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Review

Prevalence of chronic kidney disease in people with severe mental illness: systematic review and meta-analysis

Claire Carswell, Rebecca Ellen Nisbet, Jakiah Khan, Zaahidah Patel, Ammaarah Husain, Kate Bramham, Joseph Chilcot, Rowena Jacobs, David Philip Osborn and Najma Siddiqi

Background

People with severe mental illness (SMI) are more likely to develop long-term physical health conditions compared with those without SMI, contributing to an inequality in life expectancy. Chronic kidney disease (CKD) is a growing global health concern set to be the fifth leading cause of life-years lost by 2040. Although people with SMI may have a higher risk of CKD, there is limited research exploring the relationship between CKD and SMI.

Aims

This review aimed to examine the prevalence, incidence and risk of CKD among people with SMI.

Method

We searched Medline, Embase, PsycINFO, CINAHL, Scopus and Web of Science for epidemiological research reporting the prevalence of CKD (of any stage according to Kidney Disease Improving Global Outcomes guidelines) among people with SMI. Records were imported into Covidence and screened by two reviewers. Meta-analyses were conducted using random-effects models to examine the prevalence, incidence and risk of CKD among people with SMI.

Results

Forty-eight studies were included in the review. The pooled

prevalence of CKD was 8% in studies of people with SMI (95% CI 5%, 18%) and was highest in studies focused only on participants with bipolar disorder (95% CI 0.15 (0.06, 0.26)). The pooled incidence rate of CKD was 26.83 cases (95% CI 18.66, 38.58) per 1000 person-years. People with SMI had significantly higher odds of CKD compared with those without SMI (odds ratio 2.33 [95% CI 1.70, 3.21]).

Conclusion

People with SMI are at a significantly higher risk of having CKD compared with those without SMI. Although psychiatric medication and high rates of diabetes may play a role, the drivers of this inequality are under-researched.

Keywords

Mortality and morbidity; comorbidity; bipolar type I or II disorders; psychotic disorders/schizophrenia; liaison psychiatry.

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Severe mental illnesses (SMI; conditions such as schizophrenia, schizoaffective disorder and bipolar disorder) are associated with a significant reduction in life expectancy, known as the mortality gap.¹ On average, people with SMI die 15–20 years earlier than those who do not have SMI.^{1,2} Although a portion of this variation is attributable to suicide and accidental death, the main contributory factor to this inequality is the largely preventable poor physical health of people with SMI.^{1–3} This includes higher rates of long-term physical health conditions and poorer outcomes from those conditions.^{4–7}

Chronic kidney disease (CKD) is a progressive condition that is often asymptomatic in the early stages, and is characterised by a sustained reduction in kidney function, typically staged by estimated glomerular filtration rate (eGFR).¹¹ There are five stages of CKD according to the Kidney Disease Improving Global Outcomes guidelines and, in the latest stage (stage 5), kidney function is severely impaired, necessitating kidney replacement therapies including dialysis or renal transplantation.¹¹ According to recent global health estimates, CKD affects approximately 843.6 million individuals worldwide, a figure that continues to rise due to population ageing, increasing rates of diabetes and hypertension and other potentially modifiable risk factors.¹² Projections indicate that, by the year 2040, CKD will rank as the fifth leading cause of life-years lost globally, highlighting its growing impact on public health systems.¹³

Cardiovascular death is the leading cause of mortality among individuals living with SMI, accounting for approximately 70% of all deaths in those diagnosed with bipolar disorder or schizophrenia.⁵ Epidemiological studies have shown that individuals with SMI have a significantly elevated risk of both sudden cardiac death and overall cardiovascular mortality.^{5,8} Cardiovascular mortality is also the leading cause of death among people with CKD.^{9,10} Although the relationship between SMI and long-term physical health conditions such as cardiovascular disease and type 2 diabetes has been relatively well documented,^{5,7,14,15} CKD has not attracted the same attention despite available evidence suggesting that it may disproportionately impact people with SMI.¹⁶

Several medications used in the treatment of SMI can increase the risk of CKD.¹⁷ Lithium, a highly effective mood stabiliser used in the management of bipolar disorder and schizoaffective disorder, is associated with a range of renal side-effects,¹⁸ including nephrogenic diabetes insipidus, tubulo-interstitial nephritis and long-term decline in glomerular function.¹⁷ Acute kidney injury (AKI) can also occur in cases of lithium toxicity, when serum lithium levels are elevated beyond the narrow therapeutic range.¹⁹ Anti-psychotic medications, although not exhibiting the same renal side-effects, are known to induce or exacerbate metabolic syndrome, a cluster of conditions including obesity, dyslipidaemia, insulin resistance and hypertension, all of which are independently associated with increased risk of CKD.²⁰

Antipsychotic medications also contribute to the development of other conditions, such as type 2 diabetes mellitus and hypertension, which are well-established risk factors for CKD.^{21,22} Additionally, health risk behaviours associated with CKD are more prevalent among people with SMI – including high rates of smoking, diets high in saturated fats, sugars and sodium and high levels of sedentary behaviour.²³ Social determinants of health, including poverty, housing insecurity and reduced access to preventive health services, may exacerbate these risks and contribute to poorer health outcomes in this population, including a higher risk of CKD.^{24,25}

The early identification and proactive management of CKD are critical to mitigate progression to kidney failure and reduce cardiovascular mortality risk.^{26,27} Timely intervention, including identification of deteriorating eGFR and management of hypertension and diabetes, could slow CKD progression and improve survival outcomes.^{26,28} To contribute to improved identification and appropriate care for people with coexisting SMI and CKD, the epidemiology of this comorbidity, including its prevalence and incidence, needs to be better understood. To date there has been no systematic review or meta-analysis on the risk of CKD among people with SMI.¹⁶ Therefore, we conducted a systematic review to describe the prevalence, incidence and risk of kidney disease among people with SMI.

Objectives

This review had two overarching objectives:

- (a) Estimate the prevalence and incidence of CKD among people with SMI.
- (b) Compare the prevalence and incidence of CKD among people with SMI with those in the general population or those who do not have SMI.

Method

This systematic review protocol was prospectively published²⁹ and registered in the International Prospective Register of Systematic Reviews, no. CRD42024527215.³⁰

Search strategy

We initially searched Medline, Embase, PsycINFO, CINAHL, Scopus and Web of Science from conception until June 2024, and re-ran the search in February 2025. We used search terms specific to the population (people with SMI), outcome (CKD) and study design (epidemiological studies). The full search strings for the electronic databases can be found in the supplementary materials. We also carried out forwards-and-backwards citation searches to identify any relevant records not included in the database search, and searched the archives of subject-specific journals.

Study selection

Studies were included if they were epidemiological observational studies that reported the prevalence or incidence of CKD (any stage) in a population of adults with SMI. SMI was defined as any condition that can present with psychosis, including schizophrenia, schizoaffective disorder, bipolar disorder and depression with psychosis.

Studies were excluded if the denominator population did not consist of people with SMI, or of a majority with SMI (>50% of the denominator population). If studies did not report the proportion of people with SMI, these were also excluded. Studies were also

excluded if they included participants who were under the age of 18 years (unless data for participants over the age of 18 could be extracted and analysed separately).

Studies were also excluded if they reported only the prevalence or incidence of AKI, or if they did not differentiate AKI from CKD.

Data extraction (selection and coding)

Screening and identification of included records was conducted using Covidence Veritas Health Innovation, Melbourne, Australia (www.covidence.org). Title, abstract and full-text screening was completed by C.C., R.E.N., J.K., A.H. and Z.P., with two independent reviewers reviewing each of the records at both stages and any disagreements resolved through discussion and consensus or, if needed, by consultation with an independent author.

Data extraction started on 5 September 2024. The data extraction table was piloted by C.C. and R.E.N., and data were extracted for each article by two of five independent reviewers (C.C., R.E.N., J.K., Z.P. and A.H.). The extracted data included author, year, publication type, aim of the study, country, World Bank designation, setting, study design, study duration, year(s) of data collection, sample size, participant demographics, SMI diagnostic tool, SMI diagnoses, psychiatric medication, data collection procedures, CKD stages and definition and prevalence and incidence of kidney disease. Studies that included a comparison group of the general population or a population without SMI had additional data extracted on the demographics of comparator groups, the prevalence or incidence of CKD in the comparator group and any risk, odds or hazard ratios reported.

Risk of bias

The risk of bias for each included study was assessed by two of five independent reviewers (C.C., R.E.N., J.K., Z.P. and A.H.) using the appropriate Joanna Briggs Institute (JBI) critical appraisal tools. Where discrepancies arose between scores or the choice of checklist, this was resolved through discussion and consensus and, if needed, referred to a third independent reviewer. Each study was scored based on the total number of items that applied to that study. Because there is no validated categorisation of quality within JBI critical appraisal tools, for this review, studies with no items checked as 'no' or 'unclear' were assessed as high quality, those with one item checked as 'no' or 'unclear' were assessed as moderate quality and those with two or more items checked as 'no' or 'unclear' were assessed as low quality.

Data analysis

Narrative synthesis

The characteristics of the included studies were summarised and described to provide an overview of the evidence.

Meta-analyses

Random-effect models were used in the meta-analyses to account for the high level of heterogeneity. As per the protocol, clinically heterogeneous studies were excluded from the meta-analyses due to the lack of similarity of patient cohorts (for example, studies that reported only the prevalence of CKD among people with SMI and a specific comorbidity were excluded from the analysis). Studies were also excluded if their study design did not result in reporting prevalence or incidence in a way that would allow pooling. In the meta-analyses of ratios, studies were included only if the comparison was between the prevalence or incidence of CKD in people with SMI and people without SMI or the general population. Comparisons with other populations, such as people with other mental health conditions (e.g. anxiety or depression), or between different types of psychiatric drugs, were not pooled.

