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SYSTEMATIC REVIEWS

Global prevalence of depression in chronic kidney disease: a systematic review and meta-analysis

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Abstract

Background Chronic kidney disease (CKD) is commonly associated with psychosocial problems, especially depression, contributing to poor overall outcomes. Depression has not been given adequate priority in the management of CKD patients despite its significant adverse impact on all major outcomes. This systematic review and meta-analysis determined the pooled prevalence of clinical depression in the global CKD population and sub-populations.

Methods PubMed, African Journals Online (AJOL), and EMBASE were systematically searched to identify published articles with relevant data. The pooled prevalence of clinical depression in the global CKD population was determined using random effects meta-analytic techniques. The study protocol was registered with PROSPERO (CRD42022382708).

Results Sixty-five articles were included in this review, comprising 80,932 individuals with CKD from 27 countries. The participants' mean age ranged from 11.0 to 76.3 years. Most (70.4%) of the studies had medium methodological quality. The overall pooled prevalence of depression was 26.5% (95% CI 23.1–30.1%). Studies using the Diagnostic Statistical Manual for Mental Diseases (DSM) and International Classification of Disease (ICD) returned a pooled prevalence of 25.5% and 39.6%, respectively, $p=0.03$. There was a significant difference in the pooled prevalence across regions; $p=0.002$.The prevalence of depression was higher among individuals on chronic hemodialysis compared to pre-dialysis patients (29.9% versus 18.5%; $p=0.01$) and among those on hemodialysis compared to peritoneal dialysis (30.6% versus 20.4%; $p=0.04$). There was no significant difference between adults and children (26.8% versus 15.9%, $p=0.21$). There was an increasing temporal trend in depression prevalence, though this did not achieve statistical significance ($p=0.16$).

Conclusion Depression is common in patients with CKD. The findings of this study highlight the need for clinicians to make efforts to evaluate individuals with CKD for depression, especially those with advanced stages of the disease.

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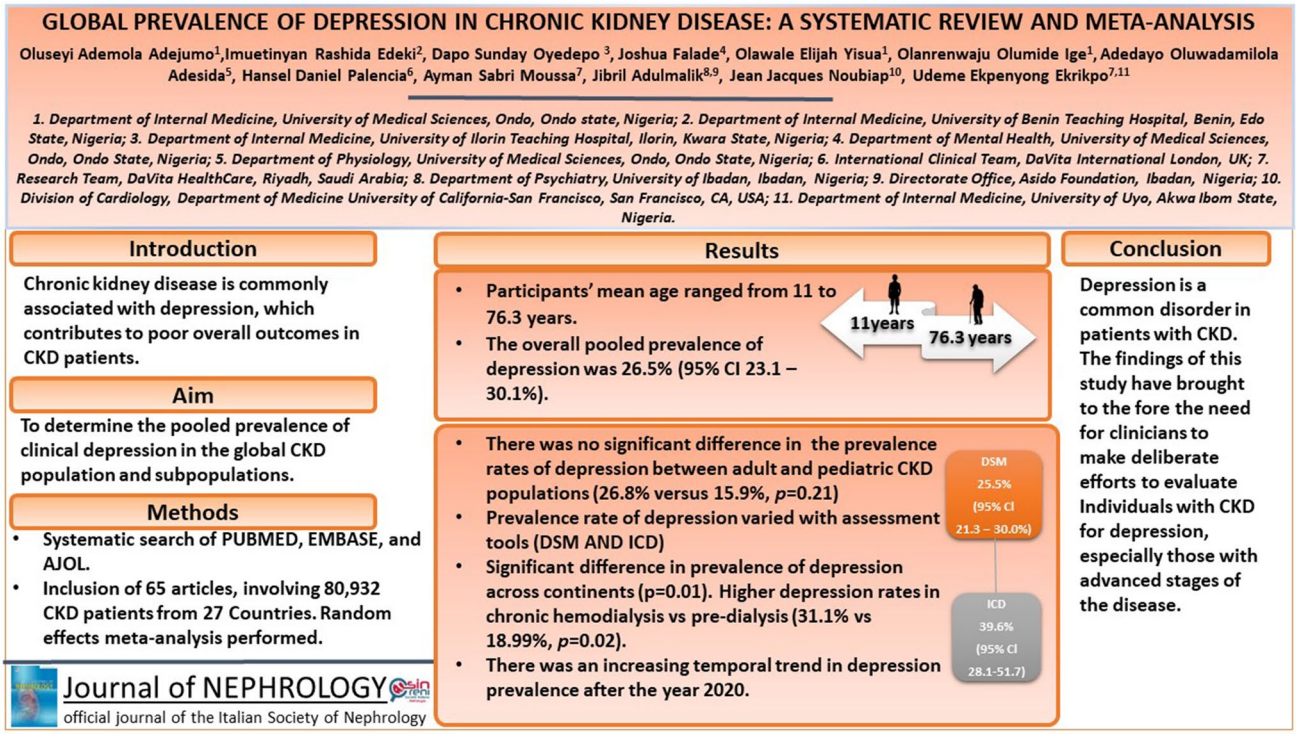
Graphical abstract



Keywords Depression · Chronic kidney disease · Systematic review · Meta-analysis

Introduction

Chronic kidney disease (CKD) is a common disease affecting about 700 million people globally [1]. It is a significant cause of mortality worldwide [2, 3]. The burden of CKD is higher in low- and middle-income countries than in high-income countries [3]. It causes a substantial economic, physical, and psychosocial burden for the patient [4, 5]. Psychosocial problems such as depression and anxiety are more commonly encountered in patients with CKD and their caregivers compared to the general population [6, 7]. These problems adversely affect the quality of life and contribute to deterioration in kidney function, progression to an advanced stage of disease, hospitalization, and mortality in individuals with CKD [8, 9]. Depression may contribute to poor adherence to medications, fluid, and dietary prescriptions of individuals with CKD [10, 11]. It also plays a pivotal role in the development of cardiovascular disease in CKD [12]. Psychosocial problems adversely affect the quality of life of individuals with CKD and contribute to overall poor outcomes of CKD [6, 13].

Despite the significant impact of psychosocial problems on the overall outcomes of CKD, they have not been given adequate priority in the management of individuals with CKD. Depression is not routinely screened for and managed in these patients, and mental health professionals were rarely mentioned in their multidisciplinary management [14]. Although there is inertia in the use of medications to manage psychosocial problems such as depression in CKD due to safety concerns by most clinicians, evidence supporting the safety of some medications and associated beneficial effects is now emerging [15]. In addition, non-pharmacological therapy, such as psychosocial interventions, has been established to improve the quality of life and reduce depression and anxiety in individuals with CKD [16]. Routine evaluation for common psychosocial problems, especially depression in this at-risk group, will aid in prompt diagnosis and allow those affected to be managed with consequent improvement in their overall outcomes.

