughts/ behaviours	10.55 (7–16)	23%	Clinical diagnosis prior to study. Confirmed by ADOS [c] and ADI-R [b], and a psychologist according to DSM-IV-TR criteria [d].	IQ ≥ 70	Not reported
Taylor and Gotham (2016)[1,2]	Cross-sectional	Recruited through local treatment clinics, other autism studies, local support groups, service providers and autism organisations.	ASD ($n = 36$)	None	18.7 (17–22)	16.7%	Clinical diagnosis prior to study. Confirmed via ADOS-G [c] and ADI-R [b] in the study	Mean not specified (IQ, range = 40–137). 27.8% IQ ≤ 70 11.1% IQ 71–85 27.1% IQ 86–100 33.3% IQ > 100	Full range of traumatic life events endorsed, including witnessing abuse. 56% experienced death of someone close to them, 50% a life-threatening injury or illness of someone in the home, 31% parental divorce.
Trelles Thorne et al. (2015)[1,3]	*Case report*	*Referred to a clinical service due to worsening aggressive and self-injurious behaviour and multiple behavioural problems*	*N = 1 (ASD, ADHD, PTSD)*	None	*9*	*Male*	*Diagnosed with PDD-NOS at 18 months and confirmed by author using Autism Mental Status Examination [c] (Grodberg* et al. 2012*)*	*Borderline intellectual* functioning; IQ = 79	*Physical and emotional abuse and exposure to domestic violence*
Ung et al. (2014)[1]	Cross sectional	Recruited via clinical referrals, flyers, brochures and organisations. Treatment-seeking sample. Recruited to have at least one anxiety disorder.	Autism ($N = 23$) AS ($n = 32$) PDD-NOS ($n = 15$)	None	11 (7–16)	16%	ASD diagnosis prior to study; confirmed via ADOS-G [c] and ADI-R [b] in the study	Full scale IQ ≥ 70	Not reported
Weiss and Lunsky (2010)[1]	*Case series*	*Clinic referral or self-referral for clinical trial of a manualised CBT treatment for mood and anxiety disorders in ASD*	$N = 3$ (AS) [$N = 1$ with PTSD]	None	Mid 40's [PTSD case: Mid 30's]	66.6% (1/3) [PTSD case: Female]	*Diagnosis confirmed by a physician or psychologist and using the Adult Asperger Assessment [a]* (Baron-Cohen et a. 2005)	*IQ > 85*	*Several sexual assaults (n = 1)*
White et al. (2012)[1,2]	Cross-sectional	Recruited via specialist ASD clinic and flyers sent out local services, school and media advertising.	AS ($N = 16$) Autism ($N = 10$) PDD-NOS ($N = 4$)	None	14.58 (12–17)	23%	ASD diagnosis prior to study; ADOS-G [c] (Lord et al. 2000) and ADI-R [b] (Lord et al. 1994)	No diagnosis of intellectual disability; verbal IQ > 70 (Verbal IQ, M = 97)	Not reported

Table 1 (continued)

First author (year)	Study type	Reason for referral (Case reports) or sampling technique (Group studies)	ASD participants	Comparison group	Mean age in years (range)	Female % or gender	ASD method of diagnosis	Level of functioning	Trauma types
		Treatment-seeking sample. Recruited to have at least one anxiety disorder.					completed during study, but not specified if all subjects crossed thresholds for ASD		
White et al. (2013)[1,2]	RCT	Recruited through university-affiliated autism centres, referrals from local clinicians, clinics, schools and media advertisements. Treatment-seeking sample. Recruited to have at least one anxiety disorder.	Autism ($n = 10$) PDD-NOS ($n = 4$) AS ($n = 16$)	No TD comparison group; data compared across the intention to treat and waitlist groups.	15 (12–17)	23%	Clinical diagnosis prior to the study. Confirmed by ADOS-G [c] in the study.	IQ, M = 97.07	Not reported
Wood et al. (2009)[1,2]	RCT	Recruited from an autism clinic in a medical centre, regional centres, parent support groups and schools. Treatment-seeking sample. Recruited to have at least one anxiety disorder.	Autism ($n = 20$) PDD-NOS ($n = 17$) AS ($n = 3$)	No TD comparison group; data compared across the intention to treat and waitlist groups.	9 (7–11)	33%	Diagnosis based on ADI-R [b] scores, ADOS-G [c] scores, a parent-report checklist pertaining to children's circumscribed interest [b] and a review of medical records. An algorithm was used to determine between ASD subtypes (Klin et al. 2005)	IQ ≥ 70	Not reported
Wood et al. (2015)[1,2]	RCT	Recruited through two university-affiliated autism centres in America via opt-in and self-referrals. Treatment-seeking sample. Recruited to have at least one anxiety disorder.	Autism ($n = 22$) PDD-NOS ($n = 3$) AS ($n = 8$)	No TD comparison group; data compared across the intention to treat and waitlist groups.	12.3 (11–15)	33%	Clinical diagnosis prior to study participation. Confirmed by ADOS-G [c] and ADI-R [b] in the study.	IQ ≥ 85	Not reported

Note: Case reports/series indicated as italicised font. Study meets criteria for inclusion based on: [1] assessment; [2] rates of PTSD; [3] treatment. Measures: [a] self-report; [b] parent/carer report; [c] clinician rating scale

AS Asperger's disorder, *ASD* autism spectrum disorder, *HFA* high functioning autism, *DBD* disruptive behaviour disorder, *OCD* obsessive-compulsive disorder, *LD* learning disability

Table 2 Outcomes of the studies included in the review

Assessment, prevalence and presentation of PTSD				Treatment of PTSD			
First author (year)	PTSD method of diagnosis (interview or questionnaire)	Proportion of PTSD cases in ASD sample (%)	Outcome of assessment: symptom presentation and/or comparisons across groups	PTSD treatment method (n sessions)	Treatment outcome measure	Treatment outcome assessed at	Outcome of treatment
Barol and Seubert (2010)[1]	*Assessment battery made up of: List of the 19 DSM IV PTSD symptoms; 59 items from the Psychiatric Questionnaire, an adaptive checklist of psychiatric symptoms; and a generic list of 32 possible indicators of PTSD in this population. Combined with self-reporting, caregiver observations and ongoing in-session response scores using SUD and VOC scales.*	*N/A*	*Not specified*	*N/A*	*N/A*	*N/A*	*N/A*
Carrigan and Allez (2017)[1,3]	*Clinician lead assessment of symptomatology (according to ICD-10 criteria)* via *patient self-report; Revised Child Impact of Events Scale* [a] *(CRIES-8; Perrin* et al. 2005*)*	*N/A*	*Patient was able to describe what he experienced mentally and emotionally such that it was clear he was suffering from PTSD according to ICD-10 criteria; CRIES-8 score of 32 (well above recommended cut off of 17) supporting PTSD diagnosis. Symptoms over the last 3 years included: arguments with parents, angry outbursts in the community (where he described feeling threatened), belief that people are out to get him and not to be trusted, blaming himself for the trauma, reduced time spent outside the house, avoiding walking to the shops alone, difficulty falling and staying asleep, remaining alert for threat, avoiding the location where the attack happened,*	*12 weeks of CBT for PTSD using Ehlers* et al. *(2005) approach, with time spent adapting language and explaining metaphors to help with engagement. One hour sessions. Few of the procedures of the cognitive therapy for PTSD, apart from language and greater explanation of metaphors, had to be adapted for the patients ID or ASD, and cognitive restructuring was possible, showing the patient was able to engage in the metacognitive processes required for cognitive therapy.*	*PTSD symptom reduction according to CRIES-8 self–report, combined with patient self-report and parent report of symptoms.*	*6 and 8 months*	*Post-therapy CRIES-8 self-report score reduced to 11. Patient and parent reported symptom reduction. At 6-month follow-up gains were reported as maintained, but CRIES-8 not administered. Patient no longer experienced flashbacks, had improved sleep, no longer argued with parents or had outbursts, was more affectionate with his siblings and nephew, no longer had nightmares, felt more in control of his memories of the attack, no longer avoided places he had before.*

Table 2 (continued)

