

ARTICLE

The association between autism and psychosis and the tools used to measure it: An updated systematic review and meta-analysis

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Abstract

Objectives: Autistic individuals are at increased risk of psychotic experiences and being diagnosed with psychotic disorders. This association may result from methodological issues, including the misinterpretation of psychosis questionnaires by autistic individuals and clinicians' difficulty distinguishing between the conditions.

Design: This meta-analysis aimed to review this association and examine whether it is moderated by the assessment measures used.

Methods: Systematic searches were conducted in PsycINFO, MEDLINE, CINAHL, Embase and Web of Science. Included studies required autism and psychosis-spectrum measurements, co-morbidity data, adult participants and quantitative data. Quality and risk of bias were assessed using the AXIS Critical Appraisal of Cross-Sectional Studies tool. Analyses examined correlations, odds ratios and Cohen's d as effects.

Results: Sixty-three papers ($N=6,903,960$) were included. Associations were found between autistic and overall ($r=.435, p<.0001$), positive ($r=.274, p<.0001$), negative ($r=.506, p<.0001$) and disorganized ($r=.366, p<.0001$) psychosis-spectrum traits. Individuals with one condition had an increased risk of being diagnosed with the other ($OR=7.03, p<.001$) and scored higher on trait measures of the other ($d=1.187, p<.0001$).

Conclusions: These meta-analyses evidence a strong association between autism and the psychosis spectrum, at both trait and diagnostic levels. Negative psychosis-spectrum traits were most strongly linked with autistic traits, while measures of positive traits showed weaker correlations,

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suggesting overlaps in expression and measurement. High heterogeneity and inconsistent reporting, however, hinder the certainty of conclusions, and research is required to better understand this overlap.

KEY WORDS

Autism, Methodology, Psychopathology/Psychological Disorders, Meta analyses/systematic reviews, Psychopathology/Psychological Disorders, Personality disorders, Psychopathology/Psychological Disorders, Psychosis/schizophrenia

Practitioner points

1. Autistic individuals are significantly more likely to receive a psychotic disorder diagnosis and score higher on psychosis-spectrum traits.
2. At a trait level, autistic traits are most strongly associated with negative psychosis-spectrum traits, with weaker associations being found for positive traits.
3. Assessments of psychotic disorders in autistic individuals should use tools that require concrete examples for psychotic phenomena, and the developmental history must be taken into account.
4. High levels of heterogeneity were found across studies in all analyses. Estimates provided should, therefore, be interpreted with caution.
5. Studies included in the correlational analyses mostly utilized university samples, and many of the diagnostic studies used registry codes without detailing the interview protocols used. As a result, generalizability is limited.

INTRODUCTION

Autism is a developmental condition characterized by difficulties in social communication and interaction, as well as restrictive and repetitive behaviours and interests (American Psychiatric Association, 2013). It is estimated that 1% of children internationally have a diagnosis of autism (Zeidan et al., 2022), though recent data from the Centers for Disease Control and Prevention (CDC) suggests this figure may be as high as 2.8% (CDC, 2023). Lower estimates are often found in non-Western, particularly developing countries, likely due to limitations in diagnostic capacity, but cultural stigmas may also play a significant role (Issac et al., 2025; Samadi et al., 2012). While prevalence in recent years appears to be on the rise, this upward trend is likely the result of refinement in the diagnostic criteria and increased awareness (Talanseva et al., 2023). These refinements have included a movement away from strict autistic diagnostic categories, such as Autistic Disorder and Asperger's Disorder, towards a spectrum-oriented view, acknowledging variability in symptom presentation and severity. Differences have been highlighted, however, in the diagnostic frameworks used to diagnose autism, with the ICD-11 allowing for a broader range of symptom combinations than the DSM-5, enabling a more diverse perspective of autism while also raising concerns about diagnostic specificity (Kamp-Becker, 2024). Further, autistic traits, particularly social deficits, have been found to be common within general population samples, though scores largely fall under clinical cutoffs and are significantly lower than those with an autism diagnosis (Constantino & Todd, 2003; Ruzich et al., 2015).

Psychosis, on the other hand, describes a spectrum of unshared experiences, such as delusional thoughts and hallucinations (American Psychiatric Association, 2013). Meta-analytic evidence suggests the international median lifetime prevalence of psychotic disorders to be approximately 0.749% (Moreno-Küstner et al., 2018), though some population estimates have this as high as 3.5% (Perälä et al., 2007). Beyond formal diagnoses, much research has examined individuals at Clinical Risk of Psychosis (CHR-P), a sub-clinical state of attenuated psychotic symptomatology, usually occurring in brief, intermittent windows. These individuals, while not yet meeting the criteria for any psychotic disorder, are at increased risk of doing so in the future, with 25% developing a psychotic disorder within 3 years (Salazar De Pablo, Radua, et al., 2021; Salazar De Pablo, Woods, et al., 2021). Within the general population, the prevalence of CHR-P is estimated to be around 1.7%, while in clinical samples, this prevalence is as high as 19.2% (Salazar De Pablo, Radua, et al., 2021; Salazar De Pablo, Woods, et al., 2021). Further, data from the World Health Organization would suggest that 7.8% of individuals internationally have had psychotic experience, hallucinations being most prominent (McGrath et al., 2015).

Recent meta-analyses have suggested that autistic individuals are at an increased risk of experiencing psychotic symptoms (Kiyono et al., 2020; Vaquerizo-Serrano et al., 2022), as well as an increased risk of developing a psychotic disorder (Lai et al., 2019; Zheng et al., 2018). Further, those with psychosis have been found to have a greater prevalence of autistic traits and are more likely to be diagnosed as autistic (De Crescenzo et al., 2019; Kincaid et al., 2017) than those without. As for how the co-occurrence of the two conditions manifests, Larson et al. (2017) found that autistic individuals with psychosis were more likely to be diagnosed with atypical psychosis than those with psychosis alone, with the duration of psychotic episodes generally not meeting the six-month minimum required for a DSM-IV-TR diagnosis of schizophrenia. They were also less likely to have stereotyped interests and behaviours compared to autistic individuals without psychosis. Further evidence of how the comorbidity presents itself is, however, limited.

As for what causes this association, there are several candidate explanations. Biological explanations are often cited, with evidence to suggest that the two conditions are associated with a multitude of shared genetic and chromosomal abnormalities (Rapoport et al., 2009; Rees et al., 2021; Sebat et al., 2009). Further, there is evidence to suggest that both conditions share several prenatal and perinatal risk factors, including parental age, birth complications, season of birth and birth weight (Davies et al., 2020; Gardener et al., 2009, 2011). Traumatic experience may also partially explain the relationship, with a recent analysis of the Avon Longitudinal Study of Parents and Children cohort study finding that traumatic experience mediated the association between autistic and psychosis traits by 41% (Dardani et al., 2023).

Relatedly, diagnostic complications may also play a role in the association. It has been suggested that autistic children may have difficulty interpreting questions regarding psychosis due to their propensity to interpret language hyperliterally (Sullivan et al., 2013). Supporting this, Wilson (2018) found that adolescents who had difficulty interpreting non-literal language, whether autistic or neurotypical, had greater difficulty interpreting the ambiguous language used in the items of the Structured Interview for Psychosis-Risk Syndromes (SIPS) pertaining to positive symptoms. Though not a psychosis measurement, similar interpretative issues have been identified with the Suicide Behaviours Questionnaire-Revised, with autistic adults reporting difficulty in understanding and responding to certain questions (Cassidy et al., 2020).

Furthermore, psychological factors may lead to diagnostic complications. Gesi et al. (2024) highlight that autistic individuals may present with 'pseudo-psychotic' traits, spanning both positive and negative domains. For example, sensory hypersensitivities and echolalia, both common traits of autism, may be mistaken for hallucinations, while social communication issues may resemble negative psychotic symptoms. Further, special interests or atypical behaviours may appear as bizarre ideas or disorganized symptoms. Such overlaps also appear with attenuated psychotic symptoms, though findings from (Vaquerizo-Serrano et al., 2022) suggest that autistic and non-autistic individuals at CHR-P have comparable rates of transition to psychosis, suggesting this association reflects not only trait overlap, but a

genuine risk. Further, evidence from case series studies suggests that autistic individuals may receive a misdiagnosis of psychosis (Dossetor, 2007; Ying et al., 2023) due to clinician difficulty in differentiating between diagnostic criteria, such as negative symptoms and catatonic behaviour. Social difficulties or asociality, for example, may be both an autistic trait and a negative psychotic symptom, and atypical autistic behaviours (including stimming) may be seen as disorganized psychotic behaviour. As such, it is important that the methods used to assess this association are considered. A better understanding of the aetiology of the comorbidity and how it manifests will enable better clinician understanding of presentations and symptom combinations, as well as the opportunity for better measure development designed with autistic individuals in mind.