This study, an update of an earlier review [17], assessed the prevalence of clinical depression in the global chronic kidney disease population. In addition, we reported the prevalence of depression in the pediatric CKD population and documented the geographic differences and temporal trends in depression prevalence in the CKD population. The findings of the study will provide helpful information on the burden of depression and also serve as empirical evidence

to include its routine evaluation and treatment in the management of CKD, especially in countries where this is not routinely done.

Methods

This systematic review and meta-analysis includes studies that document the prevalence of clinical depression among patients with CKD. The Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guideline [18] was used in reporting this study (Supplementary Table 1). This study was registered with PROSPERO with registration number CRD42022382708.

Literature search

A systematic literature search was done on published articles involving individuals with CKD who had clinically diagnosed depression. We performed a search on PubMed, African Journal Online, and Embase using terms related to depression in chronic kidney disease such as "chronic kidney disease", "CKD", "chronic renal failure", "CRF", "end-stage renal disease, "ESRD", "end-stage kidney failure", "ESKF", "dialysis-dependent chronic kidney disease", "renal failure", " non-dialysis dependent chronic kidney disease", "pre-dialysis chronic kidney disease", "chronic renal insufficiency", "dialysis population" "depression", "depressive symptom", mental health disorder ", psychiatric disorder' in conjunction with all the names of continents. The search strategy, created in April 2023, is detailed in Supplementary Tables 2A and 2B. There was no language limitation. A hand search of the reference list of articles of interest was also undertaken.

Study selection

Inclusion criteria were cross-sectional and prospective studies reporting on clinically diagnosed depression in adult and pediatric populations and pre-dialysis and dialysis populations across all the World Health Organization (WHO) regions. Exclusion criteria were studies that used screening tools to diagnose depression because it has been shown that the latter overestimate depression prevalence [19]; studies that involved kidney transplant patients; abstract papers on depression in CKD without full text; studies that determined clinical diagnosis of depression but did not clearly define the study population in terms of those on peritoneal dialysis (PD), hemodialysis (HD) or who had transplant; and randomized controlled trial studies on depression in CKD. Two investigators (OAA and OOI) independently screened records for eligibility based on titles and abstracts. Full texts of articles deemed potentially eligible were retrieved and screened by the same investigators (OAA and OOI) for final inclusion. All conflicts were resolved by a third investigator (OEY).

Data extraction and management

The following variables were extracted from selected studies: the last name of the first author, year of publication and country and continent in which the study was carried out, sample size of the study, duration of the study, study design, mean age of the study participants, stage of CKD, type of renal replacement therapy, the proportion of subjects with depression, clinical depression diagnostic criteria used [Diagnostic Statistical Manual for Mental Disorders III (DSM III), DSM IV, DSM V, International Classification of Disease-9 (ICD-9), ICD-10], and severity of depression. The data extraction form was developed with input from all the investigators, including Mental Health and Nephrology specialists. The data were extracted by two different investigators, and a third investigator resolved areas of conflict. We categorized study location based on the WHO regions [(African Region, AFR), (Region of the Americas, AMR), (South East Asian Region, SEAR), (European Region, EUR), (Eastern Mediterranean Region, EMR), and (Western Pacific Region, WPR)]. Studies were also categorized based on the year of publication of the study, severity of CKD and dialysis modality.

Methodological quality

The Joanna-Briggs Institute Critical Appraisal Checklist for Studies Reporting Prevalence Data was used to assess the methodological quality of the constituent studies [20]. Studies scored 1 for each of the nine questions with a "yes" response. Studies with scores 0–3 were regarded as poor quality, 4–6 as intermediate or medium quality, and 7–9 as high quality. Two different investigators did the quality assessment, and areas of disagreement were resolved by consensus.

Ethical consideration

Ethical approval was not required. The study protocol was registered with PROSPERO (CRD42022382708).

Statistical analysis

Stata 17.0 (Stata Corp., 2021. Stata Statistical Software: Release 17, College Station, TX) was used for statistical analysis. The pooled prevalence of depression in the global CKD population was determined using meta-analytic techniques. The study-specific estimates derived from the DerSimonian-Laird random effects model [21] were pooled to

estimate the prevalence of depression in this population. To minimize the effect of extreme values, the Freeman-Tukey double arcsine transformation [22] was used to stabilize the individual study variances before using the random effects model to obtain the pooled estimates. Publication bias was assessed using the Egger test [23]. We also undertook a subgroup analysis of pooled prevalence by continent, HD versus PD population, pre-dialysis versus dialysis CKD population, pediatric versus adult population with CKD, among studies that used different clinical diagnostic criteria such as DSM III, DSM IV, DSM V, ICD-9 and ICD-10 and among studies that fell into different range of years. Subgroup analysis was performed using the Q-test based on ANOVA. The I^2 statistic was used to determine the between-study heterogeneity.

Results

Study selection and characteristics

The systematic literature search identified 9240 articles, of which 137 were selected for full-text review after duplicate removal and title and abstract screening. Finally, 65 articles [24–88] were eligible and therefore included in this systematic review (Fig. 1), with publication years ranging from 1987 to 2023. Included studies reported on 80,932 CKD and kidney failure patients from 27 countries. There were 249 participants (3 studies) from the African Region [32, 60, 72]; 4,295 (14 studies) from the European Region [33, 35, 36, 38, 41, 45, 58, 63, 68, 70, 77, 80, 82, 84]; 4,160 (19 studies) from the Region of the Americas [24–28, 31, 34, 37, 40, 47, 55, 57, 64, 67, 69, 71, 79, 85, 87]; 679 (7 studies) from the Eastern Mediterranean Region [42, 51, 53, 62, 66, 76, 83]; 846 (7 studies) from the South East Asian Region [30, 49, 52, 61, 73, 75, 81], and 70,703 (15 studies) from the the Western Pacific Region [29, 39, 43, 45, 46, 48, 50, 54, 56, 59, 65, 74, 78, 86, 88]. Figure 2 shows the geographical distribution of the included studies.

