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Psychopathology distinguishing secondary ("organic") psychoses: A systematic review and meta-analysis☆

Graham Blackman [a,b,g,*], Hamilton Morrin [b,c], Claire Carstairs [c,d], Jack B. Fanshawe [a,g], Cameron Watson [b,c], Mao Fong Lim [e], Jonathan Phillips [a,g], Adam E. Handel [g,h], Robert A. McCutcheon [a,b,g], John Headley Ward [e], Elisavet Pappa [f], Emily M.L. Bowman [a], Rachel T.S. Chow [a], Thomas A. Pollak [b,c], Philip McGuire [a,b,g], Vaughan Bell [c,f]

[a] Department of Psychiatry, University of Oxford, Warneford Hospital, OX3 7JX, UK
[b] Department of Psychosis Studies, Institute of Psychiatry, Psychology and Neuroscience, King's College London, London, UK
[c] South London and Maudsley NHS Foundation Trust, London, UK
[d] King's College Hospital NHS Foundation Trust, London, UK
[e] Cambridgeshire and Peterborough NHS Foundation Trust, Cambridge, UK
[f] Research Department of Clinical, Educational and Health Psychology, University College London, London, UK
[g] Oxford Health NHS Foundation Trust, UK
[h] Nuffield Department of Clinical Neurosciences, UK

A B S T R A C T

A significant minority of patients who present with psychosis have an underlying medical ("organic") cause. Some of these secondary causes are reversible; therefore, early detection is critical. Psychopathology may be informative during initial assessment to determine which patients are at an increased risk of having an underlying medical cause and should be prioritised for enhanced investigation.

Through a pre-registered (CRD42024511546) systematic review and meta-analysis, we compared the psychopathology of patients with psychosis secondary to a medical cause compared to patients with primary psychosis as reported in case-control studies using PubMed from inception to September 2025. We identified 13 studies and a pooled sample size of 1564 individuals (primary psychosis = 781, secondary psychosis = 783). Poverty of speech (RR = 18.18, 95% CI = 1.43–231.5) and visual hallucinations (RR = 1.35, 95% CI 1.02–1.80) were more likely to be features of psychosis that was secondary to an underlying medical cause compared to a primary psychotic disorder. Conversely, auditory hallucinations (RR = 0.55, 95% CI = 0.50–0.61), thought insertion (RR = 0.24, 95% CI = 0.12–0.48), thought broadcast (RR = 0.30, 95% CI = 0.09–0.98), unspecified delusions (RR = 0.44, 95% CI = 0.30–0.66), delusions of persecution (RR = 0.72, 95% CI = 0.62–0.84), olfactory hallucinations (RR = 0.34, 95% CI = 0.18–0.63), and tactile hallucinations (RR = 0.26, 95% CI = 0.19–0.35) were more likely to be features of a primary psychosis. Findings underscore the clinical value of a comprehensive psychiatric assessment in patients with undifferentiated psychosis. Secondary psychoses show psychopathological differences, with certain symptoms potentially serving as 'red flags' for secondary causes. These indicators may assist clinicians in prioritising patients for further investigation.

1. Introduction

Psychosis is a heterogeneous syndrome characterised by hallucinations, delusions, and disorganisation of thought, and affects approximately 3.5% of individuals over the course of a lifetime (Perälä et al., 2007). Among patients presenting with psychosis, meta-analytic estimates indicate that around 5% have an underlying medical cause for their symptoms (Blackman et al., 2025), such as epilepsy or autoimmune encephalitis. However, this may be an underestimate, as most studies have not performed comprehensive and standardised diagnostic assessments.

Many different medical conditions can give rise to psychotic symptoms (Keshavan and Kaneko, 2013). As such, it is not feasible to exclude every possible cause in a patient who presents with psychosis and clinicians must weigh up the anticipated net clinical benefit of additional diagnostic tests. For example, over-investigation into secondary causes may delay appropriate treatment, as well as increase the risk of iatrogenic harm (Haas et al., 1998).