The prevalence of chronic kidney disease among people with severe mental illness

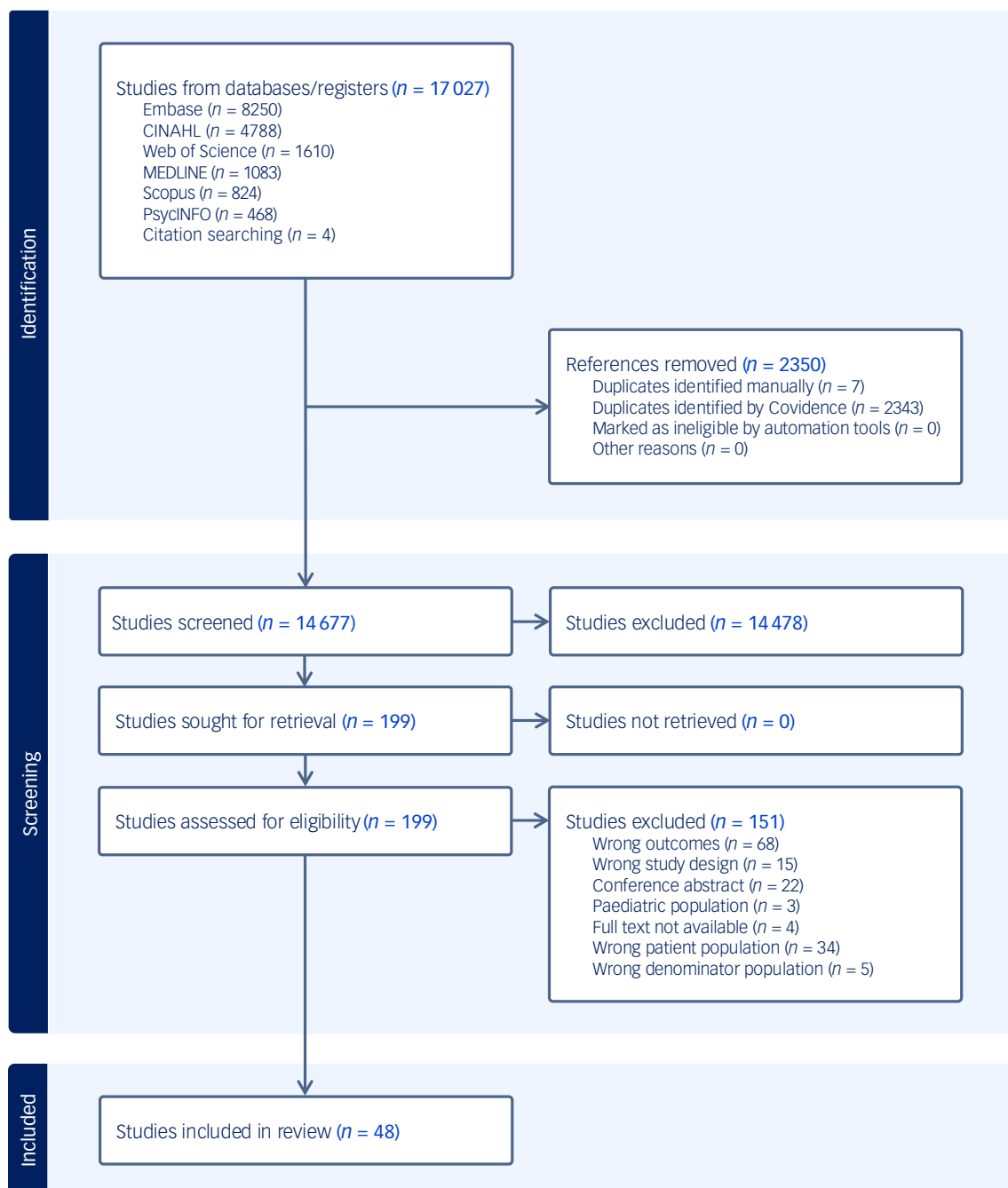


Fig. 1 Preferred Reporting Items for Systematic reviews and Meta-Analyses flow diagram.

Five meta-analyses were conducted:

- the pooled prevalence of CKD among people with SMI;
- the pooled incidence risk of CKD among people with SMI;
- the pooled incidence rate of CKD among people with SMI, per 1000 person-years, at risk;
- the pooled odds ratio of CKD among people with SMI compared with the general population;
- the pooled hazard ratio of CKD among people with SMI compared with the general population.

Sensitivity analyses

Where possible, sensitivity analyses were conducted to determine whether the method of identifying CKD influenced the pooled

result. The methods of identification of CKD were categorised into the following:

- diagnostic code
- eGFR calculation
- eGFR calculation and albuminuria
- eGFR calculation and kidney biopsy
- self-report.

Sensitivity analyses involved removal of those studies that used self-report, albuminuria or kidney biopsy from the meta-analyses where relevant (because some of the meta-analyses did not include studies that used these methods of CKD identification), and examined the impact on the overall results. Finally, we conducted a subgroup

Table 1 Overview of included studies												
Reference	Sample size ^a	SMI	Setting	Country	WB income	Study design	CKD stage reported	Comparison with the general population	CKD outcomes reported	JB1 quality appraisal	Pooled in a meta-analysis	
Presne et al, 2003 ⁷¹	74	Bipolar disorder and schizoaffective disorder	Community	France	HIC	Cohort	Stage 5 (ESRD)	No	Incidence risk	Low	No: reported kidney failure among participants already with CKD	
Carney et al, 2006 ³²	1074	Schizophrenia	Population level	USA	HIC	Cross-sectional	CKD stage 3>	Yes	Prevalence and odds ratio	High	Yes	
Tredget et al, 2010 ³³	61	Bipolar disorder	Community	UK	HIC	Cross-sectional	CKD stage 3>	No	Prevalence	High	Yes	
Schoepf et al, 2012 ³⁴	679	Schizophrenia	In-patient	UK	HIC	Cohort	NR	Yes	Prevalence and risk ratio	High	Yes	
Bocchetta et al, 2015 ³⁵	209	Bipolar disorder	NR	Italy	HIC	Cross-sectional	CKD stage 3>	No	Prevalence	High	Yes	
Smith et al, 2013 ³⁶	2582	Bipolar disorder	Population-level	UK	HIC	Cross-sectional	NR	Yes	Prevalence and odds ratio	High	Yes	
Close et al, 2014 ⁵⁷	6360	Bipolar disorder	Population-level	UK	HIC	Cohort	CKD stage 3>	No	Incidence risk	High	Yes	
Forty et al, 2014 ³⁷	785	Bipolar disorder and schizoaffective disorder	NR	UK	HIC	Cross-sectional	NR	Yes	Prevalence and odds ratio	Low	Yes	
Hendrie et al, 2014 ⁵⁸	31 588	Schizophrenia	Community	USA	HIC	Cohort	NR	Yes	Incidence risk	High	Yes	
Schoepf et al, 2014 ³⁸	1418	Schizophrenia	In-patient	UK	HIC	Cohort	NR	Yes	Prevalence and odds ratio	High	Yes	
Kessing et al, 2015 ⁵⁹	10 591	Bipolar disorder	Population	Denmark	HIC	Cohort	NR	Yes	Incidence risk and hazard ratio	High	Yes	
Reilly et al, 2015 ²⁵	31 807	Schizophrenia, bipolar disorder and unspecified psychosis	Population	UK	HIC	Cohort	NR	Yes	Prevalence	Moderate	Yes (most recent annual prevalence data)	
Tzeng et al, 2015 ⁶¹	2338	Schizophrenia	Population	Taiwan	HIC	Cohort	NR	Yes	Incidence risk, incidence rate and hazard ratio	Moderate	Yes	
Hayes et al, 2016 ³⁹	6671	Bipolar disorder	Population	UK	HIC	Cohort	CKD stage 3>	No	Prevalence and incidence rate	Moderate	Yes	
Bahorik et al, 2017 ⁷⁰	25 090	Bipolar disorder and schizophrenia	Population	USA	HIC	Cross-sectional	NR	Yes	NR (reports odds ratio only)	High	Yes	
Tondo et al, 2017 ⁴⁰	312	Bipolar disorder	NR	International	HIC and UMIC	Cohort	CKD stages 3–4	No	Prevalence	Low	Yes (prevalence of stages 3–4 at final follow-up point)	
Iwagami et al, 2018 ⁴¹	28 396	Bipolar disorder, schizophrenia and non-organic psychosis	Population	UK	HIC	Cross-sectional	NR	Yes	Prevalence and odds ratio	High	Yes	
Doornebal et al, 2019 ⁴²	201	Bipolar disorder and schizoaffective disorder	Community	The Netherlands	HIC	Cross-sectional	CKD stage 3>	No	Prevalence	Moderate	Yes	
Tzur Bitan et al, 2019 ⁴³	27 516	Schizophrenia	Population	Israel	HIC	Cross-sectional	NR	Yes	Prevalence and odds ratio	High	Yes	
Attar et al, 2020 ⁷²	1008	Schizophrenia	Population	Sweden	HIC	Cohort	CKD stages 1–3	Yes	Prevalence	High	No (reports only prevalence among people with SMI who have had a myocardial infarction)	
Garriga et al, 2020 ⁶²	65 490	Psychosis, schizophrenia and bipolar disorder	Population	UK	HIC	Cohort	NR	Yes	Incidence risk and hazard ratio	High	Yes	
Toender et al, 2020 ⁷³	3529	Schizophrenia	Population	Denmark	HIC	Cohort	NR	Yes	Incidence risk	High	No (reports only incidence among people with SMI and diabetes)	
Uju et al, 2020 ⁷⁴	144	Schizophrenia	In-patient	Japan	HIC	Cross-sectional	NR	No	NR (prevalence risk ratio reported)	Low	No (prevalence risk ratio compared between psychosis and affective disorders group)	
Chan et al, 2021 ⁷⁵	7001	Schizophrenia	Population	Hong Kong	HIC	Cohort	NR	Yes	Incidence risk and odds ratio	High	No (reports only the incidence risk of diabetic nephropathy)	
Chen et al, 2021 ⁴⁴	5854	Bipolar disorder	Population	Taiwan	HIC	Cohort	NR	No	Prevalence	High	Yes	

(Continued)