The overwhelming majority of the studies (60 studies, 92.3%) used the DSM clinical diagnostic criteria or one of its derivatives, while five studies used the ICD criteria. The sample size of the component studies ranged from 20 [72] to 67,866 [39] patients, with the proportion of women ranging from 0% [27] to 68% [76]. The mean age of the participants ranged from 11.0 years [62] to 76.3 years [79]

Most of the studies had medium methodological quality (70.8%, $n=46$) (Table 1); 14 studies (21.5%) were of high quality, including three studies from the Americas [25, 27, 79], one study from the African region [32], two studies from the Western Pacific region [44, 77], three studies from the Eastern Mediterranean region [66, 76, 83], three from the European region [63, 77, 82] and two studies from South East Asia [73, 81]. Tables 1 and 2 summarize the data extracted from the constituent articles and the subpopulations studied. The majority (39, 60.0%) of the articles reported on severe or major depressive illness only; 5 (7.7%) reported on the whole spectrum of depression; 2 (3.1%) reported only on mild or moderate depression, while 15 (23.1%) did not state depression severity.

Prevalence of depression

The overall pooled prevalence of depression was [26.5% 95% CI 23.1–30.1%), $N=65$ studies, $I^2=97.2\%$, $p<0.001$ for heterogeneity] irrespective of the clinical depression diagnostic criteria used. Studies using DSM and ICD returned a pooled prevalence of [25.5% (21.3–30.0%), $n=60$ studies, $I^2=95.9\%$, $p<0.001$ for DSM] versus [39.6% (95% CI 28.1–51.7%), $n=5$ studies, $I^2=98.7\%$, $p<0.001$ for ICD], $p=0.03$ for difference between the different diagnostic criteria (Fig. 3). The p-value for the Egger test was 0.83, suggesting no small study effects.

The South East Asian Region had the highest pooled prevalence of 43.2% (32.2–54.5%, $I^2=90.2\%$, $p<0.001$, $n=7$ studies) compared to the Region of the Americas 19.9% (16.7–23.3%, $n=19$ studies, $I^2=82.2\%$, $p<0.001$), the Western Pacific Region 23.3% (18.8–28.1%, $n=15$ studies, $I^2=93.3\%$), the African Region 27.2% (14.2–42.5%, $n=3$ studies, $I^2=78.4\%$, $p=0.01$), and the European Region 25.7% (14.8–38.3%, $n=14$ studies, $I^2=97.5\%$, $p<0.001$); $p=0.01$ for difference across groups (Supplementary Fig. 1).

There was a significantly higher pooled prevalence of clinical depression among the patients on chronic HD compared to those in the pre-dialytic stages of CKD 29.9% (24.4–35.8%, $n=44$ studies, $I^2=95.6\%$, $p<0.001$) versus 18.5% (12.9–24.9%, $n=10$ studies, $I^2=93.1\%$, $p<0.001$); $p=0.01$ for difference across the groups (Supplementary Fig. 2).

There was no significant difference in the pooled prevalence among adults compared with children (26.8% vs 15.9%; $p=0.21$), Supplementary Fig. 3. There was a higher prevalence of depression among the HD than the PD population, 30.6% (25.0–36.6%, $n=43$ studies, $I^2=95.5\%$, $p<0.001$) versus 20.4% (13.1–28.7%, $n=3$ studies, $I^2=41.7\%$, $p=0.18$); $p=0.047$ for difference between the groups, Supplementary Fig. 4. There appeared to be an increasing temporal trend in depression prevalence. However, this increase did not achieve statistical significance ($p=0.16$, Supplementary Figs. 5 and 6). The pooled prevalence for the studies published in 2000 and prior was 17.7% (8.9–28.6%) compared to 26.5% (22.2–31.1%) for those published between the years 2001 and 2020 and 34.4% (20.7–49.5%) for those published after 2020. This trend persisted when considering all studies irrespective of the diagnostic criteria used (Supplementary Fig. 5) or when only the DSM criteria were used (Supplementary Fig. 6).