Clinical "red flags" are signs and symptoms that indicate an increased risk of serious underlying aetiology. They are typically based

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* Corresponding author at: Department of Psychiatry, University of Oxford, Warneford Hospital, OX3 7JX, UK.
E-mail address: graham.blackman@psych.ox.ac.uk (G. Blackman).

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on clinical features that can be assessed during a routine clinical examination, without the need for specialist skills or equipment, and can help to identify patients who may benefit from further investigation. Evidence-based red flags have been developed for other neuropsychiatric syndromes, such as headache (Do et al., 2019), but have not yet been systematically applied to the assessment of psychotic disorders.

Certain psychopathological features of psychosis, such as visual hallucinations (Blackman et al., 2023)., have been shown to occur more frequently in patients with secondary causes. Identifying psychiatric symptoms that reliably distinguish secondary from primary (idiopathic) psychosis could provide clinicians with a practical screening tool. Such red flags would help guide decisions on which patients should be prioritised for enhanced diagnostic work-up, including neuroimaging, EEG, or cerebrospinal fluid analysis. However, to date, there has never been an attempt to meta analytically examine a broad array of psychopathological features associated with psychosis secondary to an underlying medical cause.

Using a systematic and meta-analytic approach, we sought to determine whether psychopathological features are able to distinguish secondary ("organic") psychoses.

2. Methods

Using a systematic review and meta-analytic approach, we aimed to compare the presence of specific psychopathological features in patients with psychosis secondary to a medical cause compared to patients with primary psychosis as reported in case-control studies. The study was pre-registered (CRD42024511546) and conducted according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) and Meta-analysis of Observational Studies in Epidemiology (MOOSE) frameworks (Page et al., 2021) (see Tables S1 and S2 in supplementary materials).

2.1. Search strategy and eligibility criteria

We searched the electronic database PubMed (National Library of Medicine) via the PubMed web interface (pubmed.ncbi.nlm.nih.gov) from inception to 13 September 2025 for eligible published articles in English using the terms: ("psychosis" OR "schizophrenia") AND ("features" OR "red flags" OR "indicator" OR "psychopathology" OR "phenomenology") AND ("organic*" OR "secondary").

Inclusion required studies to have: (i) included patients with psychotic symptoms or a psychotic disorder, (ii) reported on the presence, or absence of one or more psychiatric symptoms and (iii) classified patients based on whether they had a primary (idiopathic) or secondary cause to their symptoms using a case-control design.

We excluded studies of secondary psychosis which focused on medication or drug-induced psychosis exclusively (i.e. consistent with the category "mental and behavioural disorders due to psychoactive substance use"; F10-F19). When two studies reported overlapping samples, the larger was included. Guidelines, expert opinion, editorials, letters to the editor, conference proceedings, trials registers, internet resources and case reports and series were excluded. Studies were restricted to those published in English due to resource constraints. References from included articles were manually reviewed alongside relevant review articles. Minor deviations from the pre-registered analysis plan are reported in the supplementary materials.

Following deduplication, the title and abstract of articles were screened and the full text was reviewed to confirm eligibility. Only articles with full text or sufficiently detailed abstracts were included. Screening of titles and abstracts, as well as full text review was performed independently and in parallel in pairs (H.M., J.B·F, C.W., C·C, M. F.L) with a third author (G.B., J.P.) arbitrating in the event of any discrepancies. Data extraction and risk of bias assessment were performed through the same process. No automation tools were used in the selection process.

2.2. Outcome

The primary outcome was diagnosis of a primary or secondary psychosis. Patients were classified as having a primary psychosis if their symptoms were attributed to an idiopathic ('non-organic') psychotic disorder. Patients were classified as having a secondary psychosis if symptoms were attributed to an underlying medical disease state by the study authors (see Table S5 for details). Underlying disease state was further divided into pre-defined categories as previously reported (Keshavan and Kaneko, 2013) (Blackman et al., 2025) (see Table S3).