Pahwa et al, 2021 ⁴⁵	154	Bipolar disorder	Community and in-patient	USA	HIC	Cohort	CKD stage 3>	No	Incidence risk	High	Yes
Yazici et al, 2022 ⁴⁶	375	Bipolar disorder and schizoaffective disorder	Community	Turkey	UMIC	Cross sectional	CKD stages 1–3	No	Prevalence	Moderate	Yes
Cho et al, 2022 ⁶³	766	Bipolar disorder, schizophrenia and psychotic disorders	NR	South Korea	HIC	Cohort	CKD stage 3>	No	Incidence risk	High	Yes
Fransson et al, 2022 ⁴⁷	785	Bipolar disorder and schizoaffective disorder	Population	Sweden	HIC	Cross-sectional	CKD stage 3>	Yes	Prevalence and odds ratio	High	Yes
Henriques et al, 2022 ⁷⁶	20 807	Bipolar disorder	Population	Portugal	HIC	Cohort	NR	No	Prevalence	Moderate	No (denominator of the study was hospitalisation episodes, not individual patients)
Scheuer et al, 2022 ⁷⁷	30 102	Schizophrenia and bipolar disorder	Population	Denmark	HIC	Cohort	NR	Yes	Incidence rate and incidence risk ratio	High	No (reporting only incidence rate of diabetic nephropathy)
Spooner et al, 2022 ⁴⁸	11 813	Schizophrenia and bipolar disorder	Population	Australia	HIC	Cross-sectional	NR	Yes	Prevalence and odds ratio	Moderate	Yes
Bennett et al, 2023 ⁴⁹	860	Bipolar disorder, schizophrenia, major depression with psychosis, other psychotic disorders	Community	USA	HIC	Cross-sectional	NR	No	Prevalence	High	Yes
Boivin et al, 2023 ⁵⁶	248	Bipolar disorder and schizophrenia	Inpatient	France	HIC	Cohort	CKD stages 1–5	No	Prevalence	Low	Yes
Chhabria et al, 2023 ⁵⁰	40 616	Bipolar disorder	Population	USA	HIC	Cross-sectional	NR	No	Prevalence	High	Yes
Golic et al, 2023 ⁴⁴	2381	Bipolar disorder	Population	Sweden	HIC	Cohort and case-control	CKD stage 4>	Yes	Incidence	High	No (reports only SMI diagnoses for cases of CKD; breakdown of cohort unclear)
Kruckow et al, 2023 ⁵¹	77 794	Schizophrenia	Population	Denmark	HIC	Cohort	NR	No	Prevalence	High	Yes
Ponzer et al, 2023 ⁵²	8762	Bipolar disorder	Population	Finland	HIC	Cohort	NR	Yes	Prevalence and hazard ratio	Low	Yes
Taloyan et al, 2023 ⁵³	9125	Schizophrenia and bipolar disorder	Population	Sweden	HIC	Cross-sectional	NR	Yes	Prevalence and odds ratio	High	Yes
Gislason et al, 2024 ⁴⁵	3198	Schizophrenia, bipolar disorder and schizoaffective disorder	Population	Iceland	HIC	Cohort	CKD stage 3>	No	Incidence risk	High	Yes
Kessing et al, 2024 ⁶⁰	12 607	Bipolar disorder	Population	Denmark	HIC	Cohort	NR	No	Incidence risk	High	Yes
Na et al, 2024 ⁵⁵	848 058	Schizophrenia, bipolar disorder and depression with psychosis	Population	South Korea	HIC	Cross-sectional	NR	Yes	Prevalence and odds ratio	High	Yes
Pitanupong et al, 2024 ⁶⁶	307	Bipolar disorder and schizoaffective disorder	Community	Thailand	UMIC	Cohort	CKD stage 3>	No	Incidence risk and rate	Moderate	Yes
Wiuff et al, 2024 ⁶⁷	1646	Bipolar disorder	Population	Denmark	HIC	Cohort	NR	Yes	Incidence risk, incidence rate and hazard ratio	High	Yes
Chan et al, 2025 ⁶⁹	7029	Bipolar disorder	Population	Hong Kong	HIC	Cohort	CKD stage 3>	No	Incidence rate	High	Yes
Chang et al, 2025 ⁵⁴	240	Schizophrenia	NR	Taiwan	HIC	Cross-sectional	CKD stages 1–5	No	Prevalence	Low	Yes
Fransson et al, 2025 ⁷⁸	168	Bipolar disorder and schizoaffective disorder	Population	Sweden	HIC	Cohort	CKD stages 1–5	No	Prevalence	High	No (reports only data from patients who discontinued lithium)
Parsaik et al, 2025 ⁶⁸	1603	Bipolar disorder	Population	USA	HIC	Cohort	CKD stage 3>	No	Incidence risk	High	Yes

SMI, severe mental illness; WB, World Bank; CKD, chronic kidney disease; JBI, Joanna Briggs Institute; HIC, high-income country; ESRD, end-stage renal disease; NR, not reported; UMIC, upper-middle income country.
a. Denominator sample size for reporting prevalence or incidence (excluding controls used in any comparisons).

Table 2 Pooled prevalence of chronic kidney disease (CKD) among people with severe mental illness (SMI)			
Variables	Number of studies pooled	CKD prevalence, % (95% CI)	I ² statistic, %
Overall pooled prevalence	25	8 (4, 12)	99.96
By CKD stage/definition			
CKD – stage not reported	15	4 (2, 5)	99.85
CKD stages 1–3	1	37 (32, 41)	–
CKD stages 1–5	1	11 (8, 16)	–
CKD stage >3	7	12 (4, 23)	99.03
CKD stages 3–4	1	46 (41, 52)	–
By SMI			
Bipolar disorder	9	15 (6, 26)	99.87
Schizophrenia	6	2 (1, 5)	99.70
Bipolar disorder and schizoaffective disorder	4	12 (2, 28)	99.03
Mixed SMI	6	3 (2, 6)	99.80
By lithium exposure			
Lithium exposed	5	29 (17, 44)	95.89
Mixed exposure	8	7 (3, 11)	99.44
Not reported	12	3 (2, 5)	99.89
By setting			
Population	14	4 (3, 6)	99.89
Community	4	17 (3, 39)	98.64
In-patient	2	2 (1, 2)	0.01
In-patient and community	1	27 (20, 34)	–
Not reported	4	7 (2, 27)	98.94
By method of CKD identification			
Diagnostic code	16	4 (2, 6)	99.92
eGFR calculation	7	17 (8, 29)	98.82
eGFR calculation and albuminuria	1	37 (32, 41)	–
Self-report	1	3 (2, 4)	–
By year of publication			
2006–2010	2	12 (0, 60)	98.47
2011–2015	6	6 (2, 11)	99.31
2016–2020	5	10 (1, 26)	99.95
2021–2025	12	7 (3, 13)	99.97

eGFR, estimated glomerular filtration rate.

analysis to explore whether pooled prevalence estimates differed according to the use of diagnostic codes or eGFR calculations.

Certainty of evidence

We used the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) approach to determine the certainty of the synthesised evidence. GRADE is used predominantly to assess the certainty of evidence on the effectiveness of interventions. Although it has not been formally adapted for systematic reviews of prevalence or incidence, we used an approach recommended by Borges Migliavaca et al³¹ for applying GRADE to baseline risk or prognosis reviews.

Results

Figure 1 shows the Preferred Reporting Items for Systematic reviews and Meta-Analyses flow diagram. Following the removal of duplicates (*n* = 2350), 14 677 records were screened at the title and abstract stage, with 199 full-text articles screened for eligibility. At this stage, 151 articles were excluded. Reasons for exclusion included reporting wrong outcomes (*n* = 68), wrong patient population (*n* = 34) and wrong study design (*n* = 22). Records were also excluded if the full text was unavailable after contacting authors and requesting inter-library loans, including studies available only as conference abstracts (*n* = 22). In total, 48 studies were identified for inclusion in the review.

Description of included studies

Table 1 shows the characteristics of the included studies. The sample size of participants with SMI in the included studies ranged

from 61 to 848 058, with a mean of 27 379. Publication dates ranged from 2003 to 2025, with more than half published between 2020 and 2025. Most studies used a cohort design (*n* = 30, 62.5%) and were published in high-income countries (*n* = 45, 94%). The countries most commonly reported were the UK (*n* = 10, 20.8%), USA (*n* = 7, 14.6%), Denmark (*n* = 6, 12.5%) and Sweden (*n* = 5, 10.4%). The majority of studies used population-level data (*n* = 31, 64.6%), with seven studies collecting data in a community setting (14.6%) and four collecting data in in-patient settings (8.3%).

In terms of the denominator population, 17 studies collected data only from people with bipolar disorder (35.4%), and 11 included only people with schizophrenia (22.9%). Six studies included people with bipolar disorder and schizoaffective disorder (12.5%), and the remaining studies collected data from a population with mixed SMI diagnoses (*n* = 14, 29%). Thirteen studies collected data only from people who had been exposed to lithium (27.1%), and 13 collected data from populations with mixed exposure to lithium (27.1%), where a proportion of people were prescribed lithium and others were not. The remaining 22 studies (45.8%) did not report the proportion of the population prescribed lithium.

Among studies reporting the prevalence or incidence of CKD according to different stages, 27 (56.3%) used the catch-all term ‘chronic kidney disease’ without defining specific stages or eGFR thresholds to report the prevalence, and 13 (27.1%) reported stage 3 and above, typically defined as eGFR <60 mL/min/mL². Most studies used medical records to identify CKD, either through diagnostic codes (*n* = 20, 62.5%) or eGFR calculations based on data from medical records (*n* = 14, 29.2%).

Meta-analysis of prevalence

Of the included studies, 25 were included in the meta-analysis of prevalence.^{25,32–55} A sensitivity analysis was conducted to

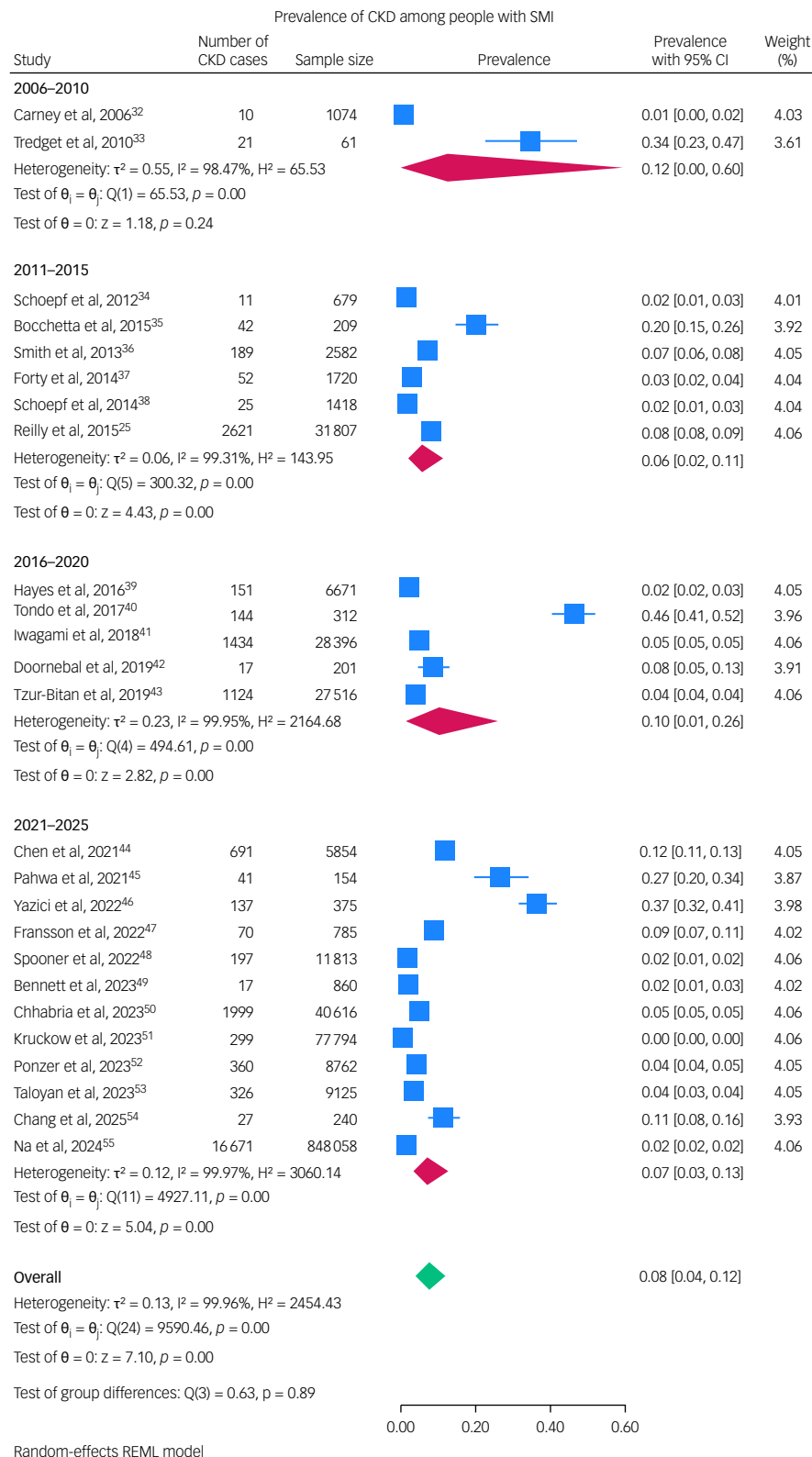


Fig. 2 Pooled prevalence of chronic kidney disease (CKD) among people with severe mental illness (SMI). REML, restricted maximum likelihood.

evaluate the impact of inclusion of the study conducted by Boivin et al,⁵⁶ which reported a very high prevalence of 98%. That study was excluded from the meta-analyses because it altered the size and precision of the results, having focused only on patients who were hospitalised and prescribed lithium. The outcomes of the sensitivity analysis are included in the supplementary materials.