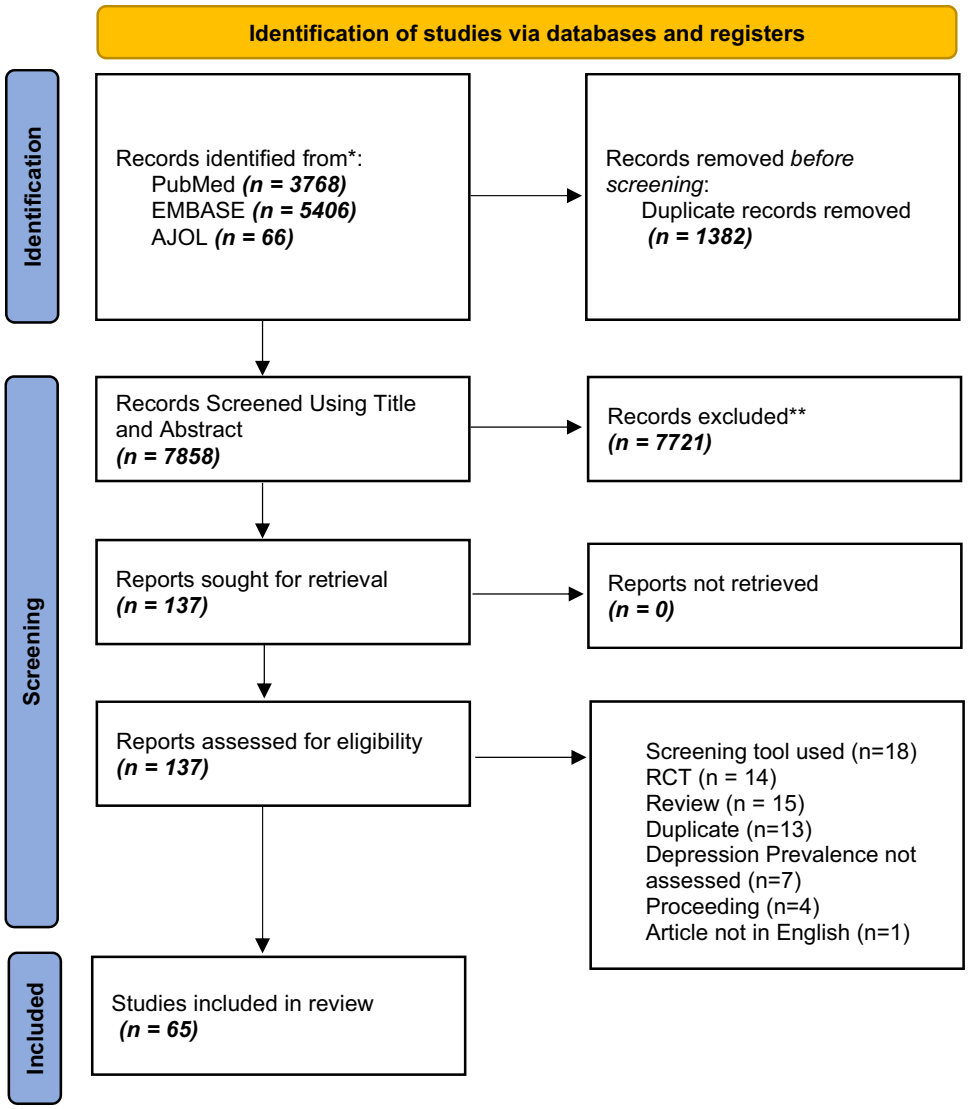


Fig. 1 PRISMA flow diagram—Identification and Screening of Articles

Discussion

This systematic review and meta-analysis determined the pooled prevalence of clinical depression among 80,932 individuals with CKD from 27 countries spread across the globe. The pooled prevalence of clinical depression was 26.5%. The prevalence varied with the CKD population's geographical location, CKD stage, age group of the individuals with CKD, and dialysis modality (HD versus PD).

The pooled prevalence of depression in the CKD population in this study is higher than the prevalence of 8.4% and 6.9% reported in the general adult population in the United States and Norway, respectively [89, 90]. Similarly, the prevalence of depression in the pediatric population with CKD is higher than the 3.2% reported in the general pediatric population in the United States [91]. These findings showed that depression is a common mental health problem in the CKD population compared to the general population. The prevalence of depression in this study is higher than 21.9% and 16.3% reported among individuals with epilepsy and cancer, respectively [92, 93], suggesting that the magnitude of depression in CKD is higher than in some other chronic illnesses.

The pooled prevalence of depression in this study is higher than 21.4% and 22.8% reported in individuals with CKD who were in pre-dialysis and dialytic stages, respectively, in a systematic review and meta-analysis by Palmer et al.[17] conducted a decade ago. It is, however, lower than 62% reported in a systematic review and meta-analysis involving a population with CKD in Iran [94]. The wide difference in the prevalence rates may be due to the method of assessment of depression and the stage of individuals with CKD that were studied. While the diagnosis of depression was made in the present study using

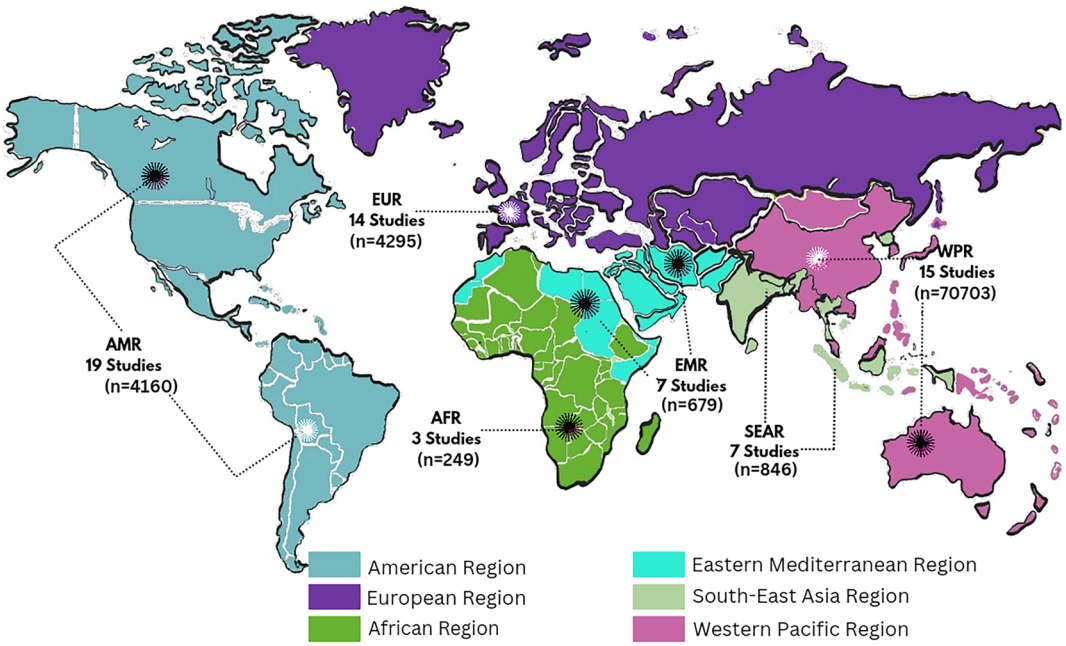


Fig. 2 Geographical distribution of included studies

standard clinical diagnostic criteria, the study in Iran used a validated depression screening tool for the diagnosis of depression. The Iranian study also involved only patients on maintenance HD, while the present study included individuals with CKD who were both in the pre-dialysis and dialysis stages.

There was no significant difference between the pooled prevalence of depression in the adult and pediatric population. However, this finding should be interpreted with caution as only two studies involving the pediatric population were included in this analysis. In addition, the prevalence of depression from these studies could have been underestimated as depression may have been unrecognized in children who are largely unable to express themselves [95] adequately. Also, the presentation of depression in children may not follow the typically known presentation as commonly seen in the adult population [95]. This underscores the need for physicians to consider these peculiarities in managing the pediatric CKD population.

The pooled prevalence of clinical depression across the various continents ranges between 19.9 and 43.2%, with the South East Asian Region having the highest while the Region of the Americas had the lowest. The African Region had the second-highest pooled prevalence of depression (27.2%). There was a significant difference in the pooled prevalence of depression in CKD across the various continents. The difference in the severity of CKD, age and socioeconomic status of individuals with CKD, available psychosocial support, governmental support, type of available health care financing, level of health care sophistication, type of maintenance HD and race may be partly responsible for the significant variations in prevalence of depression across the continents. The African continent had the lowest number of studies, while the Region of the Americas had the highest number of studies. This underscores the need for more studies on depression in the African continent in order to ascertain the magnitude of the problem in the region.