2.3. Data extraction and encoding

Data were extracted using a piloted data extraction form. For each study we recorded general characteristics (title, authors, year of publication, and extractor) and methodological details (study design, sampling technique, study year, country, definition of primary/secondary psychosis). Sample characteristics were also extracted (including the source of the sample, total sample size, and the number of patients with primary or secondary psychosis). Where reported, we extracted mean age and standard deviation for the overall sample and for primary and secondary psychosis groups separately, as well as sex distribution across groups.

Clinical features were recorded as the number of patients exhibiting specific psychopathological features, documented separately for primary and secondary psychosis. These features included hallucinations, delusions, affective symptoms, negative symptoms, and catatonia. Where available, we also documented the underlying aetiology of secondary psychosis, such as autoimmune, cerebrovascular and neurodegenerative. No imputation was undertaken for missing data.

2.4. Risk of bias and quality assessment

Risk of bias was assessed using a modified version of the JBI checklist for case-control studies (Moola et al., 2020). The tool comprises nine items, each scored as 1 ('yes') or 0 ('no/unclear'), giving a total score between 0 and 9. Based on the composite score, studies were categorized as: low risk (7–9), medium risk (4–6), or high risk of bias (0–3) (Table s6).

2.5. Statistical analysis

We conducted a meta-analysis of case-control studies to compare the psychopathological features of patients with psychosis secondary to an underlying medical cause (cases) and those with a primary psychotic disorder (controls). We limited inclusion to case–control studies to enable direct comparison between patients with primary and secondary psychosis, which would not be possible with other designs. We calculated relative risks (RRs) with 95% confidence intervals for each psychopathological feature. RRs were selected because they offer a more clinically interpretable measure of association and, unlike odds ratios, do not exaggerate effect sizes when outcomes are relatively common. When effect sizes for two or more studies were available, we performed a meta-analysis using a random-effects model to account for anticipated methodological heterogeneity across studies. The DerSimonian and Laird inverse variance method (DerSimonian and Laird, 1986) was employed to derive pooled relative risk (risk ratio) estimates and their 95% confidence intervals (CI). A continuity correction of 0.5 was applied for studies with zero cell frequencies. For forest plots, the logarithm of relative risk was visualised to facilitate interpretation. Statistical significance was determined at $p < 0.05$. Between-study heterogeneity was quantified using the I^2 statistic, categorized as low (25%), moderate (50%), or high (75%). The chi-squared test was also used to statistically assess heterogeneity.

Secondary analyses were performed for significant findings only. Meta-regression explored the moderating effect of average age

difference (secondary psychosis - primary psychosis), age of onset of psychosis and publication year. Subgroup analysis explored the effect of studies incorporating multiple or single causes of secondary psychosis, studies with structured vs non-structured assessments and neurodegenerative and non-neurodegenerative secondary causes of psychosis, provided 3 or more studies were available in each subgroup. Sensitivity analyses explored the impact of studies published prior to the year 2000. Influential study analysis (Viechtbauer and Cheung, 2010) was performed to detect studies with an excessive influence on pooled effect sizes, or which contributed substantially to between study heterogeneity using the leave-one-out paradigm (Sterne et al., 2001) (Harrer et al., 2021). Adjusted RR (ARR) were calculated based the removal of influential studies. Publication bias was evaluated through visual inspection of funnel plots (Sterne et al., 2001) and tested through Egger's test (Egger et al., 1997). Statistical analysis was conducted using R version 4.1.1 (Team, 2021) and used the *meta* and *dmetar* packages (Balduzzi et al., 2019).