Assessment, prevalence and presentation of PTSD				Treatment of PTSD			
First author (year)	PTSD method of diagnosis (interview or questionnaire)	Proportion of PTSD cases in ASD sample (%)	Outcome of assessment: symptom presentation and/or comparisons across groups	PTSD treatment method (n sessions)	Treatment outcome measure	Treatment outcome assessed at	Outcome of treatment
			difficulties concentrating on TV programmes or books, suppressing trauma memories, ruminating about what he could have done to prevent the trauma, flashbacks of the trauma, concern that trauma symptoms were a sign of madness.				
Carvill and Marston (2002)[1]	*Clinical assessment of symptoms suggestive of ICD-10 criteria* via *information from staff, families and previous psychiatric concerns. Behaviour monitored for 4–6 weeks.*	*N/A*	*It was not possible to assign accurate and reliable ICD-10 diagnosis for 2 patients due to their unusual behavioural presentation. In two of these cases where accurate diagnosis could not be made, a "probable differential diagnosis" of "PTSD or depressive illness" and "Anxiety disorder or PTSD" was made.*	*N/A*	*N/A*	*N/A*	*N/A*
Cook et al. (1993)[1,3]	*Psychiatrists evaluation using direct interview techniques with the patient, diagnosis made according to DSM-III-R criteria*	*N/A*	*Patient initially reported the abuse to his parents, who noticed a number of changes in his behaviour around this time. During psychiatrists interview, the patient was able to report the events of abuse and his related emotional state. PTSD was diagnosed according to DSM-III-R criteria.*	*Individual psychotherapy, with additional support for parents. Therapist and parents enabled patient to ventilate his feelings and reassured him regarding current and future safety (n sessions not reported)*	*Psychiatrists assessment*	*Follow-up over 4 years post-trauma.*	*Reduced anxiety symptoms including no emotional distress on talking about the school (trauma setting) and reduced frequency of reexperiencing symptoms. Increased anxiety continued to occur towards environmental trauma reminders (anniversaries and visiting similar buildings). 4 years later the client continued to show increased anxiety to trauma reminders but frequency of reexperiencing symptoms reduced.*

Table 2 (continued)

Assessment, prevalence and presentation of PTSD				Treatment of PTSD			
First author (year)	PTSD method of diagnosis (interview or questionnaire)	Proportion of PTSD cases in ASD sample (%)	Outcome of assessment: symptom presentation and/or comparisons across groups	PTSD treatment method (n sessions)	Treatment outcome measure	Treatment outcome assessed at	Outcome of treatment
de Bruin et al. (2007)[1,2]	Dutch version of the DISC-IV [b] (Ferdinand & van der Ende 1998; Shaffer et al. 1993)	0/94 (0%)	19.1% had no co-morbidities, 13.8% met criteria for mood disorders, 55.3% met criteria for an anxiety disorder, 19.1% had internalising disorders, 21.3% disruptive behaviour disorders, 40.5% internalising and disruptive behaviour disorders. No PTSD cases.	N/A	N/A	N/A	N/A
Harley et al. (2014)[1,3]	*Trauma Symptom Checklist for young children [b] (TSCYC; Briere 2005); Life events measured by - Traumatic Events Screening Inventory [b] (TESI-PRR; Ghosh-Ippen* et al. *2002) and Life Stressor Checklist Revised [b] (Wolfee* et al. *1993).*	*N/A*	*Clinically significant symptoms of avoidance, arousal, anger and aggression on TSCTC. Total score on TSCTC for PTSD was clinically significant but in normal range for intrusions sub-scale.*	*Child-parent psychotherapy (CPP). 60-min weekly sessions, held with father and aunt, together with child. 8 session assessment and engagement phase. 27 session intervention phase working with all family and using play with the child. Occupational therapist brought in as co-therapist half way through to aid engagement. Building safe relationships and bonds. 8 session Termination phase.*	*Trauma Symptom Checklist for young children (TSCYC) [b]; Family Impact of Childhood Disability Scale (FCID) [b]; Parenting Stress Index-Short Form (PSI-SF - measure of parental distress) [b]; qualitative exit interview with father and aunt.*	*Post-treatment*	*Substantial improvement in PTSD symptoms on TSCYC scores, with only the avoidance scale remaining clinically significant and overall profile no longer suggestive of PTSD. Father endorsed more positive consequences of having a child with a disability on the FCID, although continued to report some negative consequences. Father also continued to experience high levels of stress in parent-child dysfunctional interaction and difficult child sub-scales. No longer met criteria for Disruptive Behaviour Disorder NOS. Eye contact and social overtures had increased*
Hofvander et al. (2009)[1,2]	Structured Clinical Interview for DSM-IV - Axis I disorders [a] (SCID; First et al. 1997) $n = 63$; all other participants had DSM-IV-based	2/122 (1.6%)	Lifetime DSM-IV ratings: 43% met criteria for ADHD, 14% met criteria for dyslexia, 12% met criteria for a psychotic disorder, 53% for lifetime mood	N/A	N/A	N/A	N/A

Table 2 (continued)

Assessment, prevalence and presentation of PTSD				Treatment of PTSD			
First author (year)	PTSD method of diagnosis (interview or questionnaire)	Proportion of PTSD cases in ASD sample (%)	Outcome of assessment: symptom presentation and/or comparisons across groups	PTSD treatment method (n sessions)	Treatment outcome measure	Treatment outcome assessed at	Outcome of treatment
	structured clinical interviews including a lifetime DSM-IV symptoms checklist with individual criteria or symptom definitions for all Axis I disorders. Axis II disorders assessed in 96% of the sample, using either the SCID-II ($n = 95$) or a clinical interview.		disorder, 8% for bipolar disorder,16% met criteria for substance misuse, 62% for a personality disorder, 1.6% for PTSD.				
Hollocks et al. (2016)[1,2]	The Child and Adolescent Psychiatric Assessment [b] (CAPA; Angold and Costello 2000)	0/55 0%	21 of the ASD group did not meet criteria for any anxiety disorder. 76% of those that did meet anxiety criteria had more than one co-occurring anxiety disorder. No participants met criteria for PTSD.	N/A	N/A	N/A	N/A
Kosatka and Ona (2014)[1,3]	Psychiatrists assessment and diagnosis. Diagnosis changed from anxiety disorder NOS to PTSD.	N/A	Avoidance of strangers, difficulties sleeping and anhedonia.	Zoloft 100 mg PO daily and EMDR treatment administered according to standard procedures with eye movement for BLS. Events targeted from least to most traumatic to avoid overwhelming patient. Mother present during all sessions as requested by client. 3 sessions a week on Monday, Wednesday, Friday ($n = 9$ sessions). Some difficulty putting emotions into words during assessment phase of EMDR Client able to tolerate EMDR using eye movements, only side effect was vivid dreams.	PTSD checklist [a] (PCL; DSM-IV; Weathers et al. 1994)	Post-treatment and 8 months follow-up	Post-intervention PCL score reduced from 60 to 23. Two of worst traumas reduced from 10/10 SUDS to 0/10 SUDS. At follow-up, PCL score was 21. Happy in mood and no hand wringing or hair twirling seen. Still taking Zoloft 100 mg PO daily and Trazodone 50 mg PO qhs for sleep. Improvements in social life.
Mattila et al. (2010) [1]	K-SADS-PL [a b] (Kaufman et al.1997) assessing current and lifetime episodes	Not reported	Not reported	N/A	N/A	N/A	N/A

Table 2 (continued)

Assessment, prevalence and presentation of PTSD				Treatment of PTSD			
First author (year)	PTSD method of diagnosis (interview or questionnaire)	Proportion of PTSD cases in ASD sample (%)	Outcome of assessment: symptom presentation and/or comparisons across groups	PTSD treatment method (n sessions)	Treatment outcome measure	Treatment outcome assessed at	Outcome of treatment
	according to DSM-IV criteria. Not including the exclusionary rules in DSM-IV regarding Autism.						
McConachie et al. (2014)[1,2]	ADIS-IV-C/P (Silverman & Albano, 1996). Child version is specified, however the paper also states "the trained interviewer elicited parent's observations of the child's behaviours and severity of impact on family life and recorded a clinical severity rating". [a or b - unclear]	1/32 (3.1%)	The most common anxiety disorders included generalised anxiety disorder (GAD) ($n = 26$; 81%), specific phobia ($n = 27$; 84%) and social anxiety disorder ($n = 22$; 69%).	N/A	N/A	N/A	N/A
Mehtar and Mukaddes (2011)[1,2]	K-SADS-PL, PTSD scale [ab] (Kaufman et al. 1997). Current and lifetime episodes using DSM-IV criteria; completed with child only where possible.	12/69 (17.4%) 12/18 with trauma history (66.7%)	Mean duration of PTSD symptoms was 18.75 (range = 1.5–50 months). The trauma history group had showed significantly more disruptive behaviour on the Turkish version of the ABC, than those without trauma exposure. Those with trauma also showed deterioration in ASD symptoms, aggression and agitation, sleep and appetite disturbance, self-harm and increased activity levels.	N/A	N/A	N/A	N/A
Mevissen et al. (2011)[1,3]	*Interview with parents and caregivers according to DSM-IV and DM-ID*	*N/A*	*Met criteria for PTSD according to DSM-IV and DM-ID. For DSM--IV: Parents unable to report criterion A2 as concealed emotional impact of event from caregivers. Criterion B (re-experiencing) able*	*EMDR treatment using the story telling method (due to poor communication and reluctance to follow instructions) and buzzers in hands for BLS. (4 sessions = 1 for preparation and 3 treatment sessions).*	*Interview with parents and caregivers according to DSM-IV and DM-ID*	*Post-intervention and 7 weeks and 3 months follow-up.*	*Disturbing thoughts disappeared, sustained improvements at 7 weeks follow-up. More positive mood and decrease in anger; more relaxed generally. Depressive symptoms decreased. No longer met criteria*