OBJECTIVES

Our aim was, therefore, to conduct meta-analyses on studies examining the association between autism and psychosis across both clinical and sub-clinical trait measures and to examine whether the strength of this association is moderated by the measurement methods used. Three research questions were proposed:

- Research Question 1: Is there an association between autistic traits and psychosis-spectrum traits in general population samples?
- Research Question 2: Are individuals with a diagnosis of one condition more likely to be diagnosed with the other compared to the general population?
- Research Question 3: Do individuals with a diagnosis of either condition show elevated traits associated with the other, compared to general population controls?

Three separate primary analyses were conducted. The first examined data from correlational studies that used trait/symptom score measures to assess both conditions within general population samples. A previous meta-analysis conducted a similar analysis (Zhou et al., 2019), finding no moderating effect of measure used, so this first analysis aimed to update these findings. The second examined data from studies that compared comorbidity rates of the two conditions to general population prevalence data. Finally, the third examined whether the diagnosis of either condition was associated with an increased trait/symptom score of the other, compared to general population control samples.

METHODS

Design

This study followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA; Page et al., 2021) guidelines and was preregistered on PROSPERO (ID: 368498).

Research Question 1 examined studies reporting associations between autistic and psychosis-spectrum trait scores. Psychosis-spectrum traits were defined broadly to include both schizotypal characteristics, stable personality traits associated with psychosis risk and psychotic-like experiences (PLEs), which are often transient positive psychotic phenomena. Although these are two different constructs of psychosis-spectrum, both provide estimates for psychosis-proneness within the general population (Debbané et al., 2015; Linscott & Van Os, 2013).

Research Question 2 examined studies that reported the prevalence of one condition in a sample with the other (or vice versa), relative to general population samples. Although most included studies examined schizophrenia, to allow for a broader estimate of co-occurrence with autism, psychosis-spectrum diagnoses and states, including schizoaffective disorder, first-episode psychosis (FEP), non-specified

psychotic disorders and non-clinical groups experiencing clinical high risk of psychosis, were combined as 'psychosis-spectrum' disorders.

Finally, Research Question 3 examined whether individuals with a diagnosis of either autism or a psychotic-spectrum disorder (as defined above) showed elevated scores on the other condition's trait measures. This analysis aimed to assess whether the presence of a clinical diagnosis corresponded to elevated traits in the opposing domain. These analyses utilized the same definitions for psychosis-spectrum traits and conditions as RQ 1 and 2.

Eligibility criteria

Studies were included if they met the following criteria:

1. Use a measure of autism or autistic traits
2. Use a measure of psychosis or psychosis symptoms
3. Provide data on comorbidity between autism and psychosis
4. Include human participants
5. Include a healthy control/general population control sample
6. Participants must not have other comorbid conditions
7. Mean age of participants is greater than or equal to 18 years of age
8. Reports quantitative data

Information sources and search strategy

Studies were retrieved from systematic searches from PsycINFO (through EBSCO), MEDLINE (through EBSCO), CINAHL (through EBSCO), Embase (through Ovid) and Web of Science. A full breakdown of search terms and limiters used is reported in [Appendix 1](#). Duplicates were identified and manually removed by use of the Systematic Review Accelerator De-duplicator tool (Clark et al., 2020). The last systematic search of all listed databases was conducted on the fourteenth of November, 2024. Further studies were retrieved from previous similar meta-analyses. A review of references of included studies was also conducted, but no new papers were retrieved.

Selection process

An initial abstract screening was conducted by the first author and two voluntary research assistants. Each abstract was reviewed by the first author and at least one other reviewer. This process was conducted using RAYYAN (Ouzzani et al., 2016), a web-based application for abstract screening. Accepted papers were then exported as a .csv file, and a full-text screening was conducted. As before, each paper was reviewed by the first author and at least one other reviewer. At the end of both the abstract and full-text screening, conflicting decisions were addressed with the addition of a third rater.

Data collection process

Data was then extracted by the first author. Papers were reviewed for either measures of effect (i.e., Pearson's r , odds ratios) or data that could be used to compute measures of effect (i.e., mean trait scores to calculate standardized mean difference). Where possible, psychosis subscale data was collected to compute sub-analyses. Autistic subscale data was not extracted due to limited reporting within included studies. Where papers did not report effect data, or data allowing for the computing of effects,

corresponding authors were contacted. If authors did not respond to the initial request, a follow-up email was sent after two working weeks. If authors did not respond to the data request after 3 months, papers were then excluded.

Outcome measures

The primary outcome measure was the strength of effect between autism and psychosis, with an interest in if and how the various methods used to measure both conditions moderated the strength or directionality of the effect. These measures could have been categorical (i.e., Autism Diagnostic Interview-Revised (ADI-R) or Autism Diagnostic Observation Schedule (ADOS) for autism assessments) or continuous (i.e., Autism Quotient (AQ) for autism trait score). Participant age and gender data were also collected, if available, in order to conduct further moderation analyses.

Study quality assessment and risk of bias assessment

Study quality and risk of bias was assessed by use of the AXIS Critical Appraisal of Cross-Sectional Studies tool (Downes et al., 2016), designed for evaluating cross-sectional studies. The tool consists of 20 items assessing the factors of study aims and design, sampling methods and sample characteristics, measurement validity, appropriateness of analyses and reporting transparency (see Table S1 in Supplement for the full list of items). Each item was primarily rated with either a 'yes' or 'no' response, though for instances in which criteria were partially met, or in which adherence was questionable, a score of 'partial' was given.

Risk of bias was assessed by reviewing responses to items regarding sampling methods, management of non-responders and appropriateness of analyses. Based on these criteria, for each study, a qualitative judgement of 'low', 'medium' or 'high' risk of bias was made. Quality was assessed by reviewing responses to items pertaining to methodological strength, validity of measurements used, internal consistency of results and transparency of reporting of ethical approval and conflicting interests. Again, from these criteria, each study was assigned a qualitative judgement of 'low', 'medium' or 'high' quality.

Effect measures

Four effect measures were used in analyses. For the first research question, both Pearson's r and Spearman's ρ were used. As the effect range of both measures exists between -1 and 1 , the effects were combined into a single analysis. For the second research question, log odds ratios were calculated and then converted back to odds ratios to maintain symmetry in analysis (Borenstein et al., 2009), and for the third research question, standardized mean difference was calculated.

Synthesis methods

Analysis was conducted by use of R Studio, using the 'metafor' package. Intercept-only random effects models were used to compute the main effect size of each analysis and meta-regressions were conducted to examine the moderating effect of measure used, directionality (whether psychosis diagnosis was examined in a sample of autistic individuals or vice versa), age and gender. Only measures used three or more times were included in the moderation analyses with the aim of reducing outlier bias. The risk of publication bias was estimated by the use of Egger's tests. Both I^2 and Cochran's Q were calculated to measure the variation between studies accounted for by heterogeneity, and Baujat plots were used to

identify the contribution to heterogeneity of each study. Forest plots and Baujat plots for each analysis were generated using the metafor package for R.

Some of the included studies did not use the aforementioned measures to calculate their effect. Some reported data tables, containing diagnostic prevalence data for examined groups. Where possible, this data was used to calculate ORs, using the metafor package in R. Other studies reported mean trait scores for clinical and general population samples, which were used to calculate SMD.