Table 2 shows the pooled prevalence of CKD among people with SMI. Subgroup analyses were conducted to examine how prevalence differed across CKD stage, SMI diagnoses, lithium exposure, setting and year of publication. The overall pooled prevalence of CKD among people with SMI was 8% (95% CI 4%, 12%). Studies that collected data only from people with schizophrenia had the lowest prevalence of CKD (2%, 95% CI

Table 3 Pooled incidence risk of chronic kidney disease (CKD) among people with severe mental illness (SMI)			
Variables	Number of studies	CKD incidence risk, % (95% CI)	I ² statistic
Overall pooled incidence risk	13	5 (3, 7)	99.65
By length of follow-up			
<5 years	2	3 (0, 12)	99.64
6–10 years	4	3 (1, 8)	98.73
16–20 years	3	8 (5, 12)	98.94
21–25 years	1	2 (2, 33)	–
26–30 years	2	7 (0, 26)	99.41
>31 years	1	4 (4, 5)	–
By CKD stage/definition			
CKD – stage not reported	6	3 (1, 6)	99.65
CKD stage >3	6	7 (2, 13)	99.24
CKD stage >4	1	4 (4, 5)	–
By SMI			
Bipolar disorder	7	6 (2, 10)	99.70
Schizophrenia	2	5 (3, 9)	89.95
Bipolar disorder and schizoaffective disorder	1	2 (1, 4)	–
Mixed SMI	3	3 (0, 10)	99.45
By lithium (n = 8)			
Lithium exposed only	5	5 (1, 12)	99.37
Mixed exposure	4	5 (1, 10)	99.68
Not reported	4	4 (2, 8)	99.37
By setting (n = 8)			
Population	10	6 (3, 9)	99.76
Community	2	3 (1, 5)	63.91
Not reported	1	1 (1, 2)	–
By year of publication (n = 8)			
2011–2015	4	6 (5, 7)	90.60
2016–2020	2	5 (0, 22)	99.94
2021–2025	7	4 (1, 8)	99.44

1%, 5%) compared with those where data were collected only from people with bipolar disorder (15%, 95% CI 6%, 26%). Additionally, studies reporting on the prevalence of CKD only among people with SMI exposed to lithium had a substantially higher prevalence (29%, 95% CI 17%, 44%) compared with those reporting mixed-exposure cohorts (7%, 95% CI 3%, 11%). A further sensitivity analysis was conducted to determine whether the exclusion of studies that used albuminuria or self-report to identify CKD influenced the results, but this had little effect (7%, 95% CI 4%, 11%).

The forest plot for the meta-analysis of prevalence, divided by year of publication, is shown in Fig. 2.

Meta-analysis of incidence risk

Thirteen studies were included in the meta-analysis of incidence risk.^{39,57–68} A sensitivity analysis was conducted to determine whether the exclusion of studies that used biopsy or self-report to identify CKD influenced the results. However, this did not result in a substantial change in the estimate (4%, 95% CI 0%, 11%).

Table 3 reports the pooled incidence risk of CKD among people with SMI. Subgroup analyses were conducted to examine how incidence differed across length of follow-up, CKD stage, SMI diagnoses, lithium exposure, setting and year of publication. The overall pooled incidence risk of CKD among people with SMI was 5% (95% CI 3%, 7%). Studies reporting the incidence of CKD stage 3 and above had a higher incidence risk (7%, 95% CI 2%, 13%) compared with those that reported the incidence of CKD and did not specify a stage (3%, 95% CI 1%, 6%). Incidence risk was highest at 16–20 years’ (8%, 95% CI 5%, 12%) and 26–30 years’ follow-up

(7%, 95% CI 0%, 26%), although most studies had fewer than 20 years of follow-up.

Figure 3 shows the forest plot for the meta-analyses of incidence risk of CKD, according to the length of follow-up.

Meta-analysis of incidence rates

Four studies were pooled in a meta-analysis of incidence rates,^{39,61,67,69} with one reporting rates specifically in people exposed to lithium and not exposed to lithium,⁶⁷ and another reporting incidence rates specific to lithium exposure and gender.⁶⁹ Therefore, eight different rates were pooled across four studies. The pooled incidence rate was 26.83 cases (95% CI, 18.66–38.58) per 1000 person-years. Figure 4 shows the forest plot for the meta-analyses of incidence rates.

Meta-analysis of odds ratios

Eleven studies were included in the meta-analysis of odds ratios for the prevalence of CKD among people with SMI.^{32,36–38,41,43,47,48,53,55,70} Table 4 reports the pooled odds ratio of CKD among people with SMI compared with those without SMI or the general population. Subgroup analyses were conducted to examine how odds differed across CKD stage, SMI diagnoses and year of publication. Only one study reported the odds of CKD among people with SMI and lithium exposure compared with a population without SMI,⁴¹ and only one study reported the odds of CKD in an in-patient population with SMI compared with people without SMI;³⁸ therefore, a subgroup analysis of odds ratios could not be conducted across lithium exposure and setting. A sensitivity analysis was performed to determine whether removal of self-reporting of CKD diagnosis influenced the pooled odds ratio,³⁷ but this had a minimal effect (pooled odds ratio 2.25, 95% CI 1.62, 3.11).

The overall pooled odds ratio showed significantly higher odds of CKD among people with SMI than for those without (2.34, 95% CI 1.68, 3.25). These increased odds were observed across all subgroup analyses.

Figure 5 shows the forest plot for the meta-analyses of odds ratios.

Meta-analysis of hazard ratios

Table 5 reports the pooled hazard ratios of CKD among people with SMI.^{52,59,61,62,67} Due to the limited number of studies that provided hazard ratio data (n = 5), only one subgroup analysis was conducted to explore the overall pooled hazard ratio for CKD among people with SMI, which was 1.96 (95% CI 1.13, 3.40).

Figure 6 shows the forest plot for the meta-analyses of hazard ratios according to SMI diagnosis.

Studies excluded from meta-analyses

In total, eight studies were included in the review but excluded from the meta-analyses,^{71–78} the primary reason being clinical heterogeneity (n = 5). Of these five,^{69,72,73,77,78} three reported the incidence of diabetic kidney disease among people with SMI and type 2 diabetes. Chan et al⁷⁵ found an incidence risk of 6.1% for diabetic kidney disease among people with schizophrenia, which was lower among people with diabetes who did not have schizophrenia (adjusted odds ratio 0.91, 95% CI 0.82–1.01). By contrast, Scheuer et al⁷⁷ found that people with SMI (either bipolar disorder or schizophrenia) had an incidence rate of 30.55 per 1000 person-years for diabetic kidney disease. The incidence rate ratio (IRR) was significantly higher compared with those without severe mental illness (IRR 1.15, 95% CI 1.12–1.18), even after adjusting for substance use and comorbidities (IRR 1.08, 95% CI 1.05–1.12).

The three remaining studies were excluded from the analysis because of methodological heterogeneity, which included reporting

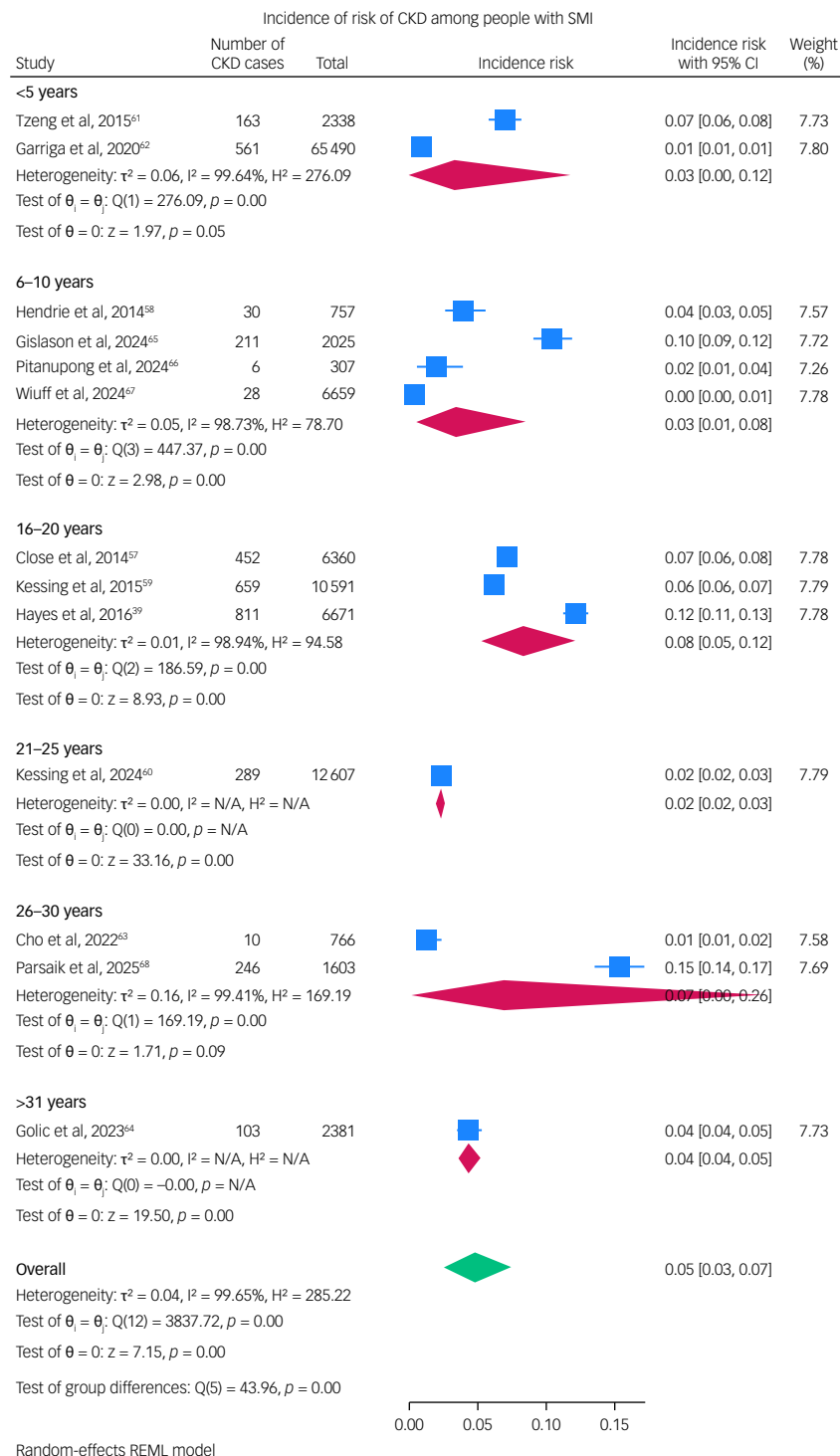


Fig. 3 Pooled incidence risk of chronic kidney disease (CKD) among people with severe mental illness (SMI).