3. Results

The database search identified 2268 publications, with an additional 15 studies identified through other sources. Exclusion by title reduced the number of studies to 428, and exclusion by abstract reduced this to 108. Full-text review identified 13 eligible studies (Leuchter and Spar, 1985; Cutting, 1987; Johnstone et al., 1988; Funayama et al., 2022; Llorca et al., 2016; Etlouba et al., 2018; Alciati et al., 2001; Mulsant et al., 1993; Van Assche et al., 2019; Schutte et al., 2020; Tuokko et al., 1999; Matsuura et al., 2004; Mellers et al., 2000) for inclusion (Fig. S1 for PRISMA flow chart and Table S3 for summary of included studies).

3.1. Study and patient characteristics

The pooled sample was 1564 (primary psychosis = 781, secondary psychosis = 783). Study sample size varied between 26 and 330 patients and publication year ranged between 1985 and 2022. Average age in the secondary psychosis group ranged between 27 and 79 years. In all but one study (Funayama et al., 2022), average age in patients with secondary psychosis was older than patients with a primary psychosis with an age difference of 0 to 35 years. Female patients constituted 44% (n = 693) of the overall pooled sample. Seven studies matched cases and controls on one or more characteristics. In terms of underlying causes of secondary psychosis, the most common categories were degenerative disease (n = 326), infection (n = 89), and seizures (n = 86). In seven studies, all patients with a secondary cause belonged to a single category, most commonly a degenerative disease (k = 4) (Table S4 for further details). In terms of quality assessment, scores on the modified JBI checklist ranged between 4 and 8 out of 9 (Table S6). Overall, 8 studies were at medium risk and 5 were at low risk of bias. No studies were at high risk of bias.

3.2. Meta analysis

Regarding perceptual abnormalities, patients with secondary psychosis were more likely to experience visual hallucinations compared to patients with a primary psychotic disorder, with a Relative Risk (RR) of 1.35 (k = 9, 95% CI 1.02–1.80, p = 0.038) and a I^2 statistic of 78%, indicating a high degree of heterogeneity. In contrast, patients with secondary psychosis were less likely to have auditory hallucinations (k = 10, RR = 0.55, 95% CI = 0.50–0.61, $p < 0.001$, $I^2 = 0$), tactile hallucinations (k = 5, RR = 0.26, 95% CI = 0.19–0.35, $p < 0.001$, $I^2 = 0$), and olfactory hallucinations (k = 5, RR = 0.34, 95% CI = 0.18–0.63, $p < 0.001$, $I^2 = 52\%$). In terms of abnormal thought content, patients with secondary psychosis were significantly less likely to have non-specified delusions than patients with a primary psychosis disorder (k = 8, RR = 0.44, 95% CI = 0.30–0.66, $p < 0.001$, $I^2 = 87\%$). Patients with secondary psychosis were also significantly less likely to have delusions of persecution (k = 3, RR = 0.72, 95% CI = 0.62–0.84, $p < 0.001$, $I^2 = 67\%$). In terms of thought interference, patients with secondary psychosis were significantly less likely to experience thought insertion (k = 2, RR = 0.24, 95% CI = 0.12–0.48, $p < 0.001$, $I^2 = 0$) and thought broadcast (k = 2, RR = 0.30, 95% CI = 0.09–0.98, $p = 0.046$, $I^2 = 0$) than patients with a primary psychotic disorder. Finally, for speech and language abnormalities, patients with secondary psychosis were significantly more likely to have poverty of speech than patients with a primary psychotic disorder (k = 3, RR = 18.18, 95% CI = 1.43–231.5, $p = 0.026$, $I^2 = 62\%$). Fig. 1 presents a summary forest plot of all pooled meta-analytic estimates across psychopathological features. Individual forest plots for each meta-analysis are provided in Supplementary Fig. S3.

3.3. Moderators and sub-group analysis

Meta-regression found age difference ($p < 0.001$, CI 0.04–0.09) and publication year ($p < 0.001$, CI –0.06 - -0.02) were significant modifiers for thought disorder only (see Fig. S5). Due to insufficient studies, the impact of age of psychosis onset was not explored.