RESULTS

Research question 1: Correlational analyses

Study selection and characteristics

Thirty-six papers reported correlational data for the first analysis. From these, 31 data points were extracted examining correlations between autistic traits score and overall psychosis-spectrum trait score data, as well as 38 data points examining correlations between autistic traits and positive psychosis-spectrum traits, 30 for negative and 23 for disorganized. The most common autism measurement used within these was the Autism Quotient (AQ; Baron-Cohen et al., 2001), used in 30 of the included papers, and the most common psychosis-spectrum trait measurement was the Schizotypal Personality Questionnaire (SPQ; Raine, 1991), used in 12. An overview of each of the included studies for these analyses can be found in Table 1.

One included study for these analyses measured the association using several questionnaires, across two samples. For the overall analyses, we combined these correlations into a single effect. For the moderation analyses, however, we included two data points from the same sample, as bias testing concluded no significant differences in effect whether the study was excluded or not.

Figure 1 presents a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses; Page et al., 2021) flowchart of the selection process for all included papers.

Risk of bias and quality assessment

Of the 36 papers, only seven were deemed to have a low risk of bias, while the remaining 29 were deemed to have a medium risk. This risk was most commonly introduced due to issues relating to sampling representativeness and lack of reporting of, or adjustment to, non-response bias. As for study quality, only eight studies were deemed to be of high quality, while the remaining 31 were deemed to be of medium quality. This was primarily due to few studies making attempts to justify sample sizes, which were often small convenience samples. None of the included studies contained alarming risk of bias concerns, and all were generally methodologically robust.

Results of synthesis

The intercept-only model for the analysis of correlation coefficients revealed a significant positive effect between autism trait and overall psychosis-spectrum trait scores ($r = .435$, 95% CI = 0.379–0.487, $p < .0001$, $k = 26$). A forest plot of the effect sizes of each study, as well as the overall effect size, is presented in Figure 2. Heterogeneity between the studies was considerable ($I^2 = 95.79\%$; Q (df = 25) = 1154.0492, $p < .0001$). Increased mean age of samples was significantly associated with decreased effect sizes ($p = .008$), but no moderating effect of proportion of males was found. Measurement type significantly moderated the association. A moderate association was found between autistic and overall schizotypal trait scores ($r = .457$, 95% CI = [.41–.51], $p < .0001$, $k = 20$), while

TABLE 1 Study characteristics of correlational analyses.

Name, year	N	% of males	Mean age (range)	Sample type	Autism measure	Psychosis measure	Overall (k=31)	Positive (k=38)	Negative (k=30)	Disorganized (k=23)
Abu-Akel, Apperly, Wood, Hansen, and Mevorach (2017)	202	21.29%	21.45 (NIR)	University	AQ	CAPEp	NA	0.31	NA	NA
Abu-Akel, Apperly, Wood, and Hansen (2017)	24	20.83%	21.21 (NIR)	Community	AQ	CAPEp	NA	0.28	NA	NA
Abu-Akel et al. (2018)	58	22.41%	20.95 (18–34)	Community	AQ	CAPEp	NA	0.442	NA	NA
Abu-Akel et al. (2018)	69	27.54%	26.26 (17–36)	Community	AQ	CAPEp	NA	0.215	NA	NA
Blain et al. (2017)	107	29.91%	19.73 (NR)	University	AQ-10	SPQ	0.4	0.28	0.36	0.36
Butler et al. (2015)	194	43.80%	21.31 (NR)	Community	AQ-10	SPQ-B	0.249	0.115	0.197	0.249
Choteau et al. (2016)	347	55.90%	21.8 (NR)	University	AQ	SPQ	0.55	0.294	0.605	0.368
Claridge and McDonald (2009)	77	42.86%	20.7 (17–27)	University	AQ	O-LIFE: Introversive Anhedonia	NA	NA	0.5	NA
Bin Dawood et al. (2023)	71	35.21%	22.42 (18–37)	University	AQ	SPQ-BR	0.455	NA	NA	NA
Del Giudice et al. (2010)	199	49.70%	22.6 (21–35)	Uni/Community	AQ	SPQ	NA	0.24	0.63	NA
Del Giudice et al. (2014)	151	50.30%	25.9 (18–38)	Uni/Community	AQ	SPQ	0.473	0.2	0.619	NA
Dinsdale et al. (2013)	605	37.19%	19.4 (NR)	University	AQ	SPQ-BR	0.43	0.21	0.5	0.29
Ford et al. (2017)	835	25.30%	26.15 (18–40)	University	AQ	SPQ	0.679	0.494	0.733	0.614
Georgiou et al. (2021)	508	54.72%	26.51 (18–80)	Community	AQ	MSS-B	0.341	0.418	0.224	0.21
Gillespie et al. (2017)	55	29.09%	20 (18–37)	University	AQ	CAPEp	NA	0.472	NA	NA
Gong et al. (2017)	2469	27.70%	18.75 (NR)	University	AQ	SPQ	0.419	0.213	0.515	0.353
Horder et al. (2014)	772	28.11%	NR (<17–>61)	University (Staff inc.)	AQ	CAPS	NA	0.333	NA	NA
Hurst et al. (2007)	607	22.24%	19.26 (17–55)	University	AQ	SPQ	0.47	0.25	0.53	0.32
Karvelis et al. (2018)	39	38.50%	23 (18–69)	Community	AQ	SPQ	0.602	NA	NA	NA
Karvelis et al. (2018)	83	49.40%	25.7 (18–69)	Community	AQ	RISC	NA	0.074	NA	NA
Louzolo et al. (2017)	925	100.00%	24.98 (18–35)	Community	AQ	PDI	NA	0.192	NA	NA
Mamah et al. (2022)	9564	52.92%	21.2 (15–25)	Community	AQ (Adolescent version)	pWERCAP	0.19	NA	NA	NA

TABLE 1 (Continued)

Name, year	N	% of males	Mean age (range)	Sample type	Autism measure	Psychosis measure	Overall (k=31)	Positive (k=38)	Negative (k=30)	Disorganized (k=23)
Martínez et al. (2021)	7353	43.19%	51.2 (NA)	Community	AQ-20	PSQ	0.05	NA	NA	NA
Mearley et al. (2014)	144	39.58%	25.3 (18–55)	Uni-/Community	AQ	SPQ	0.54	0.41	0.6	0.36
Melchers et al. (2015)	107	93.00%	22.21 (NA)	University	AQ	CAPE	0.583	0.354	0.591	NA
Milne et al. (2017)	30	76.67%	35.37 (19–68)	Community	SRS	CAPS	0.16	NA	NA	NA
Nenadić et al. (2021)	264	21.59%	20.66 (NA)	University	AQ	SPQ-B, O-LIFE, MSS, CAPEp & CAPEn	0.53	0.35	0.47	0.44
Nenadić et al. (2021)	376	34.84%	24.04 (NA)	Community	AQ	SPQ-B, O-LIFE, MSS, CAPEp & CAPEn	0.5	0.25	0.45	0.38
Nenadić et al. (2021)	264	21.59%	20.66 (NA)	University	AQ	CAPEp & CAPEn	NA	0.384	0.516	NA
Nenadić et al. (2021)	376	34.84%	24.04 (NA)	Community	AQ	SPQ-B	0.493	0.265	0.452	0.375
Nenadić et al. (2021)	376	34.84%	24.04 (NA)	Community	AQ	O-LIFE	0.505	0.265	0.493	0.41
Nenadić et al. (2021)	264	21.59%	20.66 (NA)	University	AQ	O-LIFE	0.54	0.326	0.476	0.473
Nenadić et al. (2021)	376	34.84%	24.04 (NA)	Community	AQ	MSS	0.497	0.229	0.405	0.357
Nenadić et al. (2021)	264	21.59%	20.66 (NA)	University	AQ	MSS	0.511	0.327	0.404	0.399
Raynal, Goutaudier, et al. (2016)	294	33.67%	20.31 (18–26)	University	AQ-Short	SPQ-B	0.414	0.142	0.448	0.303
Raynal, Melioli, et al. (2016)	466	33.70%	20.58 (18–24)	Uni-/Community	AQ-10	SPQ-BR	0.317	0.226	0.233	0.272
Russell-Smith et al. (2011)	362	24.03%	18.7 (NA)	University	AQ	O-LIFE	0.46	0.15	0.51	0.38
Russell-Smith et al. (2011)	639	30.67%	19.1 (NA)	University	AQ	O-LIFE (MODIFIED) ^a	0.51	0.19	0.56	0.38
Russell-Smith et al. (2013)	284	28.20%	20.1 (NA)	University	AQ: Social Skills subscale	O-LIFE: Introverted Anhedonia	NA	NA	0.74	NA
Salminen et al. (2022)	296	35.81%	19.6 (NA)	University	AQ	SPQ-B—Cognitive-Perceptual	NA	0.174	NA	NA