the incidence of kidney failure only among a cohort of people with SMI who already had CKD,⁷¹ reporting ratio comparisons that could not be pooled⁷⁴ and used hospitalisation episodes as the denominator (as opposed to the population sample size or person-years at risk).⁷⁶

Quality of evidence: GRADE

We judged the overall quality of evidence available to be low. The risk of bias in individual studies was assessed as low, because most

included studies were of high or moderate quality. However, our judgement was downgraded due to the indirectness of the evidence (with over half of the studies not having a primary aim to determine the prevalence or incidence of CKD in people with SMI); and also to the high level of heterogeneity in the included studies, the imprecision across confidence intervals of the included studies and the lack of representation of prevalence estimates from important settings (such as from low- and middle-income countries (LMICs)) and estimates according to specific factors including ethnicity, gender and antipsychotic medication prescriptions.

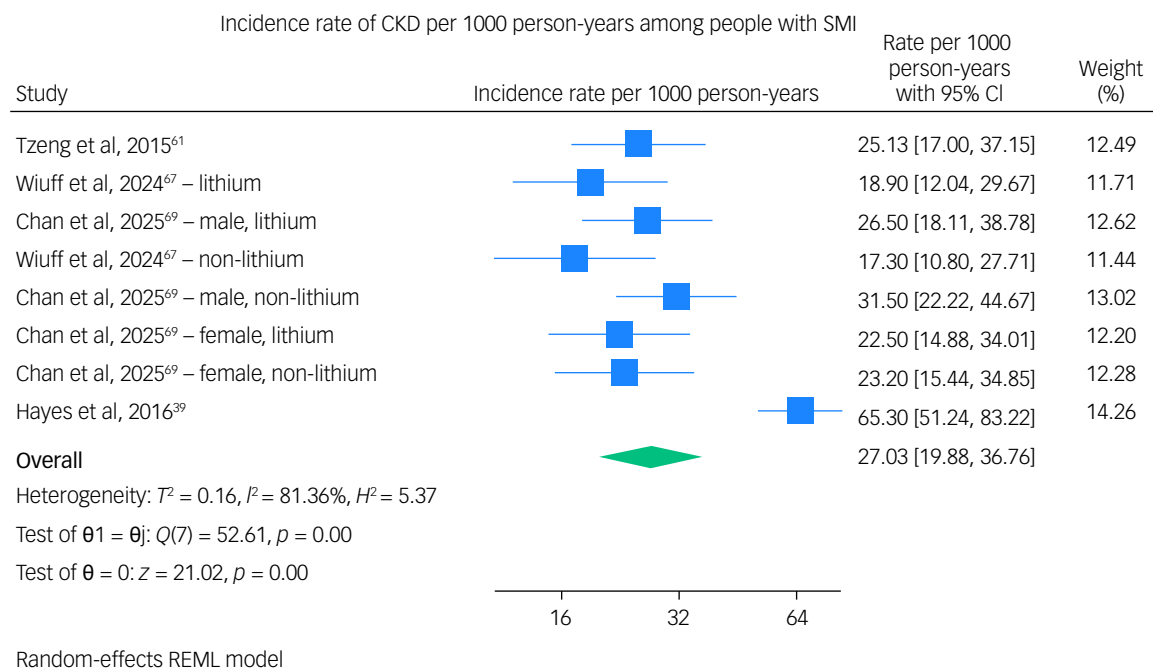


Fig. 4 Pooled incidence rates (per 1000 person-years) of chronic kidney disease (CKD) among people with severe mental illness (SMI).

Table 4 Pooled odds ratios of chronic kidney disease (CKD) among people with severe mental illness (SMI) compared with those without SMI			
Variables	Number of studies	Pooled odds ratio (95% CI)	I ² statistic, %
Overall pooled odds ratio	11	2.33 (1.70, 3.21)	99.00
By CKD stage/definition			
CKD – stage not reported	9	2.33 (1.63, 3.34)	99.20
CKD stage >3	2	2.19 (1.56, 3.07)	12.70
By SMI ^a			
Bipolar disorder	2	2.41 (2.19, 2.66)	0
Schizophrenia	4	1.92 (1.56, 2.36)	57.30
Bipolar disorder and schizoaffective disorder	2	2.78 (1.22, 6.33)	71.50
Mixed SMI	4	2.34 (1.30, 4.21)	99.60
By year			
2006–2010	1	2.94 (1.55, 5.57)	–
2011–2015	3	2.50 (2.02, 3.09)	17.00
2016–2020	3	2.48 (1.34, 4.57)	99.30
2021–2025	4	1.83 (1.29, 2.59)	97.20

a. Bahorik et al⁷⁰ reported odds ratios separately for bipolar disorder and schizophrenia, whereas Iwagami et al⁴¹ reported odds ratios separately for those exposed to lithium and those not exposed.

Discussion

This is the first systematic review to evaluate CKD prevalence, incidence and risk among people with SMI. We found that there was an 8% prevalence of CKD (all stages) in included studies, with the highest prevalence among populations with either a history of lithium exposure (29%) or a diagnosis of bipolar disorder (15%). The pooled incidence risk of CKD was 5%, and the pooled incidence rate was 26.8 per 1000 person-years.

The pooled prevalence of CKD in this meta-analysis is lower than that in meta-analyses of prevalence among the general population, where the estimated prevalence of CKD is approximately 10.8%.⁷⁹ In this review, the incidence risk is hard to compare because most studies report only the incidence risk as a proportion without contextualising it within a specific follow-up time; however, the pooled incidence rate of 26.8 per 1000 person-years is

higher than findings from epidemiological studies conducted in the general population: for example, a study conducted in the Netherlands reported an incidence rate for CKD of approximately 12.13 per 1000 person-years.⁸⁰

A further contrast to the lower pooled prevalence of CKD in comparison with the literature on the general population is that in studies where there were direct comparisons between the general population and people with SMI, the latter consistently had higher odds of CKD. The pooled odds ratio for CKD was 2.33 and, although this was highest in studies focused on populations with bipolar disorder and schizoaffective disorder (odds ratio 2.78), studies that focused only on people with schizophrenia also had significantly higher odds of CKD (odds ratio 1.98, 95% CI 1.56, 2.36). One reason for the comparatively low pooled prevalence estimate, but consistently higher odds and hazard, of CKD among people with SMI compared with the general population could be the

Odds ratio of CKD among people with SMI compared to the general population

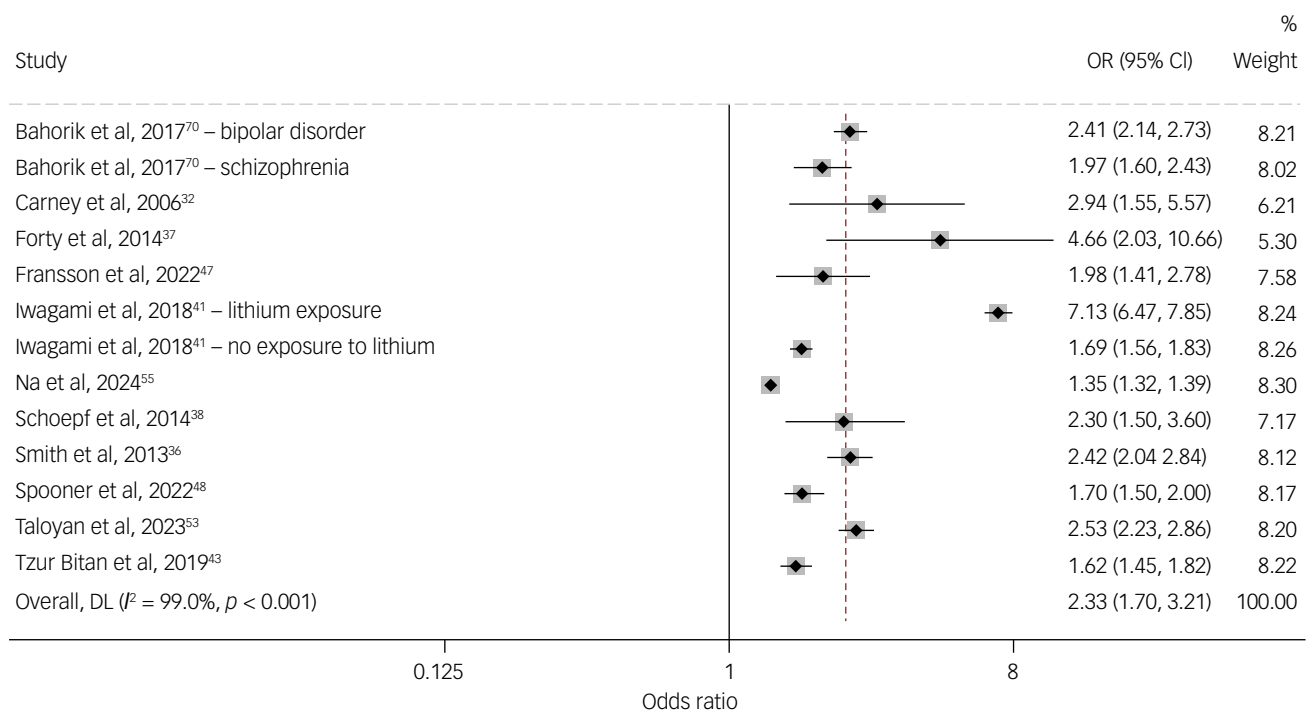


Fig. 5 Pooled odds ratio (OR) of chronic kidney disease (CKD) among people with severe mental illness (SMI) compared with the general population. DL, DerSimonian-Laird.