Among the studies included in this review, DSM diagnostic criteria were more commonly used for the diagnosis of clinical depression. This may be due to the fact that DSM has a better application in research settings than ICD [96]. Although the DSM was primarily designed for use by psychiatrists in the United States, unlike ICD, which is a global disease classification designed for use by all health practitioners, especially in low and middle-income countries, its use has been reported in many other countries [96]. The pooled prevalence of depression in the studies that used ICD criteria was 39.6%, which was significantly higher than 25.5% in the studies that used DSM criteria. This finding is similar to the report of Wittchen et al. [97], which showed a higher depression prevalence of 11.3% with ICD-10 when compared with 4.2% using DSM 4 in the same population. This finding may be because ICD has greater sensitivity in the diagnosis of mild depression than DSM [98].

There was a significantly higher pooled prevalence of depression among individuals with end-stage kidney disease (ESKD) on HD compared to those in the pre-dialysis stage

Table 1 Summary of Extracted Data from Included Articles

Surname of First Author	Publication Year	Country of Publication	Continent of Publication	WHO Region	Study Type	Total CKD Population	Female (%)	Number with depression	Mean age (years)	Number of Predialysis Individuals with CKD	Number of HD patients	Number of PD patients	Diagnostic Criteria	Number of Stage 5D Individuals with CKD with depression	Depression severity	Number with Major Depression	Number with Minor Depression	JBI Score
Hedayati	2006	United States	North America	AMR	Prospective	98	44.9	26	57.2	NA	98	NA	SCID	26	NA	17	2	6
Hedayati	2009	United States	North America	AMR	Cross-Sectional	272	0.7	57	64.5	272	NA	NA	DSM 4	NA	Severe/ Major	57	5	8
Hedayati	2010	United States	North America	AMR	Prospective	267	0.8	56	64.4	267	NA	NA	MINI	NA	NA	NA	NA	7
Hedayati	2005	United States	North America	AMR	Retrospective	1588	0	233	61.9	NA	1588	NA	ICD 9	233	NA	NA	NA	8
Chan	2017	United States	North America	AMR	Retrospective	4,948,902	48.7	464,951	62.5	NA	4,948,902	NA	ICD 9	464,951	NA	NA	NA	8
Bautovich	2018	Australia	Australia	WPR	Cross-Sectional	45	42.2	6	NA	NA	45	NA	DSM 4	6	NA	NA	NA	6
Gupta	2018	India	Asia	SEAR	Cross-Sectional	84	19	37	54	35	49	NA	DSM 5	31	Severe/ Major	37	NA	5
Jose	2006	Brazil	South America	AMR	Cross-Sectional	244	41.4	29	NA	NA	244	NA	MINI	29	NA	21	NA	7
Adesokun	2020	Nigeria	Africa	AFR	Cross-Sectional	69	53.6	24	44.7	69	NA	NA	MINI	NA	NA	NA	NA	8
Corruble	2010	France	Europe	EUR	Prospective	390	40.4	15	46	390	NA	NA	MINI	NA	Severe/ Major	15	NA	6
Drayer	2006	United States	North America	AMR	Prospective	62	48.4	17	57.3	NA	62	NA	DSM 4	17	Mild/ Minor, Severe/ Major	6	11	7
Cilan	2013	Turkey	Europe	EUR	Prospective	40	45	10	41.88	NA	NA	40	SCID	10	NA	NA	NA	5
Cilan	2012	Turkey	Europe	EUR	Prospective	40	45	9	43.3	NA	40	NA	DSM 4	9	NA	NA	NA	6

Table 1 (continued)

Surname of First Author	Publication Year	Country of Publication	Continent of Publication	WHO Region	Study Type	Total CKD Population	Female (%)	Number with depression	Mean age (years)	Number of Predialysis Individuals with CKD	Number of HD patients	Number of PD patients	Diagnostic Criteria	Number of Stage 5D Individuals with CKD with depression	Depression severity	Number with Major Depression	Number with Minor Depression	JBI Score
Balogun	2011	United States	North America	AMR	Cross-Sectional	62	51.6	19	73.5	NA	62	NA	DSM 4	19	Severe/ Major	19	NA	7
Chilcot	2008	United Kingdom	Europe	EUR	Cross-Sectional	40	40	9	53.2	NA	40	NA	MINI	9	NA	NA	NA	6
Choi	2023	Korea, South	Asia	WPR	Prospective	67,866	45.4	17,023	67.8	NA	NA	NA	ICD 10	NA	NA	NA	NA	5
Loureiro	2018	Brazil	South America	AMR	Cross-Sectional	264	40.9	37	51.26	NA	264	NA	MINI	264	Severe/ Major	37	NA	6
Reckert	2013	Germany	Europe	EUR	Cross-Sectional	52	40.4	9	62.1	NA	52	NA	SCID	8	Severe/ Major	8	NA	6
Al Zaben	2014	Saudi Arabia	Asia	EMR	Cross-Sectional	310	38.6	21	46.4	NA	309	1	SCID	310	Mild/ Minor, Severe/ Major	10	11	7
Zhu	2017	China	Asia	SEAR	Cross-Sectional	150	40	34	62.3	150	NA	NA	MINI	NA	Severe/ Major	34	NA	6
Fukunishi	2002	Japan	Asia	WPR	Prospective	508	42.7	50	65.7	NA	508	NA	DSM 4	50	Severe/ Major	50	NA	6
Soykan	2004	Turkey	Asia	EUR	Cross-Sectional	50	NA	14	NA	NA	50	NA	SCID	14	Mild/ Minor	NA	14	5
Yeh	2014	Taiwan	Asia	WPR	Cross-Sectional	195	52.8	47	58.5	NA	195	NA	MINI	47	Severe/ Major	47	NA	8
Martiny	2011	Brazil	South America	AMR	Cross-Sectional	69	45	16	50	NA	69	NA	MINI	16	Severe/ Major	16	NA	4
Koo	2005	South Korea	Asia	WPR	Prospective	62	43.6	34	48.84	NA	62	NA	DSM 4	34	Severe/ Major	34	NA	4

Table 1 (continued)