(Continues)

TABLE 1 (Continued)

Name, year	N	% of males	Mean age (range)	Sample type	Autism measure	Psychosis measure	Overall (k=31)	Positive (k=38)	Negative (k=30)	Disorganized (k=23)
Sampson et al. (2021)	653	17.30%	39.3 (18–65)	Community	AQ	CAPEp	NA	0.509	NA	NA
Shi et al. (2017)	864	NR	NA	University	AQ	SPQ	0.443	0.249	0.529	0.381
Sierro et al. (2016)	921	27.80%	22.2 (18–30)	University	AQ	sO-LIFE	0.419	0.199	0.479	0.355
Wakabayashi et al. (2012)	662	49.55%	18.9 (18–27)	University	AQ (Japanese)	SPQ	0.483	0.1	0.44	0.24
Zhou et al. (2021)	115	40.00%	21.37 (18–30)	Community	AQ	SPQ	0.425	NA	NA	NA
Ziermans et al. (2021)	337	45.40%	38.5 (16–50)	Community	AQ	CAPE	NA	0.408	0.309	NA

Abbreviations: AQ, Autism Spectrum Quotient; CAPE, Community Assessment of Psychic Experience; CAPEp, Community Assessment of Psychic Experience—Psychic subscale; CAPEn, Community Assessment of Psychic Experience—Negative subscale; CAPEp, Community Assessment of Psychic Experience—positive subscale; CAPS, Cardiff Anomalous Perception Scale; MSS(-B), Multidimensional Schizotypy Scales (-Brief); O-LIFE, Oxford-Liverpool Inventory of Feelings and Experiences; PDI, Peters' Delusion Inventory; PSQ, Psychosis Screening Questionnaire; pWERCAP, Washington Early Recognition Center Affectivity and Psychosis Screen; RISC, Rust Inventory of Schizotypal Cognitions; sO-LIFE, Short Oxford-Liverpool Inventory of Feelings and Experiences; SPQ—BR, Schizotypal Personality Questionnaire—Brief Revised; SPQ, Schizotypal Personality Questionnaire; SPQ-B, Schizotypal Personality Questionnaire—Brief; SRS, Social Responsiveness Scale.

^aModified O-LIFE—Addition impulsive nonconformity subscale of 10 items.

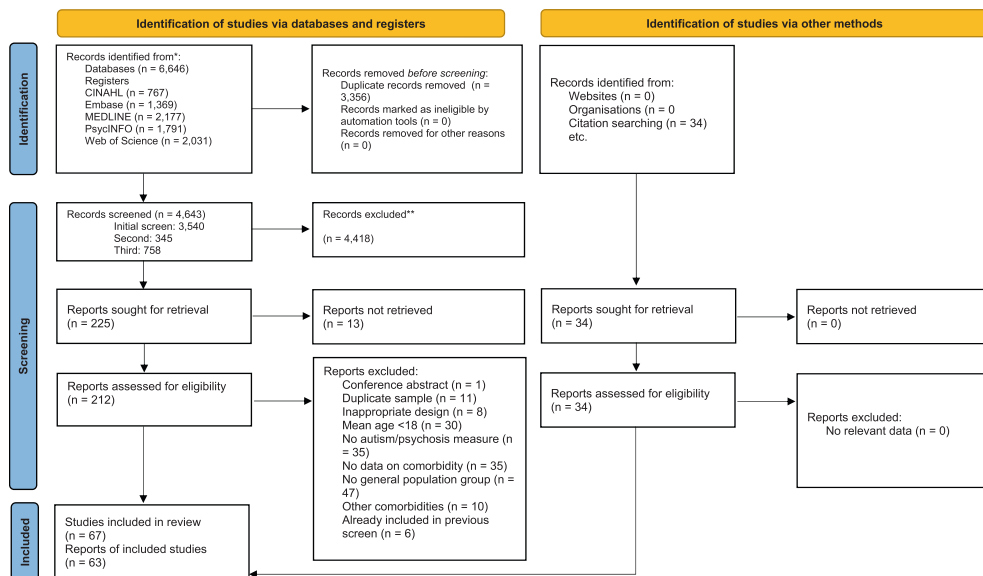


FIGURE 1 PRISMA flow diagram of systematic review process.

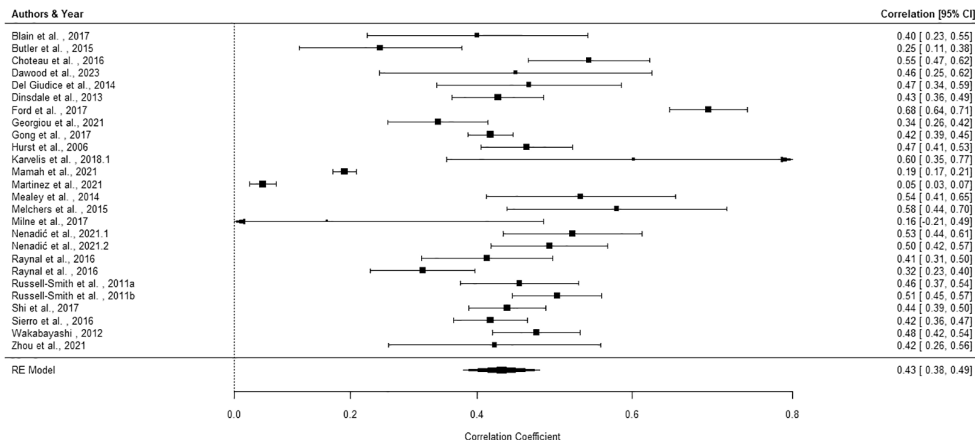


FIGURE 2 Forest plot of studies examining the association between autistic and psychotic symptoms.

no significant association was found with PLE measures ($r = .259$, 95% CI $[-.009, .492]$, $p = .058$, $k = 4$). The Egger's test found no significant funnel plot asymmetry, suggesting that there is no significant risk of publication bias. A Baujat plot revealed that three papers had significant influence on the heterogeneity (see Figure S4 in Supplement).

Sub-analyses found a large effect between overall autistic traits and negative psychosis-spectrum traits ($r = .503$, 95% CI = $0.442-0.560$, $p < .0001$, $k = 24$), and lower, yet still significant effects, were found for both positive ($r = .274$, 95% CI = $0.231-0.316$, $p < .0001$, $k = 32$) and disorganized psychosis-spectrum traits ($r = .352$, 95% CI = $0.304-0.399$, $p < .0001$, $k = 18$) (see Figures S1–S3 in Supplement for forest plots for each of these analyses). Measurement type, again, significantly moderated the association. A small effect was found between autistic and positive schizotypal trait scores ($r = .274$, 95% CI = $[.231, .316]$, $p < .0001$, $k = 32$), while no significant association was found with PLE measures ($r = .259$, 95% CI $[-.009, .492]$, $p = .058$, $k = 4$). Egger's tests for each of these analyses found no significant funnel plot

asymmetry. Heterogeneity for the positive ($I^2=85.33\%$; Q (df=31)=222.2805, $p<.0001$), negative ($I^2=94.22\%$; Q (df=23)=348.5369, $p<.0001$) and disorganized ($I^2=86.34\%$; Q (df=17)=137.5886, $p<.0001$) analyses were again severe. Baujat plots revealed a number of problematic studies for each analysis (see [Figures S5–S7](#) in Supplement). Problematic studies for each analysis generally produced significantly higher or lower effects. For the overall trait score analysis, most of the problematic studies used novel psychosis-spectrum measures, but no other methodological differences were identified.