Table 5 Pooled hazard ratios for chronic kidney disease among people with severe mental illness (SMI) compared with the general population

Variables	Number of studies	Pooled hazard ratio (95% CI)	I^2 statistic, %
Overall pooled hazard ratio	5	1.96 (1.13, 3.40)	98.50
By SMI			
Bipolar disorder	2	1.86 (1.20, 2.90)	80.60
Schizophrenia	1	1.36 (1.13, 3.40)	–
Mixed SMI	2	2.44 (0.64, 9.39)	99.70

method of identification of CKD. Most included studies relied on ICD diagnostic codes within population-level data (such as medical records and registries) to identify cases of CKD. Although this approach allows the collection of data from a representative sample over long periods of follow-up, it has been shown to underestimate the prevalence or incidence of CKD,^{81,82} especially in underserved and marginalised groups who do not have opportunistic testing. It is therefore recommended that a combination of clinical values, such as eGFR calculations and albuminuria based on medical records, be used in conjunction with diagnostic codes to ensure a more accurate estimate of the prevalence or incidence of CKD at a population level.⁸¹

The prevalence of CKD differed according to the staging of CKD, which could also reflect the methods of identification required for staging. In studies where the stage was not reported (typically population-level research using diagnostic codes) the pooled prevalence was 4%, whereas that for CKD stage 3 and above was 12%. This was also reflected in the pooled incidence risk, which for non-specified CKD was 3%, whereas for CKD stage 3 and above the incidence risk was 7%. CKD stage 3 and above has a lower

prevalence and incidence than CKD of any stage in the general population,¹² probably due to better identification when staging CKD in epidemiological studies.

The higher odds of CKD among people with SMI compared with the general population probably resulted from a multitude of different factors. We found that the odds were highest among populations where mood stabilisers, such as lithium, would be indicated (for example, bipolar disorder and schizoaffective disorder). This is not surprising considering the established risk of lowered kidney function in long-term lithium treatment¹⁷ and the associated risk of AKI.¹⁹ Additionally, increased screening in that population may lead to increased detection of CKD, particularly in the earlier stages, which is underdiagnosed in the general population.⁴¹ Importantly, the higher odds remained in populations where patients may not be exposed to lithium, such as in schizophrenia. One study, conducted by Iwagami et al,⁴¹ highlighted that the relative increased prevalence of CKD among people with SMI compared with the general population remained even when patients with any history of lithium exposure were excluded. This provides evidence that other risk factors are contributing to this risk. Second-generation antipsychotics have been associated with an increased risk of CKD,⁸³ while studies examining the relative risk of CKD across first- and second-generation antipsychotics identified combination treatment as being associated with the highest risk.⁸⁴ Although there is a lack of research evaluating the contributory factors associated with CKD risk among people with SMI, some studies identified in the present review suggest that higher rates of conditions like diabetes are not solely responsible for this increase in CKD risk, with Scheuer et al finding a significantly higher rate of diabetic nephropathy even after adjusting for substance use and multimorbidities.⁷⁷ Therefore, further research is needed to understand the factors driving this increased risk, and to identify effective strategies for reducing it.

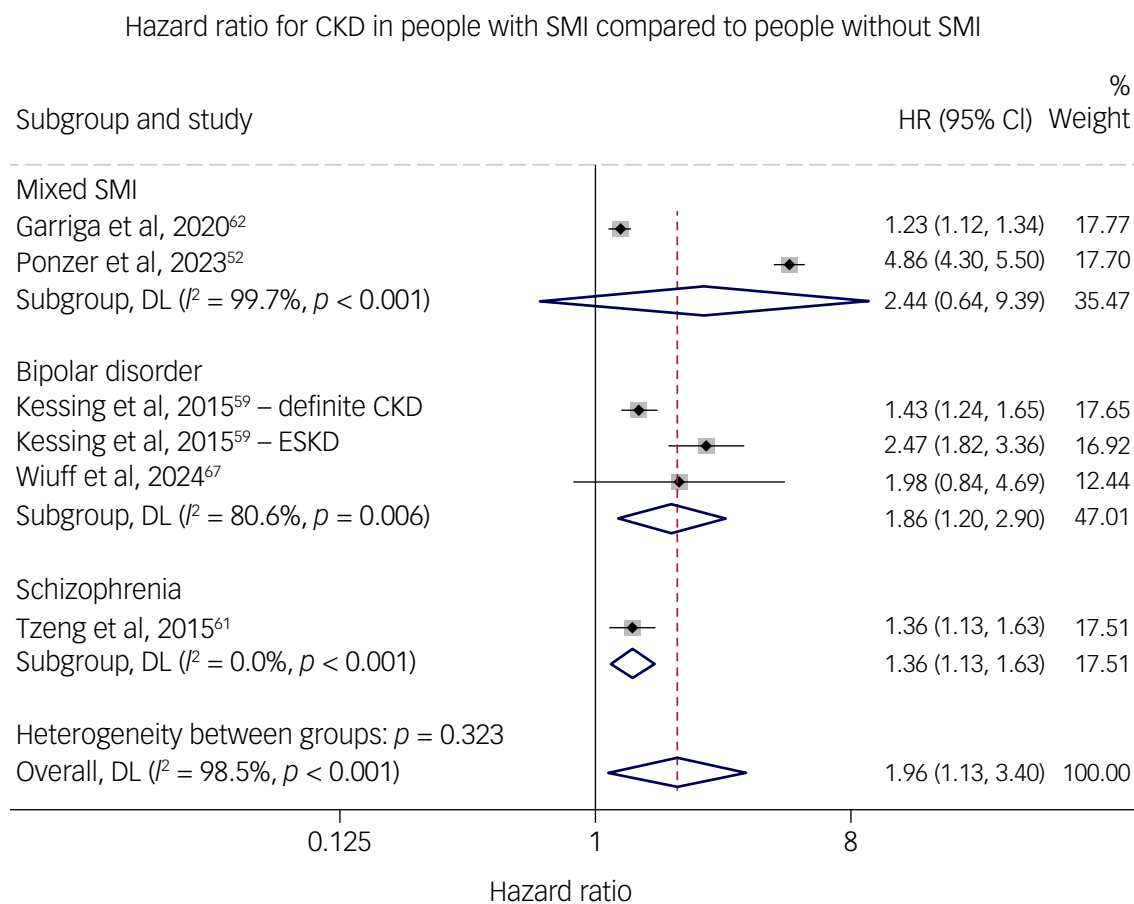


Fig. 6 Pooled hazard ratio (HR) for chronic kidney disease (CKD) among people with severe mental illness (SMI) compared with the general population. ESKD, end-stage kidney disease; DL, DerSimonian-Laird.

Despite this increased risk of CKD among people with SMI, there is evidence that people with SMI and CKD experience worse outcomes compared with those without SMI or in the general population.¹⁶ This includes higher mortality risk among people with SMI and kidney failure,⁸⁵ limited access to specialist kidney care,⁸⁶ transplant assessment^{87,88} and kidney replacement therapies,⁴³ and higher rates of emergency hospitalisation.⁸⁹ There is also evidence to suggest that people with SMI and CKD experience worse outcomes than those with SMI who do not have CKD, including associations between CKD and suicide risk.^{90,91}

Strengths and limitations

There are several strengths and limitations in this review, as well as in the overall evidence base. There was a relatively small number of articles included in the meta-analyses, particularly for meaningful subgroup analysis. Therefore, the confidence intervals in the meta-analyses lacked precision, although we were able to demonstrate an increased risk of CKD across studies reporting relevant ratios. There was a lack of research conducted in LMICs, and most studies did not provide a breakdown of CKD prevalence, incidence or risk according to SMI diagnoses, antipsychotic medication, gender, age, body mass index or multimorbidities, limiting our ability to explore potential contributory factors to the risk of CKD. However, we were able to conduct subgroup analyses according to method of CKD identification, lithium exposure and staging of CKD, highlighting some potential limitations in the evidence base that can be addressed in future research. We were able to conduct

separate meta-analyses to report prevalence, incidence risk and incidence rate, in addition to odds and hazard ratios, to provide a more comprehensive overview of the epidemiological literature on this relationship. Several pooled studies were conducted in the same country (for example, the UK), and the reliance on national data-sets may have resulted in overlapping samples that could have led to an inaccurate measure of precision for the pooled estimates.

This review was also focused specifically on studies that included people diagnosed with SMI. We did not include all studies that reported the risk of CKD among people receiving lithium treatment (if they did not report the diagnoses of included participants). Additionally, not all included studies consistently reported lithium exposure or provided a breakdown of CKD risk across lithium-exposure groups (although this was analysed when available). Therefore, the findings reported in this review may not accurately reflect the degree of risk associated with lithium exposure *per se*. Finally, the studies did not account for the impact of screening in prevalence estimates of CKD, which is particularly important in studies focused on people receiving lithium treatment, where regular screening of kidney function is part of the care pathway.¹⁷ Despite these limitations, this is the first systematic review to provide a pooled prevalence estimate of CKD among people with SMI.

Although the prevalence estimates in this review are lower than in the general population, meta-analyses of incidence rates, odds and hazard ratios demonstrate that people with SMI are at a significantly higher risk of CKD compared with those without SMI.

Lithium is known to play a role in the increased risk among people with bipolar and schizoaffective disorders. The evidence for the relationship between CKD and SMI in general is limited and imprecise and, although psychiatric medication and high rates of type 2 diabetes may contribute to the risk, the drivers of this inequality are under-researched. Further research is needed to identify any potentially modifiable risk factors and establish the global prevalence and incidence of CKD in people with SMI.

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Data availability

Data availability is not applicable because no new data were created or analysed in this study.

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Author contributions

All authors have reviewed and revised the manuscript and given approval for the final version to be published. C.C., K.B., J.C., R.J., D.P.O. and N.S. contributed to the conception and design of the work. C.C., R.E.N., J.K., Z.P. and A.H. contributed to acquisition and analysis, including screening and data collection. All authors contributed to data interpretation.

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Declaration of interest

None.