Sub-group analysis found no difference between studies that consisted of multiple, or single causes of secondary psychosis for visual hallucinations ($Q(1) = 2.03$, $p = 0.154$) or delusions ($Q(1) = 0.03$, $p = 0.853$). Subgroup analysis also revealed no significant difference between studies that included neurodegenerative or non-neurodegenerative secondary causes of psychosis ($Q(1) = 0.25$, $p = 0.62$) for visual hallucinations. Due to the limited number of studies available, further subgroup analyses were not conducted.

3.4. Robustness and sensitivity analyses

Leave-one-out sensitivity analysis indicated that Schutte et al. (2020) was influential in the meta-analyses of visual hallucinations (ARR = 1.47; 95% CI = 1.21–1.79; $p < 0.001$; $I^2 = 36.4\%$) and olfactory hallucinations (ARR = 0.44; 95% CI = 0.27–0.70; $p < 0.001$; $I^2 = 0$), with its removal increasing the effect size between primary and secondary psychosis. Van Assche et al. (2019) significantly influenced the meta-analyses of non-specified delusions (ARR = 0.39; 95% CI = 0.27–0.56; $p < 0.001$; $I^2 = 62\%$) and delusions of persecution (ARR = 1.99; 95% CI = 0.21–18.43; $p = 0.55$; $I^2 = 79\%$), with its exclusion reducing the effect size and heterogeneity. Similarly, Leuchter and Spar (1985) was influential in the analysis of delusions of persecution (ARR = 1.87; 95% CI = 0.17–20.17; $p = 0.61$; $I^2 = 82\%$), with its removal leading to decreased effect size and heterogeneity. Finally, Funayama et al. (2022) was influential in the analysis of poverty of speech (ARR = 6.95; 95% CI = 0.98–49.11; $p = 0.052$; $I^2 = 20\%$), with its exclusion resulting in a reduced effect size. Funnel plot (Fig. S2) inspections and non-significant Egger's tests indicated no clear evidence of publication bias.

Sensitivity analysis excluding publications before 2000 (see Table S7) found the associations for visual hallucinations ($p = 0.091$), poverty of speech ($p = 0.217$), and thought broadcast became nonsignificant ($p = 0.209$). In contrast, a significant association between primary psychosis and thought disorder emerged ($p = 0.001$).

4. Discussion

This meta-analysis of case-control studies identified psychopathological features that may help to distinguish patients with secondary causes of psychosis from those with a primary cause. Exploring a range of candidate symptoms, we found that visual hallucinations and poverty of speech were associated with underlying medical causes of psychosis. In contrast, auditory hallucinations, olfactory hallucinations, tactile hallucinations, thought broadcasting, thought insertion, persecutory delusions, and unspecified delusions were associated with a primary cause.