Table 2 (continued)

Assessment, prevalence and presentation of PTSD				Treatment of PTSD			
First author (year)	PTSD method of diagnosis (interview or questionnaire)	Proportion of PTSD cases in ASD sample (%)	Outcome of assessment: symptom presentation and/or comparisons across groups	PTSD treatment method (n sessions)	Treatment outcome measure	Treatment outcome assessed at	Outcome of treatment
			to report (disturbing thoughts). Criterion C relies too strongly on verbal, subjective reporting for clients with ID. Criterion D only reported anger outbursts, but unclear if other symptoms not noted by caregivers. Symptoms included: Fears, Compulsive behaviours, outbursts of anger, frequent mood changes, disturbing thoughts about illness/knives/-death.	*Treatment had to be adapted for cognitive and emotional level.*			*for PTSD according to DSM-IV or DM-ID. At 3 months results were maintained.*
Reinvall et al. (2016)[1,2]	Development and Well-Being Assessment [b] (DAWBA; Goodman et al. 2000). Diagnosis according to DSM-IV and ICD-10 made by an experienced child psychiatrist based on the DAWBA	*ASD:* 1/60 (1.7%) *TD:* 0/60 (0%)	No significant differences between rates of PTSD in ASD and TD samples, or between the current ASD sample and the prevalence rates for TD children and adolescence (0.1%) from a larger scale ($N = 10,438$) study using the DAWBA (Ford et al. 2003)	N/A	N/A	N/A	N/A
Ryan (1994)[1,3]	*Functional analysis to rule out any gains, observation, review of videotapes of behaviours in several settings and interview with mother of patient*	*N/A*	*Symptoms included dissociative events/flashbacks of being scalded and sexual abused, triggered by hearing water running. Ongoing sleep disturbance (waking screaming), erratic appetite, hypersensitivity to touch, absence of any sexual behaviour. Crouching in the corner of the clinic room with a terrified facial expression, moaning, hypervigilant, frequent self-scratching,*	*Psychopharmacological: Carbamezepine to address dissociation, tapering and discontinuation of beta blockers and neuroleptics. Behavioural therapy: Systematic desensitisation to water Staff: Retraining staff to reduce the number of dissociations and to assist patient in reorienting when dissociating and supporting patient to*	*None specified*	*Not specified*	*Not specified.*

Table 2 (continued)

Assessment, prevalence and presentation of PTSD				Treatment of PTSD			
First author (year)	PTSD method of diagnosis (interview or questionnaire)	Proportion of PTSD cases in ASD sample (%)	Outcome of assessment: symptom presentation and/or comparisons across groups	PTSD treatment method (n sessions)	Treatment outcome measure	Treatment outcome assessed at	Outcome of treatment
			defensive covering of chest, lower legs and genital area, shrieking, drawing up her legs and a lack of recognition of familiar staff. PTSD was diagnosed according to DSM-III-R criteria.	*find ways to help herself when becoming frightened.*			
Storch et al. (2013)[1,2]	Anxiety Disorder Interview Schedule – Child and Parent versions [ab] (ADIS-IV-C/P; Silverman and Albano 1996). Interviews conducted separately with child and caregiver.	6/102 (5.9%)	Comorbid diagnosis of major depressive disorder/dysthymia and PTSD significantly predicted suicidal thoughts and behaviours. Demographic variables and ASD diagnosis did not predict suicidal thoughts or behaviours, but children with Autism were more likely to have suicidal thoughts and behaviours than those with Asperger's disorder.	N/A	N/A	N/A	N/A
Taylor and Gotham (2016)[1,2]	Schedule of Affective Disorders and Schizophrenia for School Aged Children [b] (K-SADS-PL; Kaufman et al. 1997). Current and lifetime episodes using DSM-IV criteria. Parent report of disorder diagnosed by another medical provider.	0/36 (0%)	25% met clinical criteria for a mood disorder and 25% for an anxiety disorder. Mood and anxiety disorders were not associated with the number of traumatic events experienced. 90% of youth with a mood disorder had experienced a trauma; this association was significant even when accounting for IQ and sex.	N/A	N/A	N/A	N/A
Trelles Thorne et al. (2015[1,3]	*Psychiatrists diagnosis* via *interview with client and with his mother*	*N/A*	*Symptoms included nightmares, waking multiple times in the night, wetting the bed,*	*Guanfacine (0.5 mg orally twice day, titrated to 1 mg over month, increased to*	*Psychiatrists assessment and monitoring.*	*Not specified for psychological interventions; Pharmacological*	*School assistance reduced the frequency of tantrums and aggression. Outcomes*

Table 2 (continued)

Assessment, prevalence and presentation of PTSD				Treatment of PTSD			
First author (year)	PTSD method of diagnosis (interview or questionnaire)	Proportion of PTSD cases in ASD sample (%)	Outcome of assessment: symptom presentation and/or comparisons across groups	PTSD treatment method (n sessions)	Treatment outcome measure	Treatment outcome assessed at	Outcome of treatment
			fear of a strange man coming into his room and harming the family, becoming emotionally dysregulated when abuse mentioned. Sadness and withdrawal from family over last year. Aggressive and self-injurious behaviour, behavioural problems at home and school, frequent and severe temper tantrums, including throwing things and biting and kicking others, requiring A&E visit. Easily frustrated and oppositional, declining academic performance and hyperactivity and impulsivity.	*1.5 mg after sadness, sleep problems and anxiety increased) to treat anxiety, hyperarousal, aggression, irritability and poor sleep. Sertraline (10 mg orally daily) to treat PTSD symptoms, but stopped due to side effects. Aripiprazole (1 mg daily, increased to 2 mg after 3 weeks and to 3 mg during period of worsening irritability and poor sleep) to treat aggression and irritability, self-injury, hyperactivity and stereotypic behaviours. Psychotherapeutic interventions in combination with parental support and therapy, increased frequency of services in school setting (paraprofessional assigned).*		*interventions monitored over 6 months whilst medication changed and reviewed.*	*for psychological and psychoeducational treatments not specified. Authors summarises that "children with complex clinical pictures and comorbidity often do best in multi-modal treatment". Guanfacine showed good response in short period. Developed manic symptoms on Sertraline, which remitted within a week of stopping. Aripiprazole resulted in worsening mood symptoms at dosage above 2 mg, but this stabilised over time on low dose.*
Ung et al. (2014)[1]	ADIS-C/P [ab] (Silverman and Albano 1996) administered separately to children and parents. Diagnosis determined by clinician after considering child and parent responses on ADIS-C/P.	*Not specified*	Not specified	N/A	N/A	N/A	N/A
Weiss and Lunsky (2010)[1]	*Structured Clinical Interview of DSM-VI-TR Axis 1 disorders [a] (SCID-I/P; First* et al. 1997*)*	*N/A*	*Meet criteria for Past Major Depressive Episode which occurred earlier that year, post-ASD diagnosis. Met criteria for substance dependence*	*N/A*	*N/A*	*N/A*	*N/A*

Table 2 (continued)

Assessment, prevalence and presentation of PTSD				Treatment of PTSD			
First author (year)	PTSD method of diagnosis (interview or questionnaire)	Proportion of PTSD cases in ASD sample (%)	Outcome of assessment: symptom presentation and/or comparisons across groups	PTSD treatment method (n sessions)	Treatment outcome measure	Treatment outcome assessed at	Outcome of treatment
			(Marijuana use almost daily, but agreed not to use before groups). PTSD was diagnosed according to DSM-VI-TR criteria. Reported feeling trapped and angry and tried to put it out of her mind. She experienced intrusive memories and flashbacks. She described often feeling angry, as she had during the traumas and having intense distress to trauma reminders.				
White et al. (2012)[1,2]	Anxiety Disorders Interview Schedule for Children/Parents [ab] (ADIS-C/P; Silverman and Albano 1996) jointly administered to children and parents. Severity rating assigned by interviewer based on symptom scores, severity scores and clinical observation, careful not to double-code ASD features as anxiety symptoms.	1/30 (3.3)	Not specified	N/A	N/A	N/A	N/A
White et al. (2013)[1,2]	ADIS-IV-C/P [a b] (Silverman & Albano 1996), conducted jointly with child and caregiver.	1/30 (3.3%)	Primary diagnosis included social anxiety disorder ($n = 23$), separation anxiety ($n = 1$), specific phobia ($n = 16$) obsessive compulsive disorder ($n = 4$) and generalised anxiety disorder ($n = 19$), panic disorder with agoraphobia ($n = 1$). Only one participant met criteria for PTSD	N/A	N/A	N/A	N/A