Surname of First Author	Publication Year	Country of Publication	Continent of Publication	WHO Region	Study Type	Total CKD Population	Female (%)	Number with depression	Mean age (years)	Number of Predialysis Individuals with CKD	Number of HD patients	Number of PD patients	Diagnostic Criteria	Number of Stage 5D Individuals with CKD with depression	Depression severity	Number with Major Depression	Number with Minor Depression	JBI Score
Saritha	2021	India	Asia	SEAR	Cross-Sectional	300	NA	153	47	NA	300	NA	ICD 10	153	Mild/Minor, Severe/Major	48	45	7
Dimaano	2021	Philippines	Asia	WPR	Cross-Sectional	55	43.6	8	59	NA	55	NA	SCID	8	Severe/Major	8	NA	7
Alsuwaida	2006	Saudi Arabia	Asia	EMR	Cross-Sectional	26	42	4	48.1	NA	26	NA	DSM 4	4	Severe/Major	4	NA	4
Chandra	2011	India	Asia	SEAR	Cross-Sectional	60	26.6	11	38.38	NA	60	NA	MINI	11	Severe/Major	11	NA	6
Donia	2015	Egypt	Africa	EMR	Cross-Sectional	76	28.9	58	43.2	NA	76	NA	SCID	58	Mild/Minor, Moderate, Severe/Major	25	18	7
Chen	2010	Taiwan	Asia	WPR	Cross-Sectional	200	53	47	58.6	NA	200	NA	MINI	47	Severe/Major	47	NA	7
Cukor	2008	United States	North America	AMR	Cross-Sectional	70	53	23	53.3	NA	70	NA	SCID	NA	Severe/Major	20	NA	6
Huang	2007	Taiwan	Asia	WPR	Cross-Sectional	107	54.21	15	53.3	NA	107	NA	SCID	15	Severe/Major	15	NA	6
Jain	2016	United States	North America	AMR	Prospective	266	0.8	56	64	266	NA	NA	MINI	NA	Severe/Major	56	NA	7
Baykan	2012	Turkey	Europe	EUR	Cross-Sectional	83	56.6	27	44.8	NA	42	41	SCID	27	NA	NA	NA	7
Chan	2011	China	Asia	SEAR	Cross-Sectional	141	42	22	57	NA	NA	141	SCID	22	Severe/Major	22	NA	7

Table 1 (continued)

Surname of First Author	Publication Year	Country of Publication	Continent of Publication	WHO Region	Study Type	Total CKD Population	Female (%)	Number with depression	Mean age (years)	Number of Predialysis Individuals with CKD	Number of HD patients	Number of PD patients	Diagnostic Criteria	Number of Stage 5D Individuals with CKD with depression	Depression severity	Number with Major Depression	Number with Minor Depression	JBI Score
Azegbeobor	2015	Nigeria	Africa	AFR	Cross-Sectional	160	40	28	53.32	83	77	NA	MINI	NA	NA	NA	NA	7
Sumanathissa	2011	Sri Lanka	Asia	SEAR	Cross-Sectional	140	36.4	39	57.9	140	NA	NA	SCID	NA	Severe/Major	39	NA	7
Bakr	2007	Egypt	Africa	EMR	Cross-Sectional	38	36.8	4	11	19	19	NA	DSM 4	NA	Severe/Major	4	NA	5
Preljevic	2013	Norway	Europe	EUR	Cross-Sectional	109	30.3	24	57.8	NA	84	25	SCID	NA	Severe/Major	NA	NA	8
Cruz	2010	Brazil	South America	AMR	Cross-Sectional	70	37.1	25	53	NA	70	NA	MINI	NA	Severe/Major	25	NA	6
Koo	2003	Korea, South	Asia	WPR	Cross-Sectional	62	43.5	34	48.8	NA	62	NA	DSM 4	NA	Severe/Major	34	NA	6
El Filali	2017	Morocco	Africa	EMR	Cross-Sectional	103	45.6	35	49.7	NA	103	NA	MINI	NA	Severe/Major	35	NA	8
Watnick	2005	United States	North Ameria	AMR	Cross-Sectional	62	32	16	63	NA	59	3	SCID	NA	Severe/Major	12	NA	7
Kalender	2006	Turkey	Europe	EUR	Prospective	141	42.6	34	49.5	26	68	47	DSM 4	29	Severe/Major	5	NA	4
Hinrichsen	1989	United States	North Ameria	AMR	Cross-Sectional	124	43.5	30	53.5	NA	124	NA	DSM 3	NA	Severe/Major	8	22	7
Loosman	2010	Netherlands	Europe	EUR	Cross-Sectional	62	46.8	21	63.5	NA	51	11	MINI	NA	Severe/Major	21	NA	4
de Alencar	2019	Brazil	South America	AMR	Cross-Sectional	173	41.6	39	68.7	NA	173	NA	MINI	NA	Severe/Major	39	NA	6

Table 1 (continued)

Surname of First Author	Publication Year	Country of Publication	Continent of Publication	WHO Region	Study Type	Total CKD Population	Female (%)	Number with depression	Mean age (years)	Number of Predialysis Individuals with CKD	Number of HD patients	Number of PD patients	Diagnostic Criteria	Number of Stage 5D Individuals with CKD with depression	Depression severity	Number with Major Depression	Number with Minor Depression	JBI Score
Aghanwa	1997	Nigeria	Africa	AFR	Prospective	20	25	7	37.65	NA	20	NA	DSM 3	7	Severe/ Major	7	NA	5
Gadia	2020	India	Asia	SEAR	Cross-Sectional	100	30	66	42.22	NA	100	NA	ICD 10	66	Mild/ Minor	9	38	9
Choi	2012	Korea, South	Asia	WPR	Prospective	81	45.7	41	52.8	NA	81	NA	DSM 4	41	NA	NA	NA	7
Niharika	2021	India	Asia	SEAR	Cross-Sectional	62	40.3	28	52.4	46	16	NA	DSM 5	NA	Severe/ Major	10	18	6
Hamody	2013	Iraq	Asia	EMR	Cross-Sectional	75	68	60	47	NA	75	NA	DSM 4	60	Severe/ Major	25	25	9
Martens	2018	Netherlands	Europe	EUR	Cross-Sectional	3083	48.2	166	59.8	NA	NA	NA	MINI	NA	Mild/ Minor, Moderate, Severe/ Major	112	54	8
Wang	2014	Taiwan	Asia	WPR	Cross-Sectional	188	52.6	45	58.5	NA	188	NA	DSM 4	45	Severe/ Major	45	NA	9
Rodriguez-Angarita	2016	Colombia	South America	AMR	Cross-Sectional	251	33	20	76.3	251	NA	NA	MINI	NA	Severe/ Major	20	NA	9
Tuna	2021	Turkey	Europe	EUR	Cross-Sectional	56	41.1	22	50.1	NA	56	NA	DSM 4	22	Severe/ Major	22	NA	7
Agrawal	2019	Nepal	Asia	SEAR	Cross-Sectional	100	45.2	51	47.5	NA	100	NA	ICD 10	51	NA	16	15	9
Kokoszka	2016	Poland	Europe	EUR	Cross-Sectional	107	47.66	84	56.63	NA	107	NA	MINI	84	Severe/ Major	31	53	8