Research question 2—Diagnostic comorbidity

Study selection and characteristics

Seventeen papers had data on diagnostic comorbidity for the second analysis. An overview of included studies for these analyses can be found in [Table 2](#). Thirteen of these papers examined the prevalence of psychosis-spectrum disorders within autistic samples. Very few papers reported interview protocols of measurement tools for diagnosis, instead only reporting the diagnostic code they fell under.

Risk of bias and quality assessment

Of the 17 papers, 13 demonstrated low risk of bias, often utilizing large, representative population datasets. Issues regarding non-response bias were, however, present in four papers, resulting in medium risk of bias ratings. Quality was also generally high, with the same 13 papers being deemed high quality. The remaining four papers, however, were rated medium quality, due to the lack of justification in sample size, as well as a lack of clarity in reporting of measurements used.

Results of synthesis

The intercept-only model for the analysis of odds ratios, again, revealed a significant positive effect (OR=7.03, 95% CI=3.68–13.43, $p<.001$, $k=17$), suggesting that individuals with one condition were over seven times more likely to be diagnosed with the other compared to the general population. A forest plot of the effect sizes of each study, as well as the overall effect size, is presented in [Figure 3](#). Due to limited data, we were not able to examine the moderating effect of the measure used. No moderating effects of age, gender or study directionality were found. Heterogeneity between the studies was considerable ($I^2=99.57\%$; Q (df=16)=1145.6134, $p<.0001$). A Baujat plot revealed that the high heterogeneity was largely the result of a single paper (Chen et al., 2015), likely due to its exceptionally large effect (see [Figure S8](#) in the Supplement). Removing this paper, however, did not significantly reduce overall heterogeneity, suggesting that heterogeneity was widespread across included studies. Egger's test did find significant funnel plot asymmetry, highlighting a risk of publication bias.

Research question 3—Effect of diagnosis on trait score

Study selection and characteristics

Thirteen papers reported mean trait score data of both a clinical sample (autism or psychosis-spectrum) and a general population sample. An overview of included studies for these analyses can be found in [Table 3](#).

Risk of bias and quality assessment

Of the 13 studies, only two were deemed to have a low risk of bias. The remaining 11 were deemed to have a medium risk of bias, primarily due to issues in sample representativeness, as well as limited reporting of possible non-response bias. Regarding quality, the same two studies were marked as being of high quality, while the remaining 11 were deemed to be of medium quality. This was, again, largely due to a lack of justification of sample size.

TABLE 2 Study characteristics of odds ratio analysis.

Name, year	n1— Diagnosis group	Diagnosis sample type	Original diagnosis (criteria)	n2— general population	% of males n1	% of males n2	n1 age (mean)	n2 age (mean)	Autism measure (classification)	Psychosis measure (classification)	OR (k=16)
Amir et al. (2023)	737	Community	CHR-P	275	57.53%	50.18%	18.49 (12–35)	19.76 (12–34)	SCID (DSM-IV/5)	SIPS, SOPS (NA)	1.218
Chen et al. (2015) ^a	725	Clinical	Autism	27,540	77.24%	NR	18.34 (NA)	14.86 (NA)	DB (ICD-9)	DB (ICD-9)	203.632
Davignon et al. (2018) ^a	4123	Community	Autism	20,615	80.67%	80.67%	18.39 (14–25)	18.44 (14–25)	DB (ICD-9)	DB (ICD-9)	4.607
Fendrich et al. (2022)	40	Clinical	Psychosis	24	50.00%	45.83%	38.1 (18–55)	33.4 (18–55)	Self-report	DIGS	0.605
Hand et al. (2020) ^a	4685	Community	Autism	46,850	67.77%	67.77%	NR (65+)	NR (65+)	DB (ICD-10)	DB (ICD-10)	26.84
Houghton et al. (2018) ^a	10,856	Community	Autism	21,712	80.69%	80.69%	18.76 (3+)	18.76 (3+)	DB (READ)	DB (Read)	6.736
Kendler et al. (2024)	2292	Community	Schizotypal Personality Disorder	11,460	48.5%	NR	NR	NR	DB (ICD-9/10)	DB (ICD-10)	19.76
Kohane et al. (2012) ^a	5276	Clinical	Autism	1,142,008	78.71%	NR	NR	NR	DB(ICD-9)	DB (ICD-9)	11.559
Krieger et al. (2021)	24,667	Clinical	Schizophrenia	24,667	63.08%	63.08%	NR (18–70)	NR (18–70)	DB (ICD-9/10)	DB (ICD-9)	7.01
Roy et al. (2015) ^a	50	Clinical	Asperger's Syndrome	4181	68.00%	50.30%	36.46 (20–62)	NR (18–65)	DB (DSM-IV)	DB (DSM-IV (German))	0.777
Schudel et al. (2016) ^a	20,492	Community	Autism	1,892,412	77.60%	51.00%	NR (1.5–33)	NR (1.5–33)	DB (ICD-8/10)	DB (ICD-8/ ICD-10)	8.793
Solberg et al. (2019) ^a	7528	Community	Autism	1,653,575	72.10%	51.00%	26.2 (NR)	33.2 (NR)	DB (ICD-10)	DB (ICD-10)	11.122
Suen et al. (2024) ^a	291	Community	Autism	1605	51.50%	39.80%	19.69 (15–24)	19.88 (15–25)	Self-report	Self-report	0.688
Supekar et al. (2017) ^a	4790	Community	Autism	1,842,575	NR	NR	NR (18+)	NR (18+)	DB (ICD-9)	DB (ICD-9)	4.476

(Continues)

TABLE 2 (Continued)

Name, year	n1— Diagnosis group	Diagnosis sample type	Original diagnosis (criteria)	Comorbidity	n2— general population	% of males n1	% of males n2	n1 age (mean)	n2 age (mean)	Autism measure (classification)	Psychosis measure (classification)	OR (<i>k</i> = 16)
Tint et al. (2023) ^a	10,646	Community	Autism	Psychotic disorders	42,607	69.75%	69.68%	NR (19–65)	NR (19–65)	DB (ICD-9/10/ DSM-IV)	DB (ICD-9/10/ DSM-IV)	13.04
Underwood et al. (2022)	7943	Community	Autism	Schizophrenia	25,941	75.49%	74.62%	NR (18+)	NR (18+)	(ICD-10/ READ v2)	(ICD-10/Read v2)	7.763
Vohra et al. (2017) ^a	1772	Community	Autism	Schizophrenia	5320	71.40%	71.50%	NR (22–64)	NR (22–64)	DB (ICD-9-CM)	DB (ICD-9)	1.595

Abbreviations: DB, Database cohort (no measurement information reported); DIGS, Diagnosis Interview for Genetic Studies; DSM, Diagnostic and Statistical Manual of Mental Disorders; ICD, International Classification of Diseases; SIPS, Structured Interview for Psychosis-Risk Syndromes; SOPS, Scale for Assessment of Psychosis-Risk Syndromes.

^aMarked studies examined psychosis diagnosis within autistic populations; unmarked studies examined autism diagnosis within samples with psychosis.

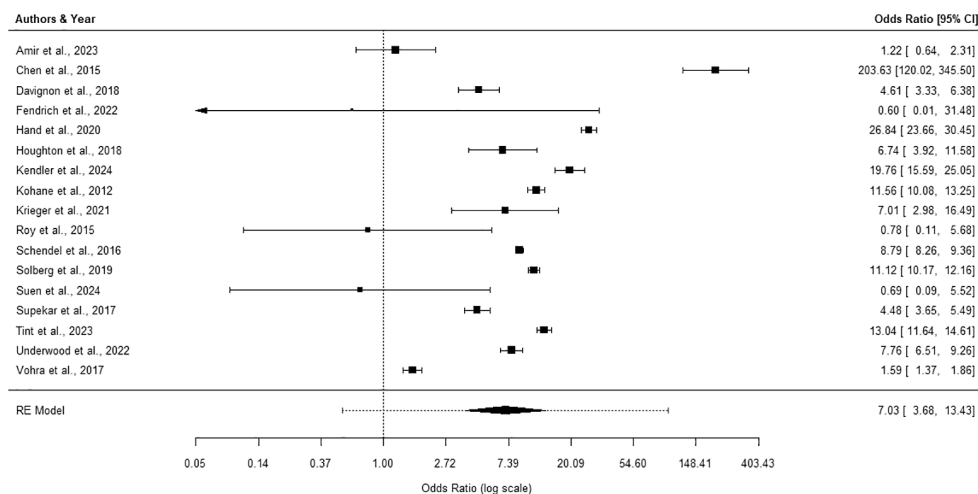


FIGURE 3 Forest plot of studies included in odds ratio analyses.