Table 2 (continued)

Assessment, prevalence and presentation of PTSD				Treatment of PTSD			
First author (year)	PTSD method of diagnosis (interview or questionnaire)	Proportion of PTSD cases in ASD sample (%)	Outcome of assessment: symptom presentation and/or comparisons across groups	PTSD treatment method (n sessions)	Treatment outcome measure	Treatment outcome assessed at	Outcome of treatment
Wood et al. (2009)[1,2]	ADIS-IV-C/P –Parent versions [b] (Silverman & Albano 1996).	1/40 (2.5%)	Primary diagnosis included social anxiety disorder ($n = 35$), separation anxiety ($n = 24$), obsessive compulsive disorder ($n = 17$) and generalised anxiety disorder ($n = 19$). Only one participant met criteria for PTSD	N/A	N/A	N/A	N/A
Wood et al. (2015)[1,2]	ADIS-IV-C/P [a b] (Silverman & Albano 1996), conducted separately with child and caregiver.	1/33 (3%)	Primary diagnosis included social anxiety disorder ($n = 14$), separation anxiety ($n = 7$), obsessive compulsive disorder ($n = 3$) and generalised anxiety disorder ($n = 9$). Only one participant met criteria for PTSD	N/A	N/A	N/A	N/A

Note: Case reports/series indicated as italicised font. Study meets criteria for inclusion based on: [1] assessment; [2] rates of PTSD; [3] treatment. Measures: [a] self-report; [b] parent/carer report; [c] clinician rating scale

AS Asperger's disorder, *ASD* autism spectrum disorder, *HFA* high functioning autism, *DBD* disruptive behaviour disorder, *OCD* obsessive-compulsive disorder, *LD* learning disability

Table 3 Quality assessment of methodology for included studies using a case report or case series design: Checklist for Case Reports (Johanna Briggs Institute 2016; http://joannabriggs.org/research/critical-appraisal-tools.html)

First author (year)	Clear description demographics	Clear description patient's history and timeline	Clear description current clinical conditions	Clear description diagnostic tests or assessment methods and result of these	Clear description of the intervention or treatment procedure	Clear description post-intervention clinical conditions	Were any adverse reactions, unanticipated events or necessary modifications described	Does the case report provide takeaway lessons regarding assessment and treatment of PTSD in ASD
Barol and Seubert (2010) [1]	Yes	Yes	No—ASD and PTSD presentation and DSM criteria	Yes—assessment PTSD No—assessment ASD & PTSD assessment outcome	Yes	Yes—descriptively No—diagnostically	Yes—specifies none present	Yes
Carrigan and Allez (2017) [1,3]	Yes	Yes	Yes	Yes—PTSD No—ASD	Yes	Yes	Yes	Yes
Carvill and Marston (2002)[1]	Yes	No	Yes	Yes	Yes	No	Yes	Yes
Cook et al. (1993) [1,3]	Yes	No—prior history Yes—post-assessment	Yes	Yes	Yes—psychopharmacology No—psychotherapy	Yes—psychopharmacology No—psychotherapy	Yes—psychopharmacology No—psychotherapy	Yes—Assessment and systemic issues No—Treatment
Harley et al. (2014)[1,3]	Yes	Yes	No—PTSD symptoms Yes—other conditions	Yes	Yes	Yes	Yes	Yes
Kosatka and Ona (2014) [1,3]	Yes	Yes	No—limited description of PTSD symptoms	Yes	Yes	Yes	Yes	Yes
Mevissen et al. (2011) [1,3]	Yes	Yes—traumas and ASD No—school, home life, health	Yes	Yes—PTSD No—ASD	Yes	Yes	Yes	Yes
Ryan (1994) [1,3]	Yes	No	Yes	No	Yes	No	No	Yes—Assessment No—Treatment
Trelles Thorne et al. (2015 [1,3]	Yes	Yes	Yes	Yes	Yes—pharmacology No—psychological and school interventions	No	Yes—pharmacology No—psychological and school	No—Assessment Yes—Treatment
Weiss and Lunsky (2010) [1]	Yes	Yes	Yes	Yes	Yes	No—PTSD Yes—depression and anxiety	Yes	No—Assessment Yes—Treatment

Note: Study meets criteria for inclusion based on [1] assessment; [2] rates of PTSD; [3] treatment

Table 4 Quality assessment of methodology for included studies using a quantitative design: EPHPP quality assessment tool for quantitative studies (Effective Public Health Practice Project; www.ephpp.ca/tools.html)

First author (year)	Representative of ASD	% agreed participate	Rating Selection bias	Study design	Randomised	Rating Study design	Aware research Q re Anxiety	Rating blinding	Tools valid	Tool reliable	Rating Data collection method	Unit analysis	Statistics appropriate	Global rating
de Bruin et al. (20077)[1,2]	2	1	2	7a	N/A	2	1	3	3	3	3	Individual	Yes	3 (weak)
Hofvander et al. (2009)[1,2]	2	1	2	7a	N/A	2	1	3	3	3	3	Individual	Yes	3 (weak)
Hollocks et al. (2016)[1,2]	2	5	2	7b	N/A	2	1	3	3	3	3	Individual	Yes	3 (weak)
Mattila et al. (2010)[1]	1	1	1	7b	N/A	2	1	3	3	3	3	Individual	Yes	3 (weak)
McConachie et al. (2014)[1,2]	2	1	2	1	Yes	1	1	3	1	1	1	Individual	Yes	2 (moderate)
Mehtar and Mukaddes (2011)[1,2]	2	1	2	7a	N/A	2	1	3	3	3	3	Individual	Yes	3 (weak)
Reinvall et al. (2016)[1,2]	2	5	2	7b	N/A	2	3	3	3	3	3	Individual	Yes	3 (weak)
Storch et al. (2013)[1,2]	2	5	2	7a	N/A	2	1	3	1	1	1	Individual	Yes	2 (moderate)
Taylor and Gotham (2016)[1,2]	1	5	1	7 a	N/A	2	3	3	3	3	3	Individual	Yes	3 (weak)
Ung et al. (2014)[1]	2	5	2	7a	N/A	2	1	3	1	1	1	Individual	Yes	2 (moderate)
White et al. (2012)[1,2]	2	5	2	7a	N/A	2	1	3	1	1	1	Individual	N/A	2 (moderate)
White et al. (2013)[1,2]	2	4	2	1	Yes	1	1	3	1	1	1	Individual	Yes	2 (moderate)
Wood et al. (2009)[1,2]	2	5	2	1	Yes	1	1	3	1	1	1	Individual	Yes	2 (moderate)
Wood et al. (2015)[1,2]	2	4	2	1	Yes	1	1	3	1	1	1	Individual	Yes	2 (moderate)

Note: 7[a] cross-sectional within groups; 7[b] cross-sectional between groups. Study meets criteria for inclusion based on: [1] assessment; [2] rates of PTSD; [3] treatment

by Carvill and Marston (2002) PTSD could not be reliably diagnosed according to ICD-10 criteria due to the clients' unusual behavioural presentation and in a further case of a client with LD the caregiver was unable to report the client's emotional state (Mevissen et al. 2011).

Anger, arguments, aggressive and oppositional behaviour at home and school or temper tantrums/outbursts, with parents and people in the community, were also reported in three children (Trelles Thorne et al. 2015; Harley et al. 2014; Mevissen et al. 2011) and two adults (Weiss and Lunsky 2010; Carrigan and Allez 2017). Symptoms which are suggestive of additional impacts on mood included reporting sadness and withdrawal (Trelles Thorne et al. 2015), anhedonia (Kosatka and Ona 2014), frequent mood changes (Mevissen et al. 2011) an erratic appetite, lost interest in activities (Weiss and Lunsky 2010), absence of sexual behaviour and self-harm. Additional symptoms which may be indicative of an exacerbation of ASD features and additional functional impairments included increased hypersensitivity to touch, compulsive behaviours, declining academic performance, hyperactivity and impulsivity. Substance dependence was reported in one case (Weiss and Lunsky 2010).