Table 1 (continued)

Surname of First Author	Publication Year	Country of Publication	Continent of Publication	WHO Region	Study Type	Total CKD Population	Female (%)	Number with depression	Mean age (years)	Number of Pre-dialysis Individuals with CKD	Number of HD patients	Number of PD patients	Diagnostic Criteria	Number of Stage 5D Individuals with CKD with depression	Depression severity	Number with Major Depression	Number with Minor Depression	JBI Score
Macaron	2014	Lebanon	Asia	EMR	Cross-Sectional	51	40	25	64	NA	51	NA	MINI	25	Severe/Major	NA	NA	8
Kalendar	2007	Turkey	Europe	EUR	Cross-Sectional	42	39.2	11	50.9	NA	NA	42	SCID	11	NA	NA	NA	7
Berney-Martinet	2018	Canada	North America	AMR	Cross-Sectional	20	45	5	14.4	20	NA	NA	DSM 4	NA	Major	5	0	7

CKD Chronic Kidney Disease, *DSM* Diagnostic and Statistical Manual of Mental Disorders 4, *ICD* International Classification of Disease, *SCID* structured clinical interview for DSM disorder, *MINI* Mini-International Neuropsychiatric Interview, *JBI* Joanna Briggs Institute, *AMR* America, *AFR* African Region, *AMR* Region of the Americas, *SEAR* South East Asian Region, *EUR* European Region, *EMR* Eastern Mediterranean Region, *WPR* Western Pacific Region

(29.9% versus 18.5%) in this study. The demands of dialysis treatment on patients with ESKD may partly account for this significant difference. Other factors, such as dietary restriction, inflammation, hormonal changes, poor sleep quality, and reduced quality of life associated with dialysis treatment, may also contribute to a higher frequency of depression in patients on HD compared to individuals with pre-dialysis CKD [15, 99]. A qualitative study by Avdal et al. [100] reported that patients with ESKD experienced despair and decreased social support from relatives and caregivers after the commencement of PD or HD. This may effectively contribute to a higher prevalence of depression in them compared to individuals with pre-dialysis CKD. This study also showed that about one in five individuals with pre-dialysis CKD had depression. This underscores the need to screen individuals with CKD, even in the early stages, for depression so that prompt treatment can be instituted. This may consequently improve their overall outcomes.

The pooled prevalence of depression was significantly higher in individuals with ESKD on maintenance HD compared with those on PD (30.6% versus 20.4%) in this study. There are conflicting reports from existing literature on the relationship between depression and mode of dialysis. The finding of this study is, however, supported by Martin et al. [101] but differs from some previous reports that showed a significantly higher prevalence of depression in PD patients compared to those on HD [102, 103]. Although some other studies reported a higher prevalence of depression in HD patients compared with PD patients, the difference was not statistically significant [104, 105].

There was an increasing temporal trend in depression prevalence after the year 2020 (34.4%) compared to 2001–2020 (26.5%) and before 2000 (17.7%). This may be a reflection of the increase in the level of awareness of mental health problems globally with improvement in campaigns geared towards sensitization of the global community. This is supported by a review by Foulke et al. [106], where it was reported that there has been increased recognition and diagnosis of mental health disorders over the years.

The use of clinical methods of assessment of depression is more specific than the use of validated screening tools in the CKD population. Depression screening tools have been reported to over-diagnose depression in individuals with CKD, especially those at advanced stages [17]. The study by Palmer et al. [17] is instructive in this regard, as it showed that the prevalence of depression was higher in the CKD population when depression screening tools were used compared to when clinical diagnostic criteria were deployed. This was also buttressed by Smith et al. [107] in their study, which showed prevalence rates of depression in the same individuals on maintenance HD as 47% and 5% using Beck's depression index and DSM III, respectively. Also, in cases where depression screening tools are being used in the

Table 2 Summary of sub-population characteristics and pooled prevalence

Sub-population	Number of studies	Population size	Pooled prevalence (95% CI)
Diagnostic criteria			
ICD	5	69,954	39.6 (28.1–51.7)
DSM	60	10,978	23.3 (16.5–30.8)
WHO region			
AFR	3	249	27.2 (14.2–42.5)
AMR	19	4160	19.9 (16.7–23.3)
SEAR	7	846	43.2 (32.2–54.5)
WPR	15	70,703	23.3 (18.8–28.1)
EUR	14	4295	25.7 (14.8–38.3)
EMR	7	679	37.1 (12.7–65.6)
Age group			
Adult	63	80,874	26.8 (23.3–30.4)
Pediatric	2	58	15.9 (4.2–32.3)
CKD Stage & modality			
Pre-dialysis population	14	2,034	18.5 (12.9–24.9)
Dialytic individuals	44	6407	29.9 (24.4–35.8)
HD population*	43	6125	30.6 (25.0–36.6)
PD population*	3	223	20.4 (13.1–28.7)
Temporal Divisions			
2000 and Prior	4	342	17.7 (8.9–28.6)
2001–2020	58	12,251	25.7 (21.2–30.5)
Beyond 2020	3	68,339	32.2 (14.8–52.4)