An association between visual hallucinations and medical causes of

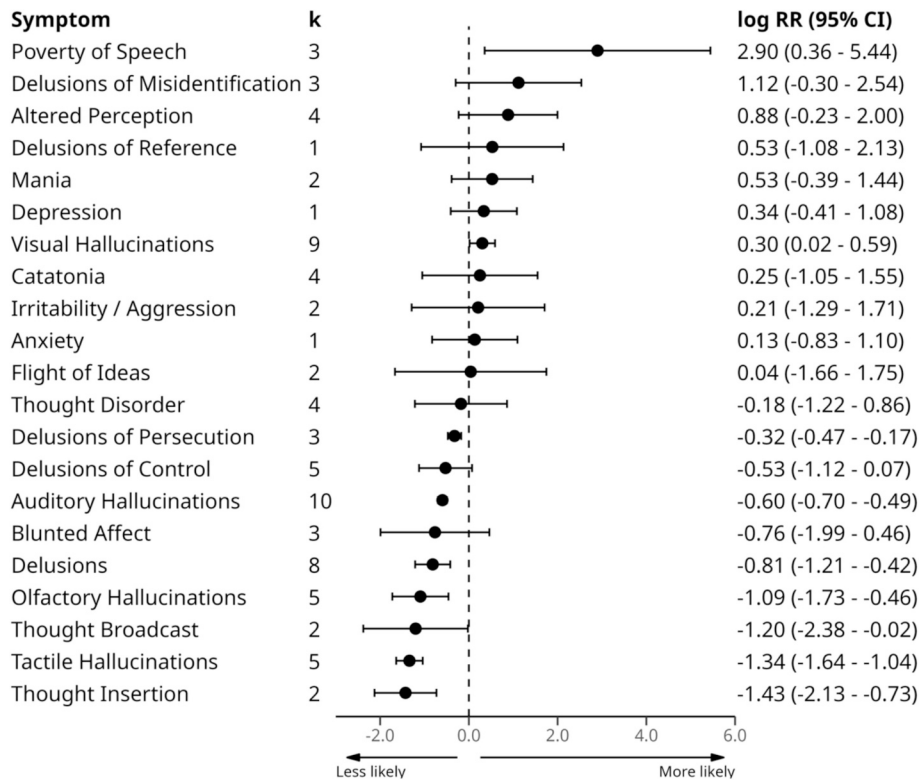

Fig. 1. Forest plot of psychopathological features. Pooled logarithm of the relative risk (RR) and 95% confidence intervals reported alongside number of studies included (k). Effect size estimates (black circle) to the right of the x-axis indicates an increased likelihood of secondary psychosis compared to primary psychosis. Effect size estimates to the left of the x-axis indicates a decreased likelihood of secondary psychosis.

psychosis aligns with existing meta-analytic evidence (e.g., Blackman et al., 2023). However, the link with poverty of speech is less well-established. A possible explanation could be that poverty of speech reflects altered levels of consciousness or cognitive symptoms in certain medical conditions associated with psychosis, such as neurodegenerative diseases or encephalopathies (McKeon et al., 2018).

The association between auditory hallucinations, persecutory delusions, thought insertion, and thought broadcasting broadly aligns with the typical clinical presentation of schizophreniform disorders. Notably, these features (except for persecutory delusions) correspond with the 'first-rank' symptoms of schizophrenia described by Kurt Schneider in 1957. Interestingly, these symptoms were incorporated into the ICD diagnostic criteria for schizophrenia until ICD-10 in 1993, when concerns regarding their specificity led to their removal. Our findings, in keeping with recent evidence (Soares-Weiser et al., 2015) suggest that first-rank symptoms may indeed be clinically useful from a diagnostic perspective in terms of identifying patients more likely to have a primary psychotic disorder, particularly in contexts where early differentiation between idiopathic and secondary psychoses is critical.

In contrast, some results were counterintuitive, such as olfactory and tactile hallucinations appearing more common in primary psychosis. These were surprising given olfactory hallucinations are associated with temporal lobe lesions (Chen et al., 2003), and tactile hallucinations are associated with acute alcohol withdrawal states (Platz et al., 1995). Possible methodological explanations include reporting bias, under-reporting, misclassification, or differences in how symptoms were elicited. Moreover, olfactory hallucinations may not be entirely unexpected, given impairments in the olfactory cortex in patients with primary psychotic disorders, including schizophrenia (Turetsky et al., 2003).

In secondary analyses, only thought disorder was found to be moderated by age differences between primary and secondary psychosis and publication year. No differences were observed between studies that grouped multiple causes of secondary psychosis and those that focused on a single category. Furthermore, findings remained robust after the removal of influential studies, except for poverty of speech and delusions of persecution.