Synthesis of results

The intercept-only model for the analysis of standard mean differences also revealed a significant positive effect, with diagnosis of one condition predicting an increased trait score of the other ($d=1.216$, $95\% \text{ CI}=0.87\text{--}1.563$, $p < .0001$, $k=13$). A forest plot of the effect size of each study, as well as the overall effect, is presented in Figure 4. As with the previous analysis, due to limited data, we could not examine the moderating effect of measure used. No moderating effects were found for directionality, mean age or proportion of males. Heterogeneity between studies was considerable ($I^2=92.96\%$; Q (df=12)=370.3137, $p=0.001$). A Baujat plot revealed that heterogeneity was largely explained by a single paper (Suen et al., 2024) (see Figure S9 in Supplement). If this paper was removed, heterogeneity dropped significantly ($I^2=68.02\%$; Q (df=11)=29.7086, $p=0.0018$). Egger's test identified significant funnel plot asymmetry, suggesting a risk of publication bias. If, however, the abovementioned paper was removed from analyses, Egger's test became insignificant.

DISCUSSION

These meta-analyses provide an updated review of the association between autism and the psychosis spectrum. In line with previous research, a significant association was found between the two conditions, regardless of the methods and measures of assessment used. In line with the findings from Zhou et al. (2019) ($k=19$), Research Question 1 revealed that within the general population samples, overall autism trait scores were significantly positively associated with overall psychosis-spectrum symptom scores. Significantly lower overlaps, however, were found with questionnaires examining PLEs (e.g., CAPE) and positive schizotypy (e.g., SPQ). Further in line with their findings, sub-analyses revealed that negative psychosis symptoms were more strongly associated with autistic traits than positive or disorganized symptoms.

Research Question 2 revealed that individuals with a diagnosis of either autism or a psychosis-spectrum condition were more likely to be diagnosed with the other, compared to general population samples. This finding is, again, supported by previous meta-analyses (Lugo Marín et al., 2018; Varcin et al., 2022). Finally, Research Question 3 found that individuals with a diagnosis of either autism or a psychosis-spectrum condition were more likely to score higher on trait score measures of the other condition, compared to general population samples. This finding is also in line with those of previous

TABLE 3 Study characteristics of standardized mean difference analysis.

Name, year	n1— Diag. Sample group type	Diagnosis	n2—Gen. population	% of males n1	% of males n2	n1 mean age (range)	n2 mean age (range)	Autism measure (classification)	Psychosis measure (classification)	SMD (<i>k</i> = 13)
Craig et al. (2004) ^a	17 Clinical	Asperger's syndrome	16	88.24%	68.75%	24.12 (NR)	29.44 (NR)	NR (ICD-10)	Paranoia Scale	1.406
de Bildt et al. (2016)	18 Clinical	Schizophrenia	21	100.00%	100.00%	37 (19–61)	34.24 (21–53)	ADOS	Clinician (not specified)	1.386
Lugnegård et al. (2015)	36 Clinical	Schizophrenic psychosis	49	63.89%	38.78%	29.1 (NR)	28.6 (NR)	AQ	SCID-I (DSM-IV)	1.459
Martinez et al. (2017)	36 Clinical	Schizophrenia	20	83.33%	85.00%	23.4 (NR)	23.4 (NR)	AQ	DIGS (DSM-IV-TR)	0.788
Matsuo et al. (2015)	44 Clinical	Schizophrenia	65	45.45%	27.69%	36.9 (25–59)	42.2 (25–59)	SRS-A	MINI/PANSS (DSM-IV-TR)	1.242
Milne et al. (2017) ^a	30 Clinical	Autism	30	76.67%	63.33%	32.65 (19–68)	35.37 (19–70)	NR	CAPS	1.744
Pinkham et al. (2008) ^a	12 Clinical	Autism	12	100.00%	100.00%	24.08 (18–35)	27.08 (18–35)	NR (DSM-IV)	Paranoia Scale	1.292
Sasamoto et al. (2011)	20 Clinical	Schizophrenia	25	70.00%	64.00%	34.5 (NR)	34.5 (NR)	AQ	SCID (DSM-IV)	1.578
Suen et al. (2024) ^a	486 Community	Probable autism	1295	NR	NR	NR (NR)	NR (NR)	AQ-10	PQ-B	−0.208
Uphthegrove et al. (2018)	99 Clinical	FEP	381	67.68%	21.00%	25.61 (16–35)	20.61 (17–39)	AQ	NR (ICD-10)	0.845
Wouters and Spek (2011)	21 Clinical	Schizophrenia	21	100.00%	100.00%	40.9 (18–65)	40.8 (18–65)	AQ	SCID-I (DSM-IV-TR)	1.498
Zhang et al. (2016)	37 Clinical	Schizophrenia	38	81.08%	78.95%	20.95 (NR)	21.32 (NR)	AQ (Chinese)	NR (DSM-IV-TR)	2.176
Ziermans et al. (2021)	504 Clinical	Psychotic disorder	337	72.42%	45.40%	33.4 (16–50)	38.5 (16–50)	AQ	NR (DSM-IV-TR)	1.153

Abbreviations: ADOS, Autism Diagnostic Observation Schedule; AQ, Autism Spectrum Quotient; CAPS, Cardiff Anomalous Perception Scale; DIGS, Diagnosis Interview for Genetic Studies 3.0; DSM, Diagnostic and Statistical Manual of Mental Disorders; MINI, Mini-International Neuropsychiatric Interview; PANSS, Positive and Negative Symptoms Scale; PQ-B, Prodromal Questionnaire-Brief; SCID, Structured Clinical Interview for DSM-IV; SRS-A, Social Responsiveness Scale for Adults.

^aMarked studies examined psychosis-spectrum traits within autistic populations; unmarked studies examined autistic traits within samples with psychosis.

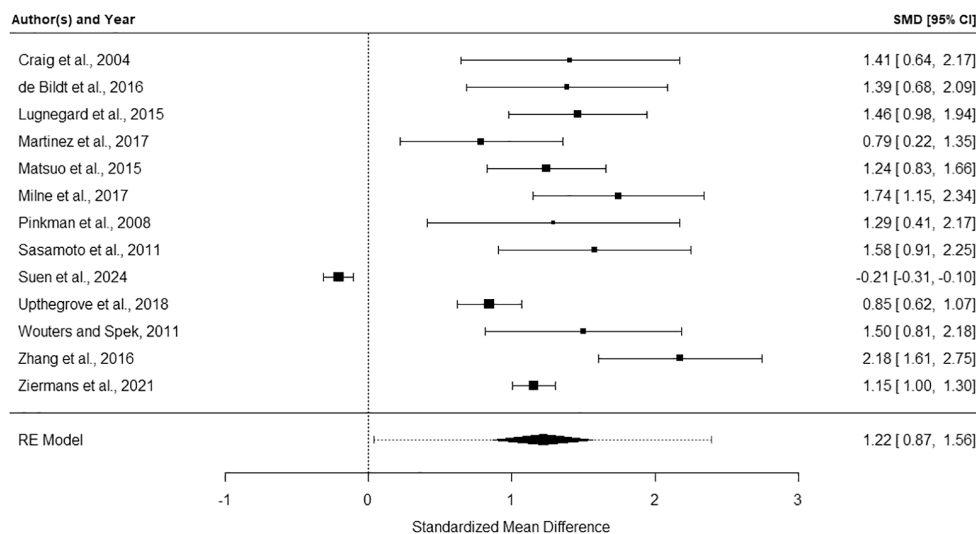


FIGURE 4 Forest plot of studies included in the standardized mean difference analyses.

meta-analyses (De Crescenzo et al., 2019; Kiyono et al., 2020; Vaquerizo-Serrano et al., 2022). As for moderating variables, higher mean age was associated with smaller effects for the correlational analysis (RQ1), and the effect size for the association between a diagnosis of autism and psychosis (RQ2) was larger for males than females. For RQ2 and RQ3, it was not possible to examine the type of measure as a moderator due to a lack of sufficient data.