Group Studies

A total of 823 cases were reported across the 14 included papers. Sample size varied from 30 to 122, with a median of 52.5. The majority of studies recruited children and adolescents (White et al. 2012; Ung et al. 2014; Reinvall et al. 2016; de Bruin et al. 2007; Storch et al. 2013; Hollocks et al. 2016) with a mean age of 11.69 years. Only three studies also included individuals aged 18 and over (Hofvander et al. 2009; Taylor and Gotham 2016; Mehtar and Mukaddes 2011). One paper was based on a sample of males (Taylor and Gotham 2016), whilst all other articles were based on mixed-gender samples. The highest proportion of females recruited was 33%, which occurred within three studies (Hofvander et al. 2009; Wood et al. 2009; Wood et al. 2015), the median was 23.5% female participants. Six of the studies selectively advertised for or recruited individuals with an anxiety disorder (White et al. 2012; Ung et al. 2014; Storch et al. 2013; Wood et al. 2009; Wood et al. 2015; White et al. 2013). For a full summary of demographic characteristics, see Table 1.

The traumatic experiences of the samples were not specified in 12 articles. In the two studies that reported their participants had been victims of mixed traumas (Taylor and Gotham 2016; Mehtar and Mukaddes 2011). A range of assessment measures and informants was used across the studies, see Table 2. All articles employed a standardised semi-structured interview to assess PTSD symptomatology, with the most common being the Anxiety Disorders Interview Schedule for Children and Parents (ADIS C/P; Silverman and Albano 1996) which used in six studies

(White et al. 2012; Ung et al. 2014; Storch et al. 2013; Wood et al. 2009; Wood et al. 2015; White et al. 2013). Only Ung et al. (2014) tested the inter-rater reliability of the assessment measure (ADIS C/P) for PTSD diagnosis in youth with ASD. They found the ADIS C/P to have excellent inter-rater reliability (kappa = 1.0); however, the rates of PTSD were not reported. Only three papers specified that the interviewers were careful to take into account the behavioural overlaps between symptoms of anxiety and ASD when coding (White et al. 2012; White et al. 2013; Hollocks et al. 2016).

PTSD symptom presentations were not reported within any of the papers. However, Storch et al. (2013) found that co-occurring ASD, mood disorder and PTSD significantly predicted suicidal thoughts and behaviours, with other individual differences or psychopathology not predicting suicidal ideation or behaviours.

Rates of PTSD Diagnosis in People with ASD

Of the group studies reviewed above, all but two (Ung et al. 2014; Mattila et al. 2010) reported information regarding the occurrence of current (i.e. last month) or lifetime PTSD in a group of individuals with ASD. However, none of these were large-scale well-controlled population-based studies assessing prevalence. Within these 12 studies, rates of PTSD were reported across a total of 703 cases. The mean sample size of studies reporting rates of PTSD was 58.58 (range 30–122). Although all but one study (Hollocks et al. 2016) recruited a mixed-gender sample, no articles reported the rates of PTSD in ASD separately for men and women.

The rates of PTSD reported across the literature to date are presented in Table 5; PTSD rates have been subdivided according to the age of the sample (children/adolescents and adult) and the rating period used for diagnosis (current, lifetime and 12 months). Studies were included in the child/adolescent or the adult category according to the mean age of their sample being under or over 18 years of age, respectively. Seven of the studies assessing current PTSD in children and adolescents selectively advertised for and/or recruited individuals with anxiety disorders (White et al. 2012; Storch et al. 2013; Wood et al. 2009; Wood et al. 2015; White et al. 2013; McConchie 2014; Ung et al. 2014); with this being a necessary prerequisite for access treatment it is possible that individuals may have had an incentive to artificially inflate their symptom reports thus biasing the overall rates of PTSD within the samples. Rates of PTSD occurrence were substantially higher across the aforementioned studies (3.52%) compared to the two studies that measured current PTSD in child and adolescent samples that were not recruited based on any characteristic other than ASD status (0.85%; Reinvall et al. 2016; Hollocks et al. 2016). Across the literature, three studies found no cases that meet criteria for PTSD (de Bruin et al. 2007; Taylor and Gotham 2016; Hollocks et al. 2016). These three papers, with the lowest rates of PTSD, also contained some of the highest proportion of males within their samples (88.3–100%), although all studies reporting rates of PTSD contained predominantly male samples (median 77%, mean 79%).

Treatment of PTSD in People with ASD

Seven papers met eligibility criteria for inclusion in the treatment synthesis, reporting additional information regarding the treatment of PTSD in individuals with ASD. All included papers were case presentations, with no cross-sectional or RCT studies reporting treatment outcomes separately for individuals with PTSD and ASD. The following section provides an expanded overview of the results regarding the treatment of PTSD in individuals with ASD, supplementing the information in Tables 1, 2, and 3.

Cases ranged from 6 to 26 years of age, with the median being 12. Ability levels varied drastically across the cases, as outlined within Table 1. All cases were referred for assessment or treatment within a specialist clinical service. Multiple treatment interventions, combining pharmacological and talking therapies, were employed in the treatment of three cases. Three cases received psychotherapy (Cook et al. 1993; Trelles Thorne et al. 2015; Harley et al. 2014), one received individual CBT therapy using the Ehlers and Clark (2000)

Table 5 Rates of PTSD in individuals with ASD

Age group and rating period for PTSD diagnosis (Studies Included)	N: total sample	Mean rate of PTSD	Mean age (range)	Mean % Females
Children and Adolescents: Current PTSD (White et al. 2012; Reinvall et al. 2016; Storch et al. 2013; Hollocks et al. 2016; Wood et al. 2009; Wood et al. 2015; White et al. 2013; McConachie et al. 2014)	382	2.85%	12.13 (6.5–17)	21%
Children and Adolescents: Lifetime PTSD (Mehtar and Mukaddes 2011)	69[1]	17.4%[1]	11.7 (6–18) [1]	23%[1]
Children and Adolescents: 12-month PTSD (De Bruin 2007)	94[1]	0%[1]	8.5 (6–12) [1]	11.7%[1]
Adults: Lifetime PTSD (Hofvander et al. 2009; Taylor and Gotham 2016)	158	0.8%	23.85 (16–60)	25%

[1] These statistics are gained from one paper and are not an average

approach (Carrigan and Allez 2017), one received behavioural therapy using systematic desensitisation (Ryan 1994), and two received EMDR (Kosatka and Ona 2014; Mevissen et al. 2011). The number of sessions ranged from 4 (EMDR) to 43 (child-parent psychotherapy), with a median of 10.5 sessions; three articles did not report the number of sessions, length of treatment or duration of each therapy session (Ryan 1994; Cook et al. 1993; Trelles Thorne et al. 2015).

Six cases provided information regarding treatment outcome (Carrigan and Allez 2017; Kosatka and Ona 2014; Mevissen et al. 2011; Cook et al. 1993; Harley et al. 2014; Trelles Thorne et al. 2015). Follow up periods, reported in five articles, varied from immediately post-intervention—4 years post-intervention, with the median being 6 months post-treatment. Post-treatment symptom reduction was reported in all six cases, with all but one (Trelles Thorne et al. 2015) reporting a reduction in PTSD symptomatology specifically, in addition to reductions in anger, aggression, tantrums, disturbing thoughts, anxiety and depressive symptoms reported in some cases. Improved quality of life (in regards to relationships and school), improvement in positive parental view of their child and improvements in ASD symptoms such as eye contact and social overtures were also reported. Symptoms that were reported not to remit in some cases included PTSD avoidance symptoms and parental stress following child-psychotherapy and anxiety towards environmental trauma reminders, such as buildings and anniversaries, following psychotherapy. It was reported in two articles that slight modifications to therapy were needed to support features of ASD (Kosatka and Ona 2014; Carrigan and Allez 2017).

Risk of Bias

Case Studies

Single-case or case series designs are inherently limited in their ability to contribute to the efficacy literature. The articles reviewed here presented a detailed description of the assessment and presentation of PTSD symptoms within an ASD client group; however, generalisation of the findings to the wider population of individuals with ASD is limited by the restricted sample size, lack of comparison group and the impact of possible confounds not being accounted for. The methodological quality of these studies was assessed using a checklist for case reports (The Joanna Briggs Institute 2016), see Table 3.