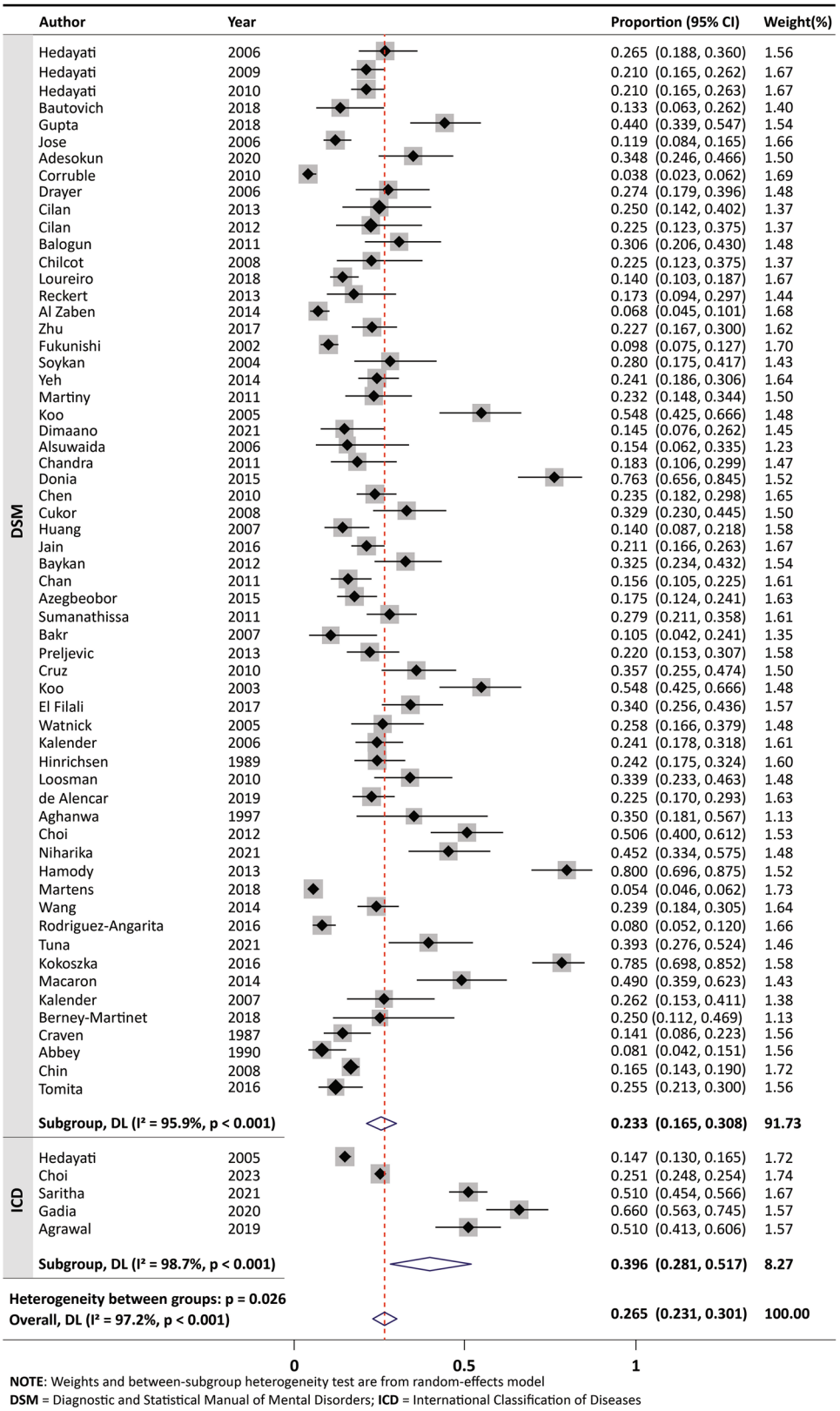
*Excludes articles whose prevalence estimates combined PD and HD populations instead of reporting separately for each population

HD hemodialysis, *PD* peritoneal dialysis, *ICD* International Classification of Disease, *DSM* Diagnostic and Statistical Manual of Mental Disorders, *WHO* World Health Organization, *AFR* African Region, *AMR* Americas, *SEAR* South East Asia Region, *WPR* Western Pacific Region, *EUR* European Region, *EMR* Eastern Mediterranean Region, *CKD* Chronic Kidney Disease

assessment of depression, individuals with advanced CKD may have some uremic symptoms such as poor sleep, anorexia, fatigue, and lack of concentration, which may overlap and be regarded as somatic symptoms of depression [15, 99]. Another limitation of the use of depression screening tools lies in the fact that a higher score is commonly used as a cut-off in advanced CKD compared to the general population [15, 99]. These cut-off values may vary in different studies using the same screening tool, introducing major inconsistencies.

Depression has a significant adverse impact on the overall outcomes of CKD. Hence, it deserves adequate attention by being promptly diagnosed and managed by the clinician. Depression is associated with poor compliance with treatment follow-up, increased suicidal tendency, withdrawal from dialysis, non-adherence to medications, dietary and fluid restrictions and malnutrition-inflammatory-atherosclerosis [10, 11, 108–110]. These may account for the increased hospitalization and disease progression, reduced quality of life, and increased mortality in individuals with CKD who have depression [6, 8, 9, 13, 111–113]. Prompt diagnosis and management of depression may mitigate these adverse consequences and improve the overall outcome of these patients.

There is clinician inertia in treating depression in CKD with antidepressants because of uncertainty about the pharmacokinetic properties of the medications and safety profile in people with reduced kidney function. This is supported by a report that showed that only about one-third of individuals with CKD diagnosed with depression received treatment [114]. Furthermore, most randomized controlled trials on the efficacy and safety of antidepressants exclude individuals with CKD. Despite the above, there is evidence, though limited, to support the effectiveness of antidepressants in reducing depression and improving QoL in individuals with CKD [115]. This present systematic review showed that clinical depression is common in CKD and lends credence to the need for the inclusion of the CKD population in clinical trials on the efficacy of antidepressant treatment. Management of depression also involves non-pharmacological treatments. There are reports of some randomized controlled trials that showed the efficacy of non-pharmacological treatment of depression, such as cognitive-based therapy and relaxation



NOTE: Weights and between-subgroup heterogeneity test are from random-effects model
DSM = Diagnostic and Statistical Manual of Mental Disorders; **ICD** = International Classification of Diseases

Fig. 3 Pooled prevalence of depression in the CKD population by diagnostic criteria

techniques, in the treatment of depression in CKD [16, 116–118]. A multidisciplinary team-based approach that includes mental health professionals will, therefore, be highly valuable in the management of individuals with CKD with depression.

A limitation of this study is that only a few studies in this review determined the prevalence of depression in the early stages of CKD. Secondly, there was limited information on the prevalence of clinically diagnosed depression in the pediatric population, being reported in only two studies. The strength of this systematic review lies in the fact that the pooled prevalence of depression found in the CKD population is a fairly true representation of the magnitude of the disease. This is particularly true because the study included only articles that used clinical interviews, which are more specific than screening tools.

Conclusion

This systematic review and meta-analysis showed that depression is a relatively common mental health disorder in the CKD population. It has brought to the fore the need for clinicians to make deliberate efforts to evaluate individuals with CKD, especially those with advanced stages of the disease for depression. The findings of this review have also given credence to the call to include the CKD population in large, randomized controlled trials on the safety and efficacy of antidepressants because they are potential beneficiaries of the findings of such studies.

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Declarations

Conflict of interest The authors have no conflicts of interest to declare.

Ethical approval Ethical approval was not required since no new patients were recruited. The study was a meta-analysis based exclusively on already published data.

Research involving human participants and/or animals Not applicable. The present study is a literature-based meta-analysis.

Informed consent Not applicable. No new participants were recruited.

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