Given the results of our meta-analyses, three key points need to be discussed: (i) the overlap between autistic traits and negative symptoms, (ii) diagnostic complexity and (iii) the relative lack of other moderation effects given the high heterogeneity.

- (i) Although autistic traits were found to positively correlate with all three subdimensions of psychosis-spectrum traits, the association was strongest with negative traits, suggesting considerable overlap with these constructs. This notion is supported by several studies examining overlap between autistic trait and psychosis-spectrum symptom score measures. Regarding the Autism Quotient (AQ) and the Schizotypal Personality Questionnaire (SPQ), for example, the association between the ‘social skills’ and ‘communication’ subscales of the AQ and the ‘interpersonal’ subscale of the SPQ appears to explain a large degree of the association between overall score correlation (Ford et al., 2017; Hurst et al., 2007). Further, some have even found negative correlations between AQ scores and the Cognitive-Perceptual (positive symptom) domain of the SPQ (Wakabayashi et al., 2012; Zhou et al., 2019). Of the included studies for our correlational analyses, 35% used a combination of these measures; 60% if including modified versions. As such, it is possible that the overall effects are partly explained by the similarity between these two questionnaires. Similar overlaps have also been identified between the AQ and the Brief version of the SPQ (SPQ-B; Dinsdale et al., 2013), the Multidimensional Schizotypy Scale (MSS) and the Oxford-Liverpool Inventory of Feelings and Experiences (Nenadić et al., 2021; Russell-Smith et al., 2011).

This overlap is likely explained by a combination of factors. Conceptually, it may be the case that these traits are genuinely shared between autistic and psychotic conditions, leading to legitimate overlap in measurement. It may also be the case, however, that methodological blurring may be inflating the association, with certain items failing to adequately distinguish autistic and psychosis-spectrum traits. Such blurring may also be present between items pertaining to autistic idiosyncrasies and disorganized psychosis traits (i.e., self-perceptions of odd behaviours and speech). Finally, it could be that

some features are transdiagnostic, possibly related to shared biological (e.g., genetic and chromosomal mutations) (Rapoport et al., 2009; Rees et al., 2021; Sebat et al., 2009) and environmental (e.g., pre- and perinatal) risk factors previously discussed (Davies et al., 2020; Gardener et al., 2009, 2011). These findings, coupled with both the modest effects of our positive symptoms analyses and the risk of item misinterpretation, call into question whether much of this research is truly measuring the association between autism and psychosis.

Attempts have been made, however, to mitigate the effect of this trait similarity. The Psychopathology in Autism Checklist (PAC), developed by Helverschou et al. (2009), is a 30-item carer-reported questionnaire examining symptoms of anxiety, depression, obsessive-compulsive disorder and psychosis that do not overlap with symptoms of autism. To date, however, this questionnaire has not been widely used. More recently, Parvaiz et al. (2023) developed the schiZotypy Autism Questionnaire (ZAQ), a 134-item self-report questionnaire which attempts to better discriminate between symptoms of autism and schizotypy. The questionnaire, co-designed with autistic individuals and individuals with schizophrenia, has not yet been validated, but once trialled, may well produce lower effects than studies using standard measures of psychosis symptomology, such as the SPQ. However, none of the included studies used these measures, so an evaluation of their association with autistic traits is outstanding.

- (ii) As mentioned, it is possible that this comorbidity is partially explained by clinician difficulty in differentiating between displayed autistic and psychotic behaviours. Starling and Dossetor (2009) suggested some of the difficulties clinicians may face distinguishing between symptoms of the two conditions. They highlight that thought disorders and bizarre behaviours are symptoms of both autism and psychosis, that autistic idiosyncrasies and unusual world views may be misinterpreted as psychotic delusions and that self-talk may be viewed as evidence of auditory hallucinations. While little research has yet examined the appropriateness of using existing clinical measures of psychosis within autistic populations, some research has examined the appropriateness of the SIPS (Wilson et al., 2020). Prior findings from these researchers found that clinicians, experienced in working with autistic individuals, deemed over 60% of its items as being problematic for use within autistic populations (Fleischman et al., 2016), for reasons of symptom overlap, poor wording and complexity. Efforts have been made, however, to improve the discriminative ability of assessment tools. In a sample of 50 autistic individuals and 40 individuals with schizophrenia, Nakamura et al. (2024) found that standard ADOS-2 algorithms did not adequately differentiate between the two conditions, resulting in high rates of false positives. They found, however, that a predictive model using a subset of six ADOS-2 items significantly improved discrimination. Further investigation into the discriminative validity of such assessment tools is essential to reduce the risk of false-positive diagnoses and to ensure and expedite appropriate treatment.
- (iii) For each of the analyses, particularly for the correlational and odds ratio, heterogeneity between studies was severe, though clear reasons for this were not identified. While we found some evidence of age and sex effects on the results of the correlation and odds ratio analyses, respectively, the remainder of our moderation analyses yielded insignificant results. The heterogeneity is, therefore, largely unexplained by the moderating factors we examined. Included papers, however, differed in design (e.g., sample characteristics), in measurement (structured interviews, registry data, self-report measures) and in the examined constructs (traits, symptoms or disorders). Such methodological differences are likely to contribute to the observed variance, even if not detectable through formal analyses. It is also possible that there exist other unaccounted-for factors that help to explain the association (i.e., the presence of other comorbid conditions, IQ or socio-economic status).

Strengths and limitations

This meta-analysis provides an updated overview of the association between autism and psychosis, including more data points than previous analyses, and examines the association through a combination

of the various methodologies by which it is measured, thereby providing a holistic overview of the comorbidity profile. It also provides a thorough attempt at examining the moderating effect of measures used, highlighting gaps in the literature. Despite this, there are, however, several limitations worth noting. Firstly, in our analyses, we excluded study samples if participants had other comorbid conditions. While doing so allowed for a clearer examination of the association between the two conditions, it leaves to question the possible moderating role of additional comorbid conditions. For example, research has found increased prevalence of attention deficit hyperactivity disorder (Stralin & Hetta, 2021) and obsessive-compulsive disorder (Mawn et al., 2020) in samples with psychosis. It could, therefore, be the case that additional comorbidities, or particular combinations, better explain or further increase the risk of the comorbidity.

Secondly, in our review, we excluded grey literature, only including peer-reviewed papers. While beneficial for ensuring the quality of included research, excluding grey literature may leave meta-analyses vulnerable to publication bias (Nair & Borkar, 2023), overrepresenting studies with significant results (Conn et al., 2003; McAuley et al., 2000). The addition of grey literature would have been of particular interest in the OR and SMD analyses, considering significant risk of publication bias was identified for both.

There are also two limitations from the reviewed studies worth reporting. The first is the omission of key data. Most importantly, some of the studies identified in the review did not report effect data, or data required to calculate effects. Upon contacting the authors of these papers, few responded, and fewer still had access to the analysed data. Relatedly, for the OR and SMD analyses, while most studies reported by which guidelines diagnosis of either autism or psychosis was met (i.e., ICD or DSM), few reported the actual methods or interview protocols used to acquire diagnosis. For these reasons, we were unable to examine the moderating effect of measure for these analyses. It would, therefore, be of benefit, particularly for future research syntheses in this field, for papers to ensure such information is reported within their papers. To ensure data accessibility for meta-analyses, open science practices including the use of data repositories are encouraged.

The second issue relates to the generalizability and appropriateness of the included samples. For the correlational analysis, in particular, many of the included studies used undergraduate samples. As a result, samples mostly consisted of young adults in their early twenties, with a disproportionately low number of male participants (38%). Sex differences have been observed in the onset of psychosis, generally occurring in males in their early twenties and in women in their late twenties (Li et al., 2016). Further, there is evidence of a second risk period for women, generally occurring around the mid-forties (Grigoriadis & Seeman, 2002; Kirkbride et al., 2012). The use of such samples may, therefore, not be ideal in estimating general psychosis prevalence. Mean ages were more diverse within the OR and SMD analyses, though within these samples, there was instead an increased prevalence of males (70% and 79%, respectively). For these reasons, it is important for future research to also report data from the sexes individually.