Group Studies

A modified version of the EPHPP quality assessment tool for quantitative studies was employed to assess the risk of bias in selection, study design, blinding and data collection across the quantitative studies. As all group studies only qualified for inclusion within the assessment and prevalence aspects of this review, the tool was modified to only include relevant items in addressing the risk of bias in assessment and prevalence of PTSD in ASD; the study ratings are presented in Table 4. Seven of the studies received a moderate global rating and the remainder received a weak rating. Only two studies were scored as strong with regards to selection bias (Taylor and Gotham 2016; Mattila et al. 2010). Taylor and Gotham (2016) recruited from a wide variety of sources and including individuals across the spectrum, and Mattila et al. (2010) used a clinical sample combined with a community sample that were gathered by approaching all 8-year-olds across an entire geographical region. All other studies were rated as moderately representative, either recruiting based on a particular characteristic such as anxiety as outlined above, or lack of a characteristic, such as no history of psychiatric or neurological problems (Hollocks et al. 2016) or untreated ADHD or oppositional disorder (McConachie et al. 2014), or recruiting solely from one clinical service (Reinvall et al. 2016; Hofvander et al. 2009; de Bruin et al. 2007; Mehtar and Mukaddes 2011).

The most common design was cross-sectional, which was given a moderate quality rating; with four studies employing a randomised control trial (RCT) design and rated as strong. Whilst RCTs offer a superior experimental design and have been rated accordingly in the quality assessment ratings, it should be noted that none of these studies sufficiently broke down their results so as to detail the treatment findings specifically for those with PTSD. As a result, the quality of the study design becomes less relevant to the conclusions regarding assessment and prevalence as such data precedes randomisation and allocation. Seven studies were rated as strong with regard to their data collection method; all of these studies employed the ADIS C/P (Silverman and Albano 1996). The ADIS/CP is the only measure employed within the studies included in this review which has been shown to be valid and reliable for use with individuals with ASD, although internal consistency and content validity have yet to be tested (Wigham and McConachie 2014).

Discussion

The current review has provided an overview of the current state of the field of research into PTSD in ASD, including a total of 24 studies, 10 being case reports/series and 14 quantitative studies. All of the included studies contained information regarding the assessment of PTSD in individuals with ASD; however, details regarding the assessment, outcome and PTSD symptom presentation were extremely limited within cross-sectional and RCT studies, with two studies failing even to report the rates of PTSD found within their sample

(Ung et al. 2014; Mattila et al. 2010). Whilst case reports predominantly relied on the judgement of the clinician in diagnosing PTSD, usually following a multiple informant information gathering process, quantitative studies consistently employed standardised assessment tools to aid diagnosis. The most commonly used assessment tool was the ADIS C/P, with other tools including the DISC, CAPA, K-SADS and SCID. Importantly, the ADIS C/P is the only measure used to assess PTSD in ASD that has received preliminary support for its validity and reliability in ASD populations (Wigham and McConachie 2014; Ung et al. 2014), meaning the remaining quantitative studies employed diagnostic tools whose psychometric properties have yet to be evaluated for use within this population (Reinvall et al. 2016; de Bruin et al. 2007; Hollocks et al. 2016; Taylor and Gotham 2016; Mehtar and Mukaddes 2011; Hofvander et al. 2009). Certain measures of anxiety in ASD, such as the Multidimensional Anxiety Scale for Children, parent-report (MASC-P; March et al. 1997), have been found not to measure identical constructs in anxious individuals with and without ASD (White et al. 2015), so although tools such as the DISC, CAPA, K-SADS and SCID have been shown to be robust within the general population, it is unknown whether they are appropriate for use within ASD populations. Whist a review by Wigham and McConachie (2014) found the Spence Children's Anxiety Scale- revised (SCAS; Spence 1998) and the Screen for Children's Anxiety Related Emotional Disorders (SCARED; Birmaher et al. 1997) are the most robust measurement tools for assessing anxiety in ASD, unfortunately neither of these measures assess PTSD symptomatology.

A key issue in assessing anxiety-related symptomatology in ASD is that of differentiating between traditional co-occurring anxiety and "anxiety-like" presentations that may either be a manifestation of ASD features or an ASD-specific presentation of anxiety (for a review of this issue see Kerns 2012 and Wood and Gadow 2010). A new ASD addendum to the ADIS has been developed to allow for clearer differentiation between traditional anxiety and symptoms which may be better explained as ASD-related anxiety or features of ASD (Kerns et al. 2017). The ADIS/ASA can reliably measure comorbid and "anxiety-like" symptoms in ASD; it has been shown to be valid for the assessment of traditional anxiety symptoms and partially valid for assessing "anxiety-like" symptoms in ASD; however, unfortunately, the PTSD module was not administered or adapted by Kerns et al. (2017). Issues pertaining to the assessment and differentiation of comorbid PTSD from "PTSD-like" symptoms or features inherent to ASD also need to be teased apart in the diagnosis of PTSD in ASD; therefore, tool development and the controlled study of symptom presentation is vital to enhance understanding and treatment of PTSD in ASD. Within this review, only one paper assessed the inter-rater reliability of assessment measures in diagnosing PTSD in ASD (Ung et al. 2014), using the ADIS C/P. Whilst excellent inter-rater agreement was reported for PTSD diagnosis using the ADIS C/P, the authors failed to specify anywhere in the article what the rates of PTSD were in the sample, thus limiting the conclusions that can be drawn from this finding.

Although the ADIS C/P has been shown to be a promising tool for assessing anxiety and PTSD in ASD, the development and addition of an ADIS/ASA PTSD addendum specifying ASD-specific considerations may encourage clinicians to consider ASD symptom overlap in greater detail and aid in the accurate assessment of PTSD in ASD. Kerns et al. (2015) provide a summary of the key characteristics and considerations in designing new measures of PTSD symptomatology and sequelae, for individuals with developmental disabilities. Measures need to (1) assess prevalence of trauma exposure and post-trauma symptomatology, (2) detect risk factors, (3) track the influence of trauma on wider social and functional outcomes, (4) identify when symptom expression is severe enough to require treatment and (5) measure symptom change and assess treatment outcomes. Beginning with the adaptation of existing trauma/PTSD measures may be a first step in this process, however ultimately the design of new ASD-specific PTSD assessment measures (both clinician-led and self/informant-report tools), that are developed to suit the needs of this population and carefully account for overlapping symptomatology, would be preferential. Mehtar and Mukaddes (2011) developed a new measure called the Trauma Symptoms Investigation Form in ASD (TIF-ASD) which measures the impact of trauma exposure on core symptoms of ASD and associated behavioural disturbances (but not PTSD). The use of the TIF-ASD within this sample provided a rich data set; however, its reliability and validity have yet to be tested. The expansion of such a measure to include PTSD symptom expression may aid in exploring any possible overlap in symptomatology between ASD and PTSD and delineate these from "atypical/PTSD-like" symptoms.

PTSD symptom presentation was described in eight cases studies, with a comparable PTSD symptom profile found in individuals with ASD to that of "traditional" PTSD, providing initial evidence that PTSD does develop in individuals with ASD and can be diagnosed according to DSM-5 and ICD-10 criteria. Within two cases, standardised PTSD self-report questionnaires designed to assess DSM-IV PTSD symptomatology were used to measure symptom expression (Kosatka and Ona 2014; Harley et al. 2014), adding further support to the view that traditional PTSD presentation can and does occur in ASD. This finding unequivocally answers the query raised in past theoretical papers as to whether individuals with ASD can experience the classic symptoms of PTSD (Hoover 2015, p.294). Only in one article were two cases of an atypical post-trauma behavioural presentation described (Carvill and

Marston 2002). The two individuals with ASD and trauma histories were noted as having unusual behavioural presentations which did not neatly fit into a diagnostic category, although "possible PTSD" was considered. Taken together, these findings illustrate that whilst there is evidence to suggest that traditional PTSD can develop in ASD, it is possible that for some individuals a "PTSD-like" presentation may occur. This "PTSD-like" presentation may be best explained as either an ASD-specific variant of PTSD or a manifestation of core ASD diathesis; however, further research is needed to determine the different presentations and possible variants of PTSD in ASD and provide clear differentiation between PTSD and ASD symptomatology.