References

- Fiorillo A, Sartorius N. Mortality gap and physical comorbidity of people with severe mental disorders: the public health scandal. *Ann Gen Psychiatry* 2021; **20**: 52.
- Siddiqi N, Doran T, Prady SL, Taylor J. Closing the mortality gap for severe mental illness: are we going in the right direction? *Br J Psychiatry* 2017; **211**: 130–1.
- Hayes JF, Marston L, Walters K, King MB, Osborn DPJ. Mortality gap for people with bipolar disorder and schizophrenia: UK-based cohort study 2000–2014. *Br J Psychiatry* 2017; **211**: 175–81.
- Formánek T, Krupchanka D, Perry BI, Mladá K, Osimo EF, Masopust J, et al. Contribution of severe mental disorders to fatally harmful effects of physical disorders: national cohort study. *Br J Psychiatry* 2024; **225**: 436–45.
- Nielsen RE, Banner J, Jensen SE. Cardiovascular disease in patients with severe mental illness. *Nat Rev Cardiol* 2021; **18**: 136–45.
- de Mooij LD, Kikkert M, Theunissen J, Beekman ATF, de Haan L, Duurkoop PWRA, et al. Dying too soon: excess mortality in severe mental illness. *Front Psychiatry* 2019; **10**: 855.
- Vancampfort D, Correll CU, Galling B, Probst M, De Hert M, Ward PB, et al. Diabetes mellitus in people with schizophrenia, bipolar disorder and major depressive disorder: a systematic review and large scale meta-analysis. *World Psychiatry* 2016; **15**: 166–74.
- Correll CU, Solmi M, Veronese N, Bortolato B, Rosson S, Santonastaso P, et al. Prevalence, incidence and mortality from cardiovascular disease in patients with pooled and specific severe mental illness: a large-scale meta-analysis of 3,211,768 patients and 113,383,368 controls. *World Psychiatry* 2017; **16**: 163–80.
- Ndumele CE, Rangaswami J, Chow SL, Neeland IJ, Tuttle KR, Khan SS, et al. Cardiovascular-kidney-metabolic health: a presidential advisory from the American Heart Association. *Circulation* 2023; **148**: 1606–35.
- Jankowski J, Floege Jürgen, Fliser D, Böhm M, Marx N. Cardiovascular disease in chronic kidney disease. *Circulation* 2021; **143**: 1157–72.
- Kalantar-Zadeh K, Jafar TH, Nitsch D, Neuen BL, Perkovic V. Chronic kidney disease. *Lancet* 2021; **398**: 786–802.
- Kovesdy CP. Epidemiology of chronic kidney disease: an update 2022. *Kidney Int Suppl* 2022; **12**: 7–11.
- Foreman KJ, Marquez N, Dolgert A, Fukutaki K, Fullman N, McGaughey M, et al. Forecasting life expectancy, years of life lost, and all-cause and cause-specific mortality for 250 causes of death: reference and alternative scenarios for 2016–40 for 195 countries and territories. *Lancet* 2018; **392**: 2052–90.
- Han L, Doran T, Holt RIG, Hewitt C, Jacobs R, Prady SL, et al. Impact of severe mental illness on healthcare use and health outcomes for people with type 2 diabetes: a longitudinal observational study in England. *Br J Gen Pract* 2021; **71**: e565–73.
- Osborn DPJ, Wright CA, Levy G, King MB, Deo R, Nazareth I. Relative risk of diabetes, dyslipidaemia, hypertension and the metabolic syndrome in people with severe mental illnesses: systematic review and metaanalysis. *BMC Psychiatry* 2008; **8**: 84.
- Carswell C, Cogley C, Bramham K, Chilcot J, Noble H, Siddiqi N. Chronic kidney disease and severe mental illness: a scoping review. *J Nephrol* 2023; **36**: 1519–47.
- Schoretsanitis G, de Filippis R, Brady BM, Homan P, Suppes T, Kane JM. Prevalence of impaired kidney function in patients with long-term lithium treatment: a systematic review and meta-analysis. *Bipolar Disord* 2022; **24**: 264–74.
- Gupta S, Khastgir U. Drug information update. Lithium and chronic kidney disease: debates and dilemmas. *BJPsych Bull* 2017; **41**: 216–20.
- Grünfeld J-P, Rossier BC. Lithium nephrotoxicity revisited. *Nat Rev Nephrol* 2009; **5**: 270–6.
- Abosi O, Lopes S, Schmitz S, Fiedorowicz JG. Cardiometabolic effects of psychotropic medications. *Horm Mol Biol Clin Investig* 2018; **36**.
- Hansrivijit P, Chen Y-J, Lnu K, Trongtorsak A, Puthenpura MM, Thongprayoon C, et al. Prediction of mortality among patients with chronic kidney disease: a systematic review. *World J Nephrol* 2021; **10**: 59–75.
- Webster AC, Nagler EV, Morton RL, Masson P. Chronic kidney disease. *Lancet* 2017; **389**: 1238–52.
- Kuma A, Kato A. Lifestyle-related risk factors for the incidence and progression of chronic kidney disease in the healthy young and middle-aged population. *Nutrients* 2022; **14**: 3787.
- Grant CH, Salim E, Lees JS, Stevens KI. Deprivation and chronic kidney disease—a review of the evidence. *Clin Kidney J* 2023; **16**: 1081–91.
- Reilly S, Olier I, Planner C, Doran T, Reeves D, Ashcroft DM, et al. Inequalities in physical comorbidity: a longitudinal comparative cohort study of people with severe mental illness in the UK. *BMJ Open* 2015; **5**: e009010.
- Okpechi IG, Caskey FJ, Gaipov A, Tannor EK, Noubiap JJ, Effa E, et al. Early identification of CKD - a scoping review of the global populations. *Kidney Int Rep* 2022; **7**: 1341–53.
- Neuen BL, Jun M, Wick J, Kotwal S, Badve SV, Jardine MJ, et al. Estimating the population-level impacts of improved uptake of SGLT2 inhibitors in patients with chronic kidney disease: a cross-sectional observational study using routinely collected Australian primary care data. *Lancet Reg Health West Pac* 2024; **43**: 100988.
- Whaley-Connell A, Nistala R, Chaudhary K. The importance of early identification of chronic kidney disease. *Mo Med* 2011; **108**: 25–8.
- Carswell C, Bramham K, Chilcot J, Jacobs R, Osborn D, Siddiqi N, et al. The prevalence of chronic kidney disease in people with severe mental illness: a systematic review protocol. *PLOS One* 2025; **20**: e0310568.