CONCLUSION

This review highlights a clear association between autism and psychosis, at both a trait and diagnostic level. Findings suggest, however, that at the trait level, part of this association may be explained by overlaps in expression and measurement, as opposed to pathological overlap. As such, the appropriateness of self-report psychosis-spectrum screening tools within autistic samples should be interpreted cautiously. For diagnostic purposes, structured clinical interviews should be conducted with explicit consideration of autism, ideally by clinicians with experience in both conditions. Gold-standard interviews, such as the SCID, requiring interviewees to provide concrete examples of psychotic experiences may improve diagnostic accuracy, given that questions are worded carefully and that answers are interpreted with caution. Careful scrutiny of developmental history is essential, and collateral information from family, as well as behavioural observation, can provide further important context to better differentiate between innate autistic characteristics from the onset of psychotic symptoms.

These findings highlight several important directions for future research. Firstly, further understanding of how autistic individuals interpret psychosis-related questions is required. Inquiry should be focused on commonly used screening tools (e.g., SPQ, CAPE) and interview protocols (e.g., SIPS), and if it is the case that interpretative issues are present, amendments or alternative methods of assessment must be established. Secondly, little is currently known regarding the aetiology of the comorbidity, and as such, further research should examine factors that may moderate the association. Thirdly, more research is needed examining how psychosis manifests within autistic individuals. There is some evidence to suggest that autistic individuals may be more likely to be diagnosed with an atypical type of psychosis, and less likely to be diagnosed with schizophrenia, compared to non-autistic individuals (Larson et al., 2017), but more research of this kind is still required. With greater understanding of how the comorbidity manifests, clinicians will be able to better identify the onset of psychosis within autistic populations, facilitating earlier intervention and treatment.

AUTHOR CONTRIBUTIONS

Michael R. Miles: Conceptualization; investigation; writing – original draft; methodology; funding acquisition. **Dennis Gilm:** Conceptualization; supervision; methodology; writing – review and editing; funding acquisition. **Emma Palmer-Cooper:** Conceptualization; supervision; methodology; writing – review and editing; funding acquisition.

CONFLICT OF INTEREST STATEMENT

No conflicts of interest to declare.

FUNDING INFORMATION

This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Miles, M. R., Golm, D., & Palmer-Cooper, E. (2025). The association between autism and psychosis and the tools used to measure it: An updated systematic review and meta-analysis. *British Journal of Clinical Psychology*, 00, 1–27. <https://doi.org/10.1111/bjc.70020>

APPENDIX 1

SEARCH STRATEGY

PsycINFO (EBSCO) Search Terms

AB OR TI: autis* OR asperger* OR 'ASD' OR neurodevelopmental OR DE 'Autism Spectrum Disorders' OR DE 'Autistic Traits'

AND

AB OR TI: psychos* OR psychot* OR schizo* OR hallucinat* OR delusion*

OR DE 'Psychosis' OR DE 'Affective Psychosis' OR DE 'Alcohol Induced Psychotic Disorders' OR DE 'Brief Psychotic Disorder' OR DE 'Capgras Syndrome' OR DE 'Childhood Onset Psychosis' OR DE 'Chronic Psychosis' OR DE 'Experimental Psychosis' OR DE 'Hallucinosi' OR DE 'Paranoid Psychosis' OR DE 'Postpartum Psychosis' OR DE 'Reactive Psychosis' OR DE 'Schizophrenia' OR DE 'Senile Dementia' OR DE 'Substance-Induced Psychotic Disorders' OR DE 'Childhood Onset Psychosis' OR DE 'Childhood Onset Schizophrenia' OR DE 'Reactive Psychosis' OR DE 'Chronic Psychosis' OR DE 'Postpartum Psychosis' OR DE 'Paranoid Psychosis' OR DE 'Shared Paranoid Disorder' OR DE 'Brief Psychotic Disorder' OR DE 'Experimental Psychosis' OR DE 'Affective Psychosis' OR DE 'Process Schizophrenia' OR DE 'Substance-Induced Psychotic Disorders' OR DE 'Alcohol Induced Psychotic Disorders'

OR DE 'Schizophrenia' OR DE 'Acute Schizophrenia' OR DE 'Catatonic Schizophrenia' OR DE 'Childhood Onset Schizophrenia' OR DE 'Paranoid Schizophrenia' OR DE 'Process Schizophrenia' OR DE 'Schizoaffective Disorder' OR DE 'Schizophrenia (Disorganized Type)' OR DE 'Schizophreniform Disorder' OR DE 'Undifferentiated Schizophrenia' OR DE 'Schizophrenia (Disorganized Type)' OR

DE 'Childhood Onset Schizophrenia' OR DE 'Undifferentiated Schizophrenia' OR DE 'Process Schizophrenia' OR DE 'Paranoid Schizophrenia' OR DE 'Fragmentation (Schizophrenia)' OR DE 'Catatonic Schizophrenia' OR DE 'Acute Schizophrenia' OR DE 'Schizophreniform Disorder' OR DE 'Schizotypy' OR DE 'Schizoaffective Disorder'

AND

AB OR TI: comorbid* OR co-occur* OR concurrent OR prevalen* OR DE 'Comorbidity'

MEDLINE (EBSCO) Search Terms

AB OR TI: autis* OR asperger* OR 'ASD' OR neurodevelopmental OR (MH 'Autistic Disorder') OR (MH 'Autism Spectrum Disorder+')

AND

AB OR TI: psychos* OR psychot* OR schizo* OR hallucinat* OR delusion* OR (MH 'Psychotic Disorders+') OR (MH 'Schizophrenia Spectrum and Other Psychotic Disorders+')

AND

AB OR TI: comorbid* OR co-occur* OR concurrent OR prevalen* OR (MH 'Comorbidity')

CINAHL (EBSCO) Search Terms

AB OR TI: autis* OR asperger* OR 'ASD' OR neurodevelopmental OR (MH 'Autistic Disorder') OR (MH 'Neurodiversity') OR (MH 'Developmental Disabilities') OR (MH 'Asperger Syndrome')

AND

AB OR TI: psychos* OR psychot* OR schizo* OR hallucinat* OR delusion*

OR (MH 'Postpartum Psychosis') OR (MH 'Psychoses, Substance-Induced+') OR (MH 'ICU Psychosis') OR (MH 'Paranoid Disorders') OR (MH 'Psychoses, Alcoholic+') OR (MH 'Psychotic Disorders+') OR (MH 'Schizoaffective Disorder') OR (MH 'Affective Disorders, Psychotic+') OR (MH 'Organic Mental Disorders, Psychotic+')

OR (MH 'Schizotypal Personality Disorder') OR (MH 'Schizophrenia, Treatment-Resistant') OR (MH 'Schizophrenia, Childhood') OR (MH 'Schizoaffective Disorder') OR (MH 'Schizophrenia+')

AND

AB OR TI: comorbid* OR co-occur* OR concurrent OR prevalen* OR (MH 'Comorbidity') OR (MH 'Diagnosis, Dual (Psychiatry)')

Embase (Ovid) Search Terms

AB OR TI: autis\$ OR asperger\$ OR ASD OR neurodevelopmental

AND

AB OR TI: psychos\$ OR psychot\$ OR schizo\$ OR hallucinat\$ OR delusion\$

AND

AB OR TI: comorbid\$ OR co-occur\$ OR concurrent OR prevalen\$

- Limiter: Remove MEDLINE Records

Web of Science Terms

TI=('autis*' OR 'asperger*' OR ASD OR neurodevelopmental) OR AB=('autis*' OR 'asperger*' OR ASD OR neurodevelopmental)

AND

TI=('psychos*' OR 'psychot*' OR 'schizo*' OR 'hallucinat*' or 'delusion*') OR AB=('psychos*' OR 'psychot*' OR 'schizo*' OR 'hallucinat*' or 'delusion*')

AND

TI=('comorbid*' OR 'co-occur*' OR 'concurrent' OR 'prevalen*') OR AB=('comorbid*' OR 'co-occur*' OR 'concurrent' OR 'prevalen*')