An additional post-trauma symptom presentation of anger and disruptive, aggressive and oppositional behaviours was described across six papers (five case studies: Trelles Thorne et al. 2015; Harley et al. 2014; Mevissen et al. 2011; Weiss and Lunsky 2010; Carrigan and Allez 2017; and 1 cross-sectional study: Mehtar and Mukaddes 2011), suggesting that trauma and/or PTSD development may have an additional negative impact on emotional and behavioural characteristics for some individuals. Worryingly PTSD diagnosis (with co-occurring major depressive disorder/dysthymia) in ASD was also found to be associated with suicidal thoughts and behaviours, in a cross-sectional study of 102 children and adolescents with ASD (Storch et al. 2013); however, this was based on a sample of only six individuals with PTSD and ASD, so requires replication. Interestingly, whilst no papers reported the specific deterioration of socio-communicative features of ASD as associated with the onset or development of PTSD, Harley et al. (2014) reports an improvement in frequency of eye contact and social overtures post-treatment. This finding raises the question as to whether trauma exposure or co-occurring PTSD may result in the exacerbation of ASD features, which can then be alleviated by PTSD treatment. Indeed, research completed by Valenti et al. (2000) into outcomes for individuals with ASD following an earthquake in Italy found that trauma exposure resulted in an exacerbation of ASD features. Studies exploring the psychiatric, behavioural and functional impairments associated with trauma exposure, comparing groups with trauma exposure and PTSD, trauma exposure without PTSD and non-trauma exposed individuals with ASD, are needed to examine the unique contribution of trauma and PTSD to symptom expression in ASD.

The most commonly reported traumatic experience for individuals with ASD was abuse, which occurred in over 60% of the trauma-exposed case examples, as well as being specified as occurring within both the cross-sectional studies that identified the types of traumatic events experienced by their participants (Taylor and Gotham 2016; Mehtar and Mukaddes 2011). This finding suggests that either, (I) individuals with ASD may be particularly vulnerable to abuse, in line with previous research showing that individuals with ASD are at increased risk of physical and sexual abuse (Mandell et al. 2005) and peer victimisation (Cappadocia et al. 2012; Blake et al. 2012), or (II) the experience of abuse results in an increased symptom burden that is more likely to require assessment and treatment (as all cases were using clinical services), in line with research in the general population showing that childhood physical (Springer et al. 2007) and sexual (Spataro et al. 2004) abuse predicts an array of mental health difficulties and increased treatment seeking. Large-scale epidemiological studies comparing patterns and effects of trauma exposure in individuals with ASD are required to fully address such a question.

Within the current review studies were classed as eligible for inclusion in summation of reported rates of PTSD diagnosis if the ASD sample size was ≥ 30. Of the 12 studies meeting this criterion, the majority measured current PTSD diagnosis, with the remainder measuring PTSD over the previous 12 months or lifetime (including current) (Table 5). As would be expected, merged estimates of the rates of PTSD in childhood and adolescence with ASD were higher when comparing lifetime diagnosis (17.4%) to current diagnosis (2.9%). However, studies assessing the rates of PTSD in children over a 12-month period found no cases with PTSD and the rates were very low (0.8%) in studies assessing lifetime PTSD in adults. The majority of studies recruited their samples from treatment seeking settings, which may include more severe and comorbid presentations (Du Fort et al. 1993); as such, the overall rates of PTSD occurrence outlined here are more representative of those which may be expected in treatment-seeking clinical samples. Overall, the rates of current PTSD were found to be higher in treatment-seeking samples when compared to studies assessing current PTSD in non-treatment-seeking samples. Interestingly, however, three studies that recruited treatment-seeking subjects found no cases of PTSD within their samples (de Bruin et al. 2007; Taylor and Gotham 2016; Hollocks et al. 2016). A large-scale population study in England found the rates of current PTSD in adulthood to be 3% (McManus et al. 2009); however, no studies have assessed the rates of current PTSD in adults with ASD. The rate of current PTSD in typically developing adolescent populations has been found to be lower than that in adulthood, at 1.6% (Kessler et al. 2012); given that the mean age of the studies assessing current PTSD in childhood and adolescence with ASD was 12.13, the merged rates of PTSD in children and adolescents with ASD found within this review (2.9%) appear to be somewhat higher than those found for adolescents within the general population (1.6%). However, as mentioned previously, the studies in children and adolescents with ASD outlined here recruited predominantly treatment-seeking populations and to date there have not been any large scale well-controlled population-based prevalence studies in individuals with ASD, so further research is needed before any clear comparisons or conclusions can be drawn.

Interestingly, general population rates have been found to vary according to gender (McManus et al. 2009), with trauma exposure more prevalent in men and the rate of PTSD higher in females (3.3% women, 2.6% men). A preponderance of male participants were included within the cross-sectional studies assessing rates of PTSD in ASD, and rates of PTSD were unfortunately not split by gender within the results. However, the studies reporting the lowest rates of PTSD (de Bruin et al. 2007; Taylor and Gotham 2016; Hollocks et al. 2016) also had some of the lowest proportions of females within their samples, tentatively suggesting that gender may also play a role in risk of PTSD development in ASD. As ASD is more prevalent in males (Baio 2012), it will be important for future research to recruit a more balanced distribution of males and females to assess whether the same association between gender and PTSD risk holds for individuals with ASD or whether characteristics of ASD are more important than gender in predicting vulnerability to PTSD. This will allow for a more accurate comparison of PTSD prevalence rates between those with ASD and general population statistics.

As children age, there is more opportunity for exposure to traumatic life events, both in terms of the breadth of events and the likelihood that they will have experienced at least one traumatic event across their lifetime. This means that studies assessing lifetime rates of PTSD in adulthood (5.6% in the general population; Rimmo et al. 2005) should have an inherently higher chance of finding cases with trauma exposure (which may act as a catalyst for PTSD development) than studies assessing lifetime prevalence of PTSD in children and adolescents, with general population rates ranging from 3 to 15% in girls and 1–6% in boys (Carr 2004). Research has also shown that PTSD presentation may differ in children (particularly those 6 years of age and under), affecting the ability to identify the condition (Scheeringa et al. 2011). Interestingly, however, the study with the largest age range (Hofvander et al. 2009) did not report the highest occurrence rates across the present articles, with the highest rates instead found within a study that used a predominantly child and adolescent sample (Mehtar and Mukaddes 2011). The lifetime occurrence of 17.4% reported by Mehtar and Mukaddes (2011) across a predominantly male sample is greater than the higher end of both the male and female neurotypical estimates for lifetime PTSD prevalence in children and adolescents (Carr, 2004) and greater than the adult prevalence rates in the general population of 6.8% (Kessler et al. 2005). As it is known that in the general population the rates of current and lifetime PTSD are greater in adulthood, it is surprising that the lifetime rates of PTSD were lower in adult samples than child/adolescent samples (Table 5). The majority of studies included in this review investigated PTSD in children and adolescents with ASD and more research is needed to clarify the incidence of PTSD in a gender balanced sample of adults with ASD.

Within the one study that reported rates of trauma exposure within their sample (Mehtar and Mukaddes 2011), the conditional probability of (lifetime) PTSD following trauma-exposure was extremely high (66.7%); an important caveat to this finding is that the rates of trauma exposure are inconsistently reported between the text and tables of that paper (p.542), meaning this may be a slight overestimate. General population rates of PTSD within samples exposed to abuse are lower than those found by Mehtar and Mukaddes (2011), ranging from 43.9% (Mcleer et al. 1992) to 48.4% (Mcleer et al. 1988) in childhood and 30.6–37.5% in adulthood (Widom 1999). Further research is needed in trauma exposed samples with ASD in order to confirm whether individuals with ASD are at increased risk of PTSD development following exposure to traumatic life events.

Another factor found to be associated with an inflated risk of trauma exposure and PTSD development in the general population is lower IQ (Breslau et al. 2006). The majority of cross-sectional studies recruited individuals with an IQ > 70; however, three studies included individuals across a range of IQ scores (de Bruin et al. 2007; Taylor and Gotham 2016; Mehtar and Mukaddes 2011). Whilst two of these studies reported no cases with PTSD in a total of 130 individuals with ASD (de Bruin et al. 2007; Taylor and Gotham 2016), the highest rates of PTSD across all studies (17.7%) were reported by Mehtar and Mukaddes (2011) where 72.5% of the sample had a mild-severe learning disability. Interestingly, although both Mehtar and Mukaddes (2011) and Taylor and Gotham (2016) used the same assessment tool to measure lifetime PTSD and relied on parent-report (K-SADS), their findings differ drastically; it is possible that the sole use of a treatment-seeking sample and reliance on a sample predominantly diagnosed with a learning disability inflated the rates of PTSD found by Mehtar and Mukaddes (2011). Further research is needed to clarify the association between IQ and communication difficulties, and trauma exposure and PTSD development in individuals with ASD across both community and clinical samples. Exploring the individual differences that confer risk of PTSD in ASD would aid in the identification of at risk groups and allow for tailored early interventions to be developed.