4.1. Clinical applications

One aim of this study was to investigate whether any psychopathological features could serve as "red flags" for the presence of an underlying medical aetiology. A key advantage of psychopathological features is that they can be assessed during routine clinical evaluations without requiring specialized skills or equipment. Currently, clinicians often rely on clinical judgment to determine which patients with psychosis are at increased risk of having an underlying medical cause, and thus warrant further investigation (e.g., MRI, EEG, lumbar puncture) or specialist referral (e.g., to a neurologist). However, this approach is vulnerable to clinician biases. Identifying evidence-based clinical "red flags" could facilitate the development of decision-support tools to help clinicians prioritize patients for additional investigations. Such tools could assist in determining the patients who would most benefit from enhanced assessments to confirm or rule out secondary causes. Equally, they could help reduce unnecessary investigations where the likelihood of influencing clinical care is low. Finally, establishing a standardised framework for referring patients (either for diagnostic investigation or consultation with other medical specialities) could facilitate communication between healthcare providers and ensure more consistent patient care.

4.2. Strengths and limitations

To our knowledge this is the first attempt to generate meta-analytic effects across an array of clinical features in distinguishing the psychopathology of patients with psychosis due to an underlying medical

cause. As such, it provides the first attempt to produce evidence-based symptom based 'red flags' for patients presenting with psychosis.

There are, nevertheless, several limitations to acknowledge. Some of the studies we included focused on the psychosis of specific underlying causes, such as epilepsy and dementia. As such, the analyses are enriched for certain disorders, in particular dementia. We addressed this through sensitivity analyses comparing neurodegenerative and non-neurodegenerative secondary causes of psychosis. Whilst subgroup analyses to explore the psychopathology of other categories (e.g., autoimmune disorders) would have been informative, we were limited by small number of studies available. Similarly, we were unable to examine potential confounders such as method of assessment, study region, or age of symptom onset, owing to limited reporting across studies.

Furthermore, there is likely to be a selection bias in the literature as only a subset of patients undergo enhanced assessment for secondary causes, which are likely to be influenced by a priori assumptions. For example, patients with a pre-existing neurological disorder may be considered more likely to have a secondary cause (and therefore undergo additional investigations to exclude a secondary cause). Whilst case-control studies are informative in distinguishing the clinical features associated with secondary causes of psychosis, they do not permit estimates of the prevalence of secondary causes of psychosis. As a result positive and negative predictive values could not be derived which would have been useful from a clinical utility perspective.

We note that nine studies had a mean sample age greater than 40 years for those with secondary psychosis (and five studies had an average age greater than 60 years). This may limit the generalisability of our findings to younger patients with first episode psychosis typically seen in early intervention services.

Many psychopathological features, such as catatonia, were only reported in a small number of studies, impacting the precision of estimates. Furthermore, sample sizes were generally modest, especially the subgroup of patients with a secondary cause. Several studies did not employ a standardised approach to data collection. Older studies may not reflect more recent diagnostic advancements. More broadly, attributing psychosis to an underlying disease state can be difficult. In many situations, the aetiology may be multifactorial. Whilst in some instances the mechanisms by which psychotic symptoms arise are reasonably well understood, in other instances (such as a space-occupying lesions), the exact mechanism is less clear. Finally, the aggregate approach used in meta-analyses limits the ability to explore the interplay between various clinical features associated with psychosis.

Some clinical features exhibited high levels of heterogeneity (e.g., visual hallucinations, delusions). It is unclear whether this is due to study-related characteristics such as aetiology, method of symptom assessment, or geographic region. Ideally, subgroup analyses could be used to explore these sources of heterogeneity; however, the limited number of available data points precluded such analyses.