- 30 Carswell C, Chilcot J, Jacobs R, Siddiqi N, Osborn D, Nisbet R, et al. *The Prevalence of Chronic Kidney Disease amongst People with Severe Mental Illness: A Systematic Review and Meta-analysis*. PROSPERO, 2024 (<https://www.crd.york.ac.uk/PROSPERO/view/CRD42024527215>).
- 31 Borges Migliavaca C, Stein C, Colpani V, Barker TH, Munn Z, Falavigna M. How are systematic reviews of prevalence conducted? A methodological study. *BMC Med Res Methodol* 2020; **20**: 96.
- 32 Carney CP, Jones L, Woolson RF. Medical comorbidity in women and men with schizophrenia: a population-based controlled study. *J Gen Intern Med* 2006; **21**: 1133–7.
- 33 Tredget J, Kirov A, Kirov G. Effects of chronic lithium treatment on renal function. *J Affect Disord* 2010; **126**: 436–40.
- 34 Schoepf D, Potluri R, Uppal H, Natalwala A, Narendran P, Heun R. Type-2 diabetes mellitus in schizophrenia: increased prevalence and major risk factor of excess mortality in a naturalistic 7-year follow-up. *Eur Psychiatry* 2012; **27**: 33–42.
- 35 Bocchetta A, Ardaur R, Fanni T, Sardu C, Piras D, Pani A, et al. Renal function during long-term lithium treatment: a cross-sectional and longitudinal study. *BMC Med* 2015; **13**: 12.
- 36 Smith DJ, Martin D, McLean G, Langan J, Guthrie B, Mercer SW. Multimorbidity in bipolar disorder and undertreatment of cardiovascular disease: a cross sectional study. *BMC Med* 2013; **11**: 263.
- 37 Forty L, Ulanova A, Jones L, Jones I, Gordon-Smith K, Fraser C, et al. Comorbid medical illness in bipolar disorder. *Br J Psychiatry* 2014; **205**: 465–72.
- 38 Schoepf D, Uppal H, Potluri R, Heun R. Physical comorbidity and its relevance on mortality in schizophrenia: a naturalistic 12-year follow-up in general hospital admissions. *Eur Arch Psychiatry Clin Neurosci* 2014; **264**: 3–28.
- 39 Hayes JF, Marston L, Walters K, Geddes JR, King M, Osborn DPJ, et al. Adverse renal, endocrine, hepatic, and metabolic events during maintenance mood stabilizer treatment for bipolar disorder: a population-based cohort study. *PLOS Med* 2016; **13**: e1002058.
- 40 Tondo L, Abramowicz M, M Alda, Bauer M, Bocchetta A, Bolzani L, et al. Long-term lithium treatment in bipolar disorder: effects on glomerular filtration rate and other metabolic parameters. *Int J Bipolar Disord* 2017; **5**: 27.
- 41 Iwagami M, Mansfield K, Hayes J, Walters K, Osborn D, Smeeth L, et al. Severe mental illness and chronic kidney disease: a cross-sectional study in the United Kingdom. *Clin Epidemiol* 2018; **10**: 421–9.
- 42 Doornebal J, Diepenbroek A, van de Luijngaarden MWM, Hartong E, Grootens KP, Kupka RW, et al. Renal concentrating ability and glomerular filtration rate in lithium-treated patients. *Neth J Med* 2019; **77**: 139–49.
- 43 Tzur Bitan D, Krieger I, Berkovitch A, Comaneshter D, Cohen A. Chronic kidney disease in adults with schizophrenia: a nationwide population-based study. *Gen Hosp Psychiatry* 2019; **58**: 1–6.
- 44 Chen C, Chan H-Y, Yeh L-L, Pan Y-J. Longitudinal factors associated with mortality in older patients with mood disorders. *J Affect Disord* 2021; **278**: 607–13.
- 45 Pahwa M, Joseph B, Nunez NA, Jenkins GD, Colby CL, Kashani KB, et al. Long-term lithium therapy and risk of chronic kidney disease in bipolar disorder: a historical cohort study. *Bipolar Disord* 2021; **23**: 715–23.
- 46 Yazıcı MK, Özçelik Eroğlu E, Ertuğrul A, Anıl Yağcıoğlu AE, Ağaoğlu E, Karahan S, et al. Renal effects of long-term lithium therapy, revisited. *Hum Psychopharmacol* 2022; **37**: e2812.
- 47 Fransson F, Werneke U, Harju V, Öhlund L, de Man Lapidoth J, Jonsson PA, et al. Kidney function in patients with bipolar disorder with and without lithium treatment compared with the general population in northern Sweden: results from the LISIE and MONICA cohorts. *Lancet Psychiatry* 2022; **9**: 804–14.
- 48 Spooner C, Afrazi S, de Oliveira Costa J, Harris MF. Demographic and health profiles of people with severe mental illness in general practice in Australia: a cross-sectional study. *Aust J Prim Health* 2022; **28**: 408–16.
- 49 Bennett CW, Gensler L, Goldsmith DR. Antipsychotics and medical comorbidity: a retrospective study in an urban outpatient psychiatry clinic. *Community Ment Health J* 2023; **59**: 641–53.
- 50 Chhabria K, Krause TM, Hamden R, Jabbi M. Indicators of co-occurrence of mood disorder on premature death due to natural and unnatural causes in administrative claims data analysis. *medRxiv* [Preprint] 2023. Available from: <https://www.medrxiv.org/content/10.1101/2023.09.26.23296173v1>.
- 51 Kruckow L, Basit S, Nordentoft M, Banner J, Boyd HA. The influence of comorbid disease on premature death due to natural and unnatural causes in persons with schizophrenia. *Schizophr Res* 2023; **257**: 27–33.
- 52 Ponzer K, Millischer V, Schalling M, Gissler M, Lavebratt C, Backlund L. Lithium and risk of cardiovascular disease, dementia and venous thromboembolism. *Bipolar Disord* 2023; **25**: 391–401.
- 53 Taloyan M, Alinaghizadeh H, Wettermark B, Jan Hasselström JH, Bertilsson BC. Physical-mental multimorbidity in a large primary health care population in Stockholm County. *Asian J Psychiatry* 2023; **79**: 103354.
- 54 Chang S-T, Liou J-Y, Wu B-J, Chen H-K. Prevalence and risk factors for chronic kidney disease among older adult patients with schizophrenia in Taiwan. *Int J Psychiatry Med* 2025; **60**: 87–96.
- 55 Na EJ, Lee J, Sohn JH, Yang M, Park Y, Sim H-B, Lee H. Characteristics of comorbid physical disease in patients with severe mental illness in South Korea: a nationwide population-based study (2014–2019). *Psychiatry Investig* 2024; **21**: 361–70.
- 56 Boivin E, Le Daré B, Bellay R, Vigneau C, Mercierolle M, Bacle A. Long-term lithium therapy and risk of chronic kidney disease, hyperparathyroidism and hypercalcemia: a cohort study. *Int J Bipolar Disord* 2023; **11**: 4.
- 57 Close H, Reilly J, Mason JM, Kripalani M, Wilson D, Main J, et al. Renal failure in lithium-treated bipolar disorder: a retrospective cohort study. *PLOS One* 2014; **9**: e90169.
- 58 Hendrie HC, Tu W, Tabbey R, Purnell CE, Ambuehl RJ, Callahan CM. Health outcomes and cost of care among older adults with schizophrenia: a 10-year study using medical records across the continuum of care. *Am J Geriatr Psychiatry* 2014; **22**: 427–36.
- 59 Kessing LV, Gerds TA, Feldt-Rasmussen B, Andersen PK, Licht RW. Use of lithium and anticonvulsants and the rate of chronic kidney disease: a nationwide population-based study. *JAMA Psychiatry* 2015; **72**: 1182–91.
- 60 Kessing LV, Knudsen MB, Rytgaard HCW, Torp-Pedersen C, Berk M. Lithium versus anticonvulsants and the risk of physical disorders - results from a comprehensive long-term nation-wide population-based study emulating a target trial. *Eur Neuropsychopharmacol* 2024; **84**: 48–56.
- 61 Tzeng N-S, Hsu Y-H, Ho S-Y, Kuo Y-C, Lee H-C, Yin Y-J, et al. Is schizophrenia associated with an increased risk of chronic kidney disease? A nationwide matched-cohort study. *BMJ Open* 2015; **5**: e006777.
- 62 Garriga C, Robson J, Coupland C, Hippisley-Cox J. NHS Health Checks for people with mental ill-health 2013–2017: an observational study. *Epidemiol Psychiatr Sci* 2020; **29**: e188.
- 63 Cho Y, Lee D, Baek JH, Hong KS. Estimated glomerular filtration rate in Korean patients exposed to long-term lithium maintenance therapy. *Int J Bipolar Disord* 2022; **10**: 4.
- 64 Golic M, Aiff H, Attman P-O, Ramsauer B, Schön S, Steingrimsdottir S, et al. Lifetime risk of severe kidney disease in lithium-treated patients: a retrospective study. *Int J Bipolar Disord* 2023; **11**: 39.
- 65 Gislason G, Indridason OS, Sigurdsson E, Palsson R. Risk of chronic kidney disease in individuals on lithium therapy in Iceland: a nationwide retrospective cohort study. *Lancet Psychiatry* 2024; **11**: 1002–11.
- 66 Pitanupong J, Jittpratoom C, Anantapong K. Chronic kidney disease incidences in Thai outpatients diagnosed with psychiatric illnesses receiving lithium maintenance therapy: a university hospital-based study. *BMC Psychiatry* 2024; **24**: 80.
- 67 Wiuff AC, Rohde C, Jensen BD, Nierenberg AA, Østergaard SD, Köhler-Forsberg O. Association between lithium treatment and renal, thyroid and parathyroid function: a cohort study of 6659 patients with bipolar disorder. *Bipolar Disord* 2024; **26**: 71–83.
- 68 Parsaik AK, Chaudhary A, Sharma S, Delgoffe BE, Gabor R, Singh B. Effects of long-term lithium therapy on kidney functioning in mood disorders: a population-based historical cohort study. *Bipolar Disord* 2025; **27**: 28–35.
- 69 Chan JKN, Solmi M, Correll CU, Man Wong CS, Lo HKY, Lai FTT, et al. Lithium for bipolar disorder and risk of thyroid dysfunction and chronic kidney disease. *JAMA Netw Open* 2025; **8**: e2458608.
- 70 Bahorik AL, Satre DD, Kline-Simon AH, Weisner CM, Campbell CI. Serious mental illness and medical comorbidities: findings from an integrated health care system. *J Psychosom Res* 2017; **100**: 35–45.
- 71 Presne C, Fakhouri F, Noël L-H, Stengel B, Even C, Kreis H, et al. Lithium-induced nephropathy: rate of progression and prognostic factors. *Kidney Int* 2003; **64**: 585–92.
- 72 Attar R, Wester A, Koul S, Eggert S, Polcwiartek C, Jernberg T, et al. Higher risk of major adverse cardiac events after acute myocardial infarction in patients with schizophrenia. *Open Heart* 2020; **7**: e001286.
- 73 Toender A, Vestergaard M, Munk-Olsen T, Larsen JT, Kristensen JK, Laursen TM. Risk of diabetic complications and subsequent mortality among individuals with schizophrenia and diabetes – a population-based register study. *Schizophr Res* 2020; **218**: 99–106.
- 74 Uju Y, Kanzaki T, Yamasaki Y, Kondo T, Nanasawa H, Takeuchi Y, et al. A cross-sectional study on metabolic similarities and differences between inpatients with schizophrenia and those with mood disorders. *Ann Gen Psychiatry* 2020; **19**: 53.
- 75 Chan JKN, Wong CSM, Or PCF, Chen EYH, Chang WC. Diabetes complication burden and patterns and risk of mortality in people with schizophrenia and

- diabetes: a population-based cohort study with 16-year follow-up. *Eur Neuropsychopharmacol* 2021; **53**: 79–88.
- 76 Henriques F, Ferreira AR, Gonçalves-Pinho M, Freitas A, Fernandes L. Bipolar disorder and medical comorbidities: a Portuguese population-based observational retrospective study (2008–2015). *J Affect Disord* 2022; **298**: 232–8.
 - 77 Scheuer SH, Kosjerina V, Lindekilde N, Pouwer F, Carstensen B, Jørgensen ME, et al. Severe mental illness and the risk of diabetes complications: a nationwide, register-based cohort study. *J Clin Endocrinol Metab* 2022; **107**: e3504–14.
 - 78 Fransson F, Werneke U, Öhlund L, Jonsson PA, Ott M. Kidney function decline improves after lithium discontinuation. *J Intern Med* 2025; **297**: 289–99.
 - 79 Hill NR, Fatoba ST, Oke JL, Hirst JA, O'Callaghan CA, Lasserson DS, et al. Global prevalence of chronic kidney disease – a systematic review and meta-analysis. *PLOS One* 2016; **11**: e0158765.
 - 80 van Blijdervleen JC, Straus SM, Zietse R, Stricker BH, Sturkenboom MC, Verhamme KM. A population-based study on the prevalence and incidence of chronic kidney disease in the Netherlands. *Int Urol Nephrol* 2014; **46**: 583–92.
 - 81 Ramagopalan S, Leahy TP, Stamp E, Sammon C. Approaches for the identification of chronic kidney disease in CPRD-HES-linked studies. *J Comp Eff Res* 2020; **9**: 441–6.
 - 82 Sundström J, Bodegard J, Bollmann A, Vervloet MG, Mark PB, Karasik A, et al. Prevalence, outcomes, and cost of chronic kidney disease in a contemporary population of 2.4 million patients from 11 countries: the CaReMe CKD study. *Lancet Reg Health Eur* 2022; **20**: 100438.
 - 83 Højlund M, Lund LC, Herping JLE, Haastrup MB, Damkier P, Henriksen DP. Second-generation antipsychotics and the risk of chronic kidney disease: a population-based case-control study. *BMJ Open* 2020; **10**: e038247.
 - 84 Wang H-Y, Huang CL-C, Feng U, Tsuang H-C. Second-generation antipsychotic medications and risk of chronic kidney disease in schizophrenia: population-based nested case-control study. *BMJ Open* 2018; **8**: e019868.
 - 85 Kimmel PL, Fwu C-W, Abbott KC, Moxey-Mims MM, Mendley S, Norton JM, et al. Psychiatric illness and mortality in hospitalized ESKD dialysis patients. *Clin J Am Soc Nephrol* 2019; **14**: 1363–71.
 - 86 Hsu Y-H, Cheng J-S, Ouyang W-C, Lin C-L, Huang C-T, Hsu C-C, et al. Lower incidence of end-stage renal disease but suboptimal pre-dialysis renal care in schizophrenia: a 14-year nationwide cohort study. *PLOS One* 2015; **10**: e0140510.
 - 87 Boyle SM, Fehr K, Deering C, Raza A, Harhay MN, Malat G, et al. Barriers to kidney transplant evaluation in HIV-positive patients with advanced kidney disease: a single-center study. *Transpl Infect Dis* 2020; **22**: e13253.
 - 88 Bayat S, Frimat L, Thilly N, Loos C, Briançon S, Kessler M. Medical and non-medical determinants of access to renal transplant waiting list in a French community-based network of care. *Nephrol Dialysis Transpl* 2006; **21**: 2900–7.
 - 89 McPherson S, Barbosa-Leiker C, Daratha K, Short R, McDonell MG, Alicic R, et al. Association of co-occurring serious mental illness with emergency hospitalization in people with chronic kidney disease. *Am J Nephrol* 2014; **39**: 260–7.
 - 90 Chen P-H, Tsai S-Y, Pan C-H, Chen Y-L, Chang H-M, Su S-S, et al. Sex-specific risk profiles for suicide mortality in bipolar disorder: incidence, healthcare utilization and comorbidity. *Psychol Med* 2023; **53**: 1500–9.
 - 91 Germack HD, Bizhanova Z, Roberts ET. Substantial hospital level variation in all-cause readmission rates among medicare beneficiaries with serious mental illness. *Healthcare* 2020; **8**: 100453.