Unfortunately, none of the treatments employed within cross-sectional or RCT studies were designed to treat PTSD per se and outcomes were not reported separately for those with co-occurring PTSD, meaning that conclusions regarding this question are limited to the findings collated from case examples. In the majority of cases, treatment was sought for PTSD resulting from exposure to emotional, physical or sexual abuse, with one case seeking treatment following exposure to traumatic deaths of close family members (Mevissen et al. 2011). This finding adds support to the proposition that abuse is associated with treatment seeking in ASD, as is the case in the general

population (Spataro et al. 2004). Prescription of psychoactive drugs Carbamexepine (Ryan 1994), Zoloft (Kosatka and Ona 2014) and Guanfacine with Sertrailne (Trelles Thorne et al. 2015) was always combined with psychological therapy, however these articles reported very limited details regarding the adjacent psychological therapy provided. Whist it is beyond the scope of this article to provide a full overview of the use of psychopharmacology in ASD, the reader is referred to McPheeters et al. (2011) for a review of this topic.

NICE guidance suggests 8–12 weekly sessions of trauma-focused psychological therapy as the first-line treatment for both children and adults with PTSD, where symptoms have been present for more than 3 months post-trauma, with families involved where appropriate in the treatment of PTSD in children and adolescents (NICE 2005). A variety of psychological therapies and treatment lengths (range 4–43-h-long sessions) were employed in the treatment of PTSD in ASD, with the most common therapy being psychotherapy (Cook et al. 1993; Trelles Thorne et al. 2015; Harley et al. 2014). Modifications were reported within EMDR (Kosatka and Ona 2014) and CBT (Carrigan and Allez 2017) PTSD treatments; however, in most treatment cases, standard procedures were employed and it was noted in one case that the patient was "able to engage in the metacognitive processes required for therapy" (Carrigan and Allez 2017). Reduced PTSD symptomatology was found following trauma-focused CBT treatment using the Ehlers and Clark approach (Carrigan and Allez), EMDR treatment (Kosatka and Ona 2014; Mevissen et al. 2011) and psychotherapy with some trauma focus (Cook et al. 1993; Harley et al. 2014). The effectiveness of trauma-focused therapies in treating PTSD in ASD is in line with the NICE guidelines for PTSD treatment in the general population. The findings of this review suggest that, at least for individuals that present with "traditional" PTSD symptoms, existing PTSD treatments may be effective in alleviating symptom burden with modifications to support features of ASD, such as allowing longer session durations or more sessions to give individuals time to process and verbalise their experiences (Kosatka and Ona 2014), simplifying language and reducing the use of metaphors (Carrigan and Allez 2017). Such modifications to the treatment of comorbidities in ASD are also supported by NICE guidelines (CG170, 2013, p.22), although a recent review suggests that in practice additional modifications over and above those recommended by NICE are often enlisted in the treatment of comorbidities in ASD (Walters et al. 2016).

Limitations

A limitation of the current systematic review was the large heterogeneity of the study designs, methodology and participant characteristics. Whilst such heterogeneity provided a full overview of the literature to date across all ASD diagnoses, it affected the ability to collectively synthesise the data meaning that sub-group comparisons had to be made on a number of levels (e.g. case/group designs and child/adult samples). There was a preponderance of male participants across the studies, which inherently produces a gender biased set of results. Further bias in sample characteristics is produced by seven studies having advertised for participants with anxiety symptoms or disorders. Results regarding PTSD symptom profiles and treatment relied on information collated from case reports, severely limiting the generalisability of the findings.

None of the included quantitative articles achieved a strong rating within the risk of bias assessment, with a number of studies advertising for individuals with anxiety disorders and recruiting predominantly from clinical services. Whilst six studies used a measure that has received at least some support for its use in ASD populations, the remaining 5 studies did not (Reinvall et al. 2016; de Bruin et al. 2007; Hollocks et al. 2016; Taylor and Gotham 2016; Mehtar and Mukaddes 2011; Hofvander et al. 2009) limiting the validity and reliability of their results and conclusions.

The inclusion criteria for this review specified that studies must be written in English and no grey literature was included, which may have resulted in studies published in other languages or non-peer reviewed formats being missed. Additional inclusion criteria for prevalence estimates specified that studies must include a minimum sample size of 30; however, if a more conservative cut off of $n = 50$ had been employed, as was used in a recent review exploring prevalence of anxiety in children and adolescents with ASD (Reardon et al. 2015), then six of the studies would have been excluded. Finally, this paper set out to systematically review the literature pertaining to PTSD in ASD across all age groups. Whilst allowing for a more representative and expansive summary of the state of the field, DSM-5 criteria for PTSD specify that presentation may differ in under 7's (Scheeringa et al. 2011). Three studies outlining assessment and presentation (Reinvall et al. 2016; de Bruin et al. 2007; Mehtar and Mukaddes 2011) and one study outlining treatment (Harley et al. 2014) included 6-year-olds at the lower end of their sampling age range, which may have influenced the overall conclusions drawn from the pooled data.

Clinical Implications and Future Research Directions

Given the limited research that has been completed in the field of PTSD in ASD, only tentative clinical conclusions can be drawn from the literature to date. However, a number of avenues for further research have been identified as a result of this narrative review.

It is clear from this review of the literature that PTSD does occur in individuals with ASD, possibly with a similar or elevated prevalence in childhood and adolescents to that

found within the general population. The vast majority of literature exploring co-occurring mental health diagnoses in individuals with ASD has neglected to assess and/or report the incidence of PTSD. Given that rates of other anxiety-related conditions are known to be inflated in individuals with ASD, it is crucial that clinicians and researchers begin routinely screening for trauma exposure and conduct appropriate assessments for PTSD symptomatology within this at risk population. The case studies included in this review provide preliminary evidence that "traditional" PTSD symptom presentations can occur in ASD and can be diagnosed according to DSM-5 and ICD-10 criteria. However, further research is needed in larger samples where the influence of individual differences such as gender, intellectual functioning and features of ASD can be investigated and "typical" and "atypical" PTSD presentations can be disentangled.

The ADIS/CP was used to assess PTSD in the majority of cross-sectional and RCT designs and at present it is the only measure assessing PTSD in ASD to have received preliminary evidence of its validity and reliability in diagnosing anxiety disorders (Wingham and McConachie 2014) and PTSD (Ung et al. 2014) in ASD. As such the ADIS/CP would be the recommended tool for diagnosis of PTSD in children and adolescence with ASD until further research has examined the measurement properties of a broader range of PTSD assessment tools in individuals with ASD; no tools have yet to be validated for the assessment of PTSD in adults with ASD. The clinical field would also benefit from research assessing the measurement properties of PTSD-specific assessment tools that have been shown to be reliable within the general population, including clinician administered measures such as the Clinician-Administered PTSD Scale for DSM-5, adult (CAPS-5; Weathers et al. 2013a) and child version (Pynoos et al. 2015), and self-report measures such as the PTSD Checklist of DSM-5 (PCL-5; Weathers et al. 2013b) and the Child PTSD Symptom Scale (CPSS; Foa et al. 2001). There are, however, difficulties relying on a single informant for assessment of PTSD in ASD, with self-reporting in ASD possibly affected by problems mentalising (Brent et al. 2004) and parent-reporting also being problematic in the assessment of internal experiences associated with PTSD (e.g. re-experiencing symptoms and confidently attributing symptoms as being associated to a particular traumatic event). As such, multi-informant approaches are recommended in the assessment of psychiatric disorders in ASD (MacNeil et al. 2009).

The evidence collated within this review relating to the treatment of PTSD in ASD comes solely from case study designs, as such they provide only an indication of the types of therapies which *may* be effective for individuals with PTSD and ASD and do not form the basis of definitive clinical recommendations. This preliminary evidence suggests that NICE recommended treatments for PTSD may also be effective for at least some individuals with ASD (with appropriate modifications), although cohort studies and clinical trials are required before any firm conclusions can be drawn about which therapies are effective in treating comorbid PTSD in ASD.

Conclusions

The findings of this systematic review highlight that although there is a shortage of well-controlled studies investigating the assessment, prevalence and treatment of PTSD in individuals with ASD, preliminary data in children and adolescents with ASD suggests that PTSD co-occurs at a similar or heightened rate to that in the general population, and PTSD in ASD can be assessed according to current DSM-5 and ICD-10 PTSD symptom criteria. Trauma exposure and associated PTSD symptomatology should be routinely assessed in individuals with ASD who present to clinical services. Preliminary evidence was found for the effectiveness of PTSD treatments recommended within the NICE guidelines, with appropriate modifications for ASD. Research is needed to develop tools that can appropriately distinguish between symptoms of ASD and PTSD and assess the efficacy of PTSD treatments within the ASD population.

Compliance with Ethical Standards

Conflict of Interest The author declares that there is no conflict of interest.

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