Definitions of psychopathological features (e.g., hallucinations, delusions, disorganisation) varied across studies, with differences in diagnostic thresholds and assessment methods. Similarly, variation in rating instruments (e.g., BPRS vs PANSS) may have introduced measurement bias in symptom assessment. The operational criteria for secondary psychosis also varied across studies: some relied primarily on clinical judgment, while others used structured diagnostic systems. Pooling such diverse studies inevitably adds to statistical heterogeneity, thereby reducing the precision of effect size estimates. Potential confounders, such as antipsychotic side effects and comorbid conditions, may also have masked or mimicked certain psychopathological features. In addition, the absence of standardised criteria for defining secondary psychosis across studies limits both comparability and interpretability. Finally, as most studies were conducted in high-income countries, generalisability to low-resource settings—where secondary psychoses may more commonly arise from infectious or nutritional causes—is restricted.

4.3. Future work

Several important questions remain unanswered and warrant further investigation. The prevalence of secondary causes of psychosis was not considered in the present study, which is critical for determining the positive and negative predictive values of candidate red flags. Given the low prevalence of many secondary causes (Blackman et al., 2025), large-scale studies in representative samples are needed that include measures of multiple red flags within the same study. Furthermore, several clinical features that were not included in the current analysis - such as age of onset of psychosis - would merit further exploration in future studies.

It is unclear whether a single clinical feature is sufficient to determine whether a patient is at an increased risk of secondary psychosis, or if a combination leads to greater predictive accuracy. Determine whether combining two or more red flags improves diagnostic accuracy, compared to using a single feature. The degree of psychopathological heterogeneity in patients with psychosis due to underlying medical conditions is another area that requires further exploration. While preliminary evidence suggests psychopathology varies by medical conditions giving rise to psychosis, this has not been systematically studied at scale. Future individual patient data (IPD) meta-analyses could refine estimates and allow more precise examination of subgroups.

The clinical utility of specific red flags also needs clarification. For example, a clinical feature with high specificity would be particularly useful for "ruling in" a secondary cause, whereas a clinical feature with high sensitivity would be more effective for "ruling out" a secondary cause. Finally, it is essential to determine whether red flags are best used to aid in the detection of secondary causes of psychosis in general, or tailored to specific underlying disease states. This consideration may be especially relevant for conditions that are rare, but potentially life-threatening or reversible, where early detection is critical.

5. Conclusion

The presence of certain psychopathological features in a patient with psychosis provides some indication regarding the likelihood of an underlying medical cause. Findings highlight the clinical value of a comprehensive psychiatric assessment in a patient with an undifferentiated psychotic presentation. Psychopathological features may help to guide clinicians in identifying which patients should be prioritised for enhanced investigation.

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CRediT authorship contribution statement

Graham Blackman: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Hamilton Morrin:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Formal analysis, Data curation, Conceptualization. **Claire Carstairs:** Writing – review & editing, Data

curation, Conceptualization. **Jack B. Fanshawe:** Writing – review & editing, Project administration, Data curation. **Cameron Watson:** Writing – review & editing, Project administration, Methodology, Data curation. **Mao Fong Lim:** Writing – review & editing, Methodology, Formal analysis, Data curation. **Jonathan Phillips:** Writing – review & editing, Writing – original draft, Data curation. **Adam E. Handel:** Writing - review & editing, Methodology. **Robert A. McCutcheon:** Writing – original draft, Methodology. **John Headley Ward:** Writing – review & editing, Methodology, Data curation. **Elisavet Pappa:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation. **Emily M.L. Bowman:** Writing – review & editing, Project administration, Data curation. **Rachel T.S. Chow:** Writing – review & editing, Project administration, Data curation. **Thomas A. Pollak:** Writing – review & editing, Methodology, Conceptualization. **Philip McGuire:** Writing – review & editing, Methodology, Conceptualization. **Vaughan Bell:** Writing – review & editing, Supervision, Methodology, Formal analysis.

Declaration of competing interest

RAM has received speaker/consultancy fees from Boehringer Ingelheim, Janssen, Karuna, Lundbeck, Newron, Otsuka, and Viatris, and co-directs a company that designs digital resources to support treatment of mental ill health.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.schres.2026.01.